THE RELATIONSHIP OF TEACHER PERCEPTIONS OF THE IMPACT OF TECHNOLOGY INTEGRATION ON TEXAS ASSESSMENT OF KNOWLEDGE AND SKILLS (TAKS) SCORES OF 9th-11th GRADE STUDENTS AT ALAMO HEIGHTS INDEPENDENT SCHOOL DISTRICT, SAN ANTONIO, TEXAS

A Record of Study

by

FRANK EDUARDO ALFARO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

May 2008

Major Subject: Educational Administration

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Approved by:

Co-Chairs of Committee,	Virginia Collier
	John R. Hoyle
Committee Members,	Alvin Larke, Jr.
	Mario Torres
Head of Department,	Jim Scheurich

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ABSTRACT

The Relationship of Teacher Perceptions of the Impact of Technology Integration on Texas Assessment of Knowledge and Skills (TAKS) Scores of 9th-11th Grade Students at Alamo Heights Independent School District, San Antonio, Texas. (May 2008)

Frank Eduardo Alfaro, B.A., Trinity University; M.A., The University of Texas at San Antonio

Co-Chairs of Advisory Committee: Dr. Virginia Collier
Dr. John Hoyle

This study examines Levels of Technology Implementation (LoTi) teacher self-ratings and Texas Assessment of Knowledge and Skills (TAKS) scores. The LoTi instrument is explained comprehensively in the study. Using a series of survey questions about classroom instruction and technology use, the instrument measures a teacher's level of technology implementation in terms of that teacher's perception of classroom practices. The study assesses the relationship between LoTi ratings and TAKS scores of 9th, 10th, and 11th grade students as reported in student records at Alamo Heights Independent School District, San Antonio, Texas. The study determined the degree to which teacher LoTi ratings were a predictor of success on TAKS exam scores as reported in student records at Alamo Heights Independent School District, San Antonio, Texas. In addition, the study ascertained the existence of differences among the variable of student economic status.

For the purposes of this study, school and student performance analysis included only Alamo Heights High School in the Alamo Heights Independent School District (AHISD). The student data in the study came from approximately 359 9th graders, 372 10th graders, and 309 11th graders (1040 total students). A total of 11 English teachers, 14 math teachers, 9 science teachers, and 10 social studies teachers (44 total teachers) from this campus made up the population under study.

The research findings of this study included:

1. A positive relationship exists between the level of technology implementation in the classroom and student performance on the TAKS test in math, English Language Arts/Reading, science, and social studies.
2. Further, the findings showed that this relationship impacts economically disadvantaged students the most in English Language Arts/Reading and math.

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CHAPTER I

INTRODUCTION

In 1983, the National Commission on Excellence in Education published *A Nation at Risk*. The report argued for the need to reform public education or risk losing our nation's dominance in business and the global economy (Barlow & Robertson, 1994; Bracey, 2003; National Commission on Excellence in Education, 1983). Just weeks after *A Nation at Risk* was published, *Time* magazine selected the personal computer as its "Man of the Year" (Friedrich, 1983). Since the time of those two simultaneous instances, information and communications technology (ICT) has became linked to school reform (Robertson, 2003a), such as in *A Nation at Risk*'s call for every student to acquire computer literacy, insisting that unless computer programming became one of the new basics taught, the nation would fall prey to the Asian tigers in the global economy. By the mid-1990s, an ideological leavening had occurred in which computer technology was accepted as an integral part of good schooling (Noble, 1996). In the United States and abroad, billions of dollars in funding have been allocated and spent on ICT for schools. In 2003 alone, over $6 billion was spent on educational technology in U.S. schools (Anderson & Dexter, 2005).

With the ostensible goal of higher student achievement, the technology outcomes for these expenditures have been categorized by some researchers in terms of

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The style for this record of study follows that of the *Human Resource Development Quarterly*.

net use, technology integration, and student tool use (Anderson & Dexter, 2005). “Net use” refers to the extent to which teachers and others in the school use e-mail and the Internet for a variety of different purposes. “Technology integration” measures the degree of integration of technology into the curriculum and into teaching practices. “Student tool use” measures the extent to which students used computers to do academic work, including writing; simulations in science and social studies, spreadsheets and databases; and looking up information on CD-ROMS, the Internet, or other computer-based resources (Anderson & Dexter, 2005). For the purposes of this study, technology integration is the technology outcome most closely associated with student achievement because it, more than the other two, relates to pedagogical practices in the process of student learning in the classroom (Brockmeier, Sermon, & Hope, 2005).

Research on instructional practices that positively impact student achievement is wide and varied (Marzano, Pickering, & Pollock, 2001). In the literature, information and communications technology (ICT) is often linked to constructivism, a learning approach in which classrooms are student-centered, active places where informed decision-making takes place using higher-order thinking, as opposed to a traditional learning approach, which is teacher-centered, passive, and devoted to factual, knowledge-based learning (International Society for Technology in Education [ISTE], 2007; Robertson, 2003a). As such, many stakeholders believe that computer technology could transform education by making teaching and learning more effective and efficient, thereby increasing student achievement. Technology, they argue, can provide new instructional options for students, transforming curricular and instructional processes into active engagement in learning (Brockmeier, Sermon, & Hope 2005). In fact, the appropriate use of technology in classroom instruction has been shown to have a positive impact on student engagement in learning and on students at risk of dropping out of school (Day, 2002; Shelly, 2002).

A teacher's use of technology as an appropriate tool for instruction depends not only on expertise of educational technology and content information, but also a working knowledge of pedagogy and best practice processes during the integration of technology into classroom instruction (Margerum-Leys & Marx, 2004). Technology use in the classroom can be seen in different stages. Teachers first learn basic technology skills, then they find value in technology as an instructional tool, and, finally, teachers reconfigure the structure and goals of lessons. The development of these lessons takes shape in different ways, but one point remains. When teachers use technology integration as an effective tool for learning, they must constantly consider existing teaching practices and modify classroom learning to increase effectiveness (Otero & Peressini, 2005). The effective use of technology to teach higher-order thinking can be linked to higher levels of student achievement and can positively impact students who are at risk of failing (Dunkel, 1990; Merino, Legarreta, Coughran, & Hoskins, 1990; Wenglinsky, 1998). Further, research supports that the specific way computers are used in the classroom is of the greatest importance when considering student achievement gains (Warschauer, Knobel, & Stone, 2004; Wenglinsky, 1998).

Since the mid-1990s, the public focus on student achievement has come to settle on the achievement gap between the rich and the poor. Equal access to computer technology, likewise, became a priority for school funding in low income areas (Robertson 2003b), and “savage inequalities” known as a “digital divide” when the term applied to the technology gap between rich and poor school children (Chen & Price, 2006; Warschauer, Knobel, & Stone, 2004). The literature has demonstrated that this digital divide applies not only to access to computer technology, but the divide extends past mere access to the *appropriate* use of that computer technology integrated as a tool for classroom instruction. *Appropriate use* of computers, in terms of classroom instruction, is commonly referred to in the research as computer use that is constructivist in its approach and technology integration that requires students to engage in higher-order thinking skills (Margerum-Leys & Marx, 2004; Wenglinsky, 1998).

Statement of the Problem

The literature distinguishes between the appropriate use of technology integration as an instructional tool and the mere use of technology in classrooms (Chen & Price, 2006; Margerum-Leys & Marx, 2004; Warschauer, Knobel, & Stone, 2004; Wenglinsky, 1998). To be sure, some have argued that there is a paucity of research linking computer access and use to higher student achievement (Cuban, 2001; Whitehead, Jensen, & Boschee, 2003). Others, however, focus research on *the way* technology is used to impact student achievement, as opposed to research on mere use (Chen & Price, 2006; Margerum-Leys & Marx, 2004; Warschauer, Knobel, & Stone, 2004; Wenglinsky, 1998). This record of study contributes to the research on the impact of technology integration on student achievement. The research that has been done to date focused on elementary grades in states other than Texas, specifically New Hampshire and Louisiana. A quasi-experimental study addressed high school student achievement in high school social studies in Georgia. Thus, not only is there a dearth of research that explores the link between technology integration and student achievement, but a gap exists in research dealing directly with teacher integration and student achievement in high school. This study addresses the impact of technology integration on high school student achievement in math and reading in Texas and partially addresses the gap in the literature by using the Levels of Technology Implementation (LoTi) framework developed by Dr. Chris Moersch. Additionally, the data inform teachers themselves regarding their own professional development, technology integration, and the academic achievement of their students.

Just as the research distinguishes between levels of appropriate use and integration of technology, it also documents the obstacles to the effective integration of technology that impacts student achievement. To sustain the change in instructional practice where technology transforms the learning environment for students, research cites numerous support systems that must be in place for teachers including collaborative learning and discourse, a strong and commonly understood purpose, and a clear vision from the principal for a transformational learning community on behalf of the principal (Anderson & Dexter, 2005; Brockmeier, Sermon, & Hope, 2005; Margerum-Leys & Marx, 2004; Otero & Peressini, 2005). Similarly, research indicates that schools with high numbers of students of low socioeconomic status tended to have low levels of leadership for technology outcomes such as integration, adversely influencing the digital divide mentioned above (Anderson & Dexter, 2005). This study addresses the problem of informing campus leadership about effective technology integration and its impact on student achievement. This study provides additional information to school administrators to use when budgeting time, money, and personnel in ways that will maximize their impact on student achievement.

Purpose of the Study

The purpose of this study was to examine Levels of Technology Implementation (LoTi) teacher self-ratings and Texas Assessment of Knowledge and Skills (TAKS) scores. The study assesses the relationship between LoTi ratings and TAKS scores of 9th, 10th, and 11th grade students as reported in student records at Alamo Heights Independent School District, San Antonio, Texas. The study determined the degree to which there was a correlation between teacher LoTi ratings and student TAKS exam scores as reported in student records at Alamo Heights Independent School District (ISD), San Antonio, Texas. In addition, the study ascertained the existence of differences in student performance in the variable of economic status as reported in student records at Alamo Heights Independent School District, San Antonio, Texas.

Research Questions

This study was guided by the following research questions:

1. Is there a relationship between teacher LoTi ratings and student TAKS scores as reported in student records at Alamo Heights High School, San Antonio, Texas?

2. Does a relationship between teacher LoTi ratings and student TAKS scores differ according to students' economically disadvantaged status as reported in student records at Alamo Heights Independent School District, San Antonio, Texas?

Operational Definitions

The findings of this study are to be reviewed within the context of the following definitions of operational terminology:

Academic Excellence Indicator System (AEIS): This statewide system database compiles specific information regarding the broad operations and achievements of all Texas state independent school districts and their respective public campuses. The AEIS database includes quantitative reporting on student performance from the Texas Assessment of Knowledge and Skills (TAKS) and information from the Public Education Information Management System (PEIMS).

Demographic Variables: Ethnicity, gender, and economically disadvantaged status are demographic variables.

Economically Disadvantaged: A student can be identified as economically disadvantaged by an independent school district if they are eligible for free or reduced-price lunch, meet requirements for Title II of the Job Training Partnership Act (JPTA), receive food stamp benefits, or qualify for other public assistance. In addition, if the student is under the parental or custodial care of a family with an annual income at or below the official federal poverty line regardless of public assistance, they, too, can be identified as economically disadvantaged.

Higher-Order Thinking: Higher-order thinking refers to the four top levels of Bloom's taxonomy of thought: knowledge, comprehension, application, analysis, synthesis, and evaluation. The categories of application through evaluation are operationally defined as high-order thinking.

Integrated/Integration: Integrated/integration is use of technology by students and teachers to enhance teaching and learning and to support curricular objectives.

Levels of Technology Implementation (LoTi): This term refers to a framework designed to measure classroom technology use. The framework focuses on the use of technology as a tool within the context of student based instruction with an emphasis on higher-order thinking. Three scores are gleaned from teacher responses to questions designed to measure Current Instructional Practice (CIP), Personal Computer Use (PCU), and Levels of Technology Implementation (LoTi). A CIP score reports, on a scale from 0-7, what methods the teacher uses to deliver instruction. How involved are the students in the classroom decision-making process? Do students help determine the problem being studied or have input in the final product that is produced? A PCU score reports, on a scale of 0-7, how comfortable teachers are in using the technology tools involved in technology integration. A LoTi score reports, on a scale of 0-6, the degree to which the respondent supports and implements instructional uses of technology in a classroom setting.

Public Education Information Management System (PEIMS): PEIMS is a statewide data management system for public education information in the state of Texas. For the purposes of this study, the major categories reported by the PEIMS report include student demographic and program participation data.

Relationship: Relationship is a connection between a dependent and an independent variable as determined by a given statistical test.

Technology: Examples of technology are computer workstations, laptop computers, wireless computers, handheld computers, digital cameras, probes, scanners, digital video cameras, analog video cameras, televisions, telephones, VCRs, digital projectors, programmable calculators, interactive white boards.

Texas Assessment of Knowledge and Skills (TAKS): The TAKS measures student mastery of the Texas Essential Knowledge and Skills (TEKS), the statewide curriculum, in reading at Grades 3-9; in writing at Grades 4 and 7; in English Language Arts at Grades 10 and 11; in mathematics at Grades 3-11; in science at Grades 5, 10, and 11; and social studies at Grades 8, 10, and 11. The Spanish TAKS is administered at Grades 3 through 6. Satisfactory performance on the TAKS at Grade 11 is prerequisite to a high school diploma.

Texas Education Agency (TEA): The TEA is comprised of the commissioner of education and agency staff. The TEA and the State Board of Education (SBOE) guide and monitor activities and programs related to public education in Texas. The SBOE consists of 15 elected members representing different regions. One member is appointed chair by the governor. Under the leadership of the commissioner of education, the TEA administers the statewide assessment program, maintains a data collection system on public schools for a variety of purposes, and operates research and information programs among numerous other duties. The TEA operational costs are supported by both state and federal funds.

Assumptions

1. The administration of the LoTi survey by Alamo Heights High School was administered according to recommended guidelines for administration of the survey.
2. The responses of teachers were true reflections of their use of technology.
3. The methodology offered a logical and appropriate design for this particular research project.

Limitations

1. The study was limited to a select number of teachers and students at Alamo Heights High School in San Antonio, Texas.
2. The study was limited to the information acquired from the literature reviews, achievement data on TAKS, and the teacher LoTi survey instrument.
3. Findings were generalized only to one school district, Alamo Heights Independent School District, San Antonio, Texas.

Significance Statement

There is a dearth of research on the impact of technology integration on student achievement. Still, school districts in Texas allot resources for technology integration into the classroom in terms of time, money, and personnel. This study assesses whether there is a relationship between the level of technology integration, as measured by LoTi ratings and student TAKS test scores. Such data provide additional information to school administrators to use when budgeting time, money, and personnel in ways that will maximize their impact on student achievement. Additionally, the data also inform teachers themselves regarding their own professional development, technology integration, and the academic achievement of their students.

Organization of the Record of Study

The record of study is divided into five major units or chapters. Chapter I contains the introduction, a statement of the problem, a purpose for the study, research questions, operational definitions, assumptions, limitations, and significance statement. Chapter II contains a review of the literature. Chapter III contains the methodology and procedures of the record of study. Chapter IV contains the results for each of the research questions. Chapter V contains the researcher’s findings, conclusions, and recommendations for further study.

CHAPTER II

REVIEW OF THE LITERATURE

Preface

This review of the literature covers five areas. The first section establishes the historical context and development of the use of computer technology in education. That historical context informs educators and educational administrators regarding lessons learned that may guide current decision-making and the need for research in this field. The second section defines categories of technology outcomes and informs educators and educational administrators of the various ways researchers have measured the use of computer technology in education. It also establishes the parameters for how the record of study at hand examines technology outcomes in terms of student achievement. The third section provides an analysis of computer use in terms of the educational philosophy and pedagogical practices underlying previous research. The fourth section contrasts the mere use with the appropriate use of computer technology in education, a distinction made in the literature. The distinction will enlighten decision-making about which technology use impacts student achievement the most. The fifth section explores the nature of technology use as it impacts students from poverty in particular and informs educators and administrators about what the research reveals in terms of impacting the student performance of this subgroup of students.

The Historical Context

In 1983, the National Commission on Excellence in Education published *A Nation at Risk*. The report argued for the need to reform public education or risk losing our nation's dominance in business and the global economy (Barlow & Robertson, 1994; Bracey, 2003; National Commission on Excellence in Education, 1983). Just weeks after *A Nation at Risk* was published, *Time* magazine selected the personal computer as its "Man of the Year" (Friedrich, 1983). Since the time of those two concurrent instances, information and communications technology (ICT) has become linked to school reform (Robertson, 2003a), such as in *A Nation at Risk*'s call for every student to acquire computer literacy, insisting that unless computer programming became one of the new basics taught, the nation would fall prey to the Asian tigers in the global economy.

To be sure, the nature of the "education crisis" identified by *A Nation at Risk* has not been universally accepted by researchers in the field (Berliner & Biddle, 1995; Nichols & Berliner, 2007). The historian Lawrence Cremin (1989) establishes one critical perspective of the claims that a "crisis" in education actually threatened our economy:

> American economic competitiveness with Japan and other nations is to a considerable degree a function of monetary, trade, and industrial policy, and of decisions made by the President and Congress, the Federal Reserve Board, and the Federal Departments of the Treasury, Commerce, and Labor. Therefore, to conclude that problems of international competitiveness can be solved by educational reform, especially educational reform defined solely as school reform, is not merely utopian and milliennialist, it is at best a foolish and at worst a crass effort to direct attention away from those truly responsible for doing something about competitiveness and to lay the burden instead on the schools. It is a device that has been used repeatedly in the history of American education. (pp. 102-103)

Further, Bracey points to two 1992 Educational Testing Service reports, an international comparison in mathematics and science showed that while America's ranks may have been largely, but not entirely low, actual scores were near international averages (Lapointe, Mead, & Askew, 1992). *Education Week* reported similar findings later that American 9-year-olds were second in the world in reading among the 27 nations tested. American 14-year-olds were eighth out of 31 countries, but only Finland had a significantly higher score (Rothman, 1992). In short, the statistics used by *A Nation at Risk* to paint a dire crisis in education have been challenged in the field even if the scare might have had a lasting impact of the public's perception that there is a crisis in education.

By the mid-1990s, an ideological leavening had occurred in which computer technology was accepted as an integral part of good schooling, whether one agreed with the doom and gloom assessment of *A Nation at Risk* (Noble, 1996) or not. In the United States and abroad, billions of dollars in funding have been allocated and spent on ICT for schools. In 2003 alone, over $6 billion was spent on educational technology in U.S. schools (Anderson & Dexter, 2005; Hancock, 2005; Harris, 2005). Douglas Noble (1996), an education historian, has studied the historical development of technology in education and has called this spending "technology fever," and adds that, "despite promising experiments, the billions already spent on technology have not had a significant impact on school effectiveness" (p. 18). While the researcher here refers to a lack of school effectiveness (below, the technology's impact on student achievement will be discussed), the technology fever has not been without its valuable lessons for educators to follow when employing technology now and in the future. Educators must remind themselves that (a) technology is often market-driven, not driven by student educational needs per se; (b) the *marketing* of the product often sells educators more than *evidence of its effectiveness* in the classroom; and (c) computer-based education often uses schools to experiment with product development rather than developing products to serve a school's actual educational needs (p. 22). Armed with these three areas of caution, Noble (1996) writes,

> Educators, therefore, need not keep abreast of every innovation for fear of losing ground or falling behind. Leave the experiments to the technophiles. The rest of us, unashamedly and with renewed integrity, should follow our own sense of sound educational practice, using proven technologies when applicable. There is no need to join the mad rush into the future or to gamble with our students' education. (p. 23)

Thus, the historical development of technology in education might be one of market driven products, but educators may practice wise decision-making to employ technology by relying on their knowledge and expertise in educational best practice.

Technology Outcomes

Technology outcomes for expenditures have been categorized by some researchers in terms of (a) net use, (b) technology integration, and (c) student tool use (Anderson & Dexter, 2005). "Net use" refers to the extent to which teachers and others in the school use e-mail and the Internet for a variety of different purposes. "Technology integration" measures the degree of integration of technology into the curriculum and into teaching practices. "Student tool use" measures the extent to which students used computers to do academic work, including writing; simulations in science and social studies, spreadsheets and databases; and looking up information on CD-ROMS, the Internet, or other computer-based resources (Anderson & Dexter, 2005).

Research that reports net use might help to document how much of a particular hardware device or application software is used and the amount that is available for use, such as the number of computers per student or access to the Internet. Such measures, however, often do not inform one of the types of use or how computer technology is used for instructional purposes. Likewise, research that documents student use may report on various quantities of use, such as time in computer labs, software applications, or Internet use. Similarly, such research often does not inform one of how the computer technology is used for instructional purposes to impact student achievement. For the purposes of this study, technology integration is the technology outcome most closely associated with student achievement because it, more than the other two, relates to pedagogical practices in the process of student learning in the classroom (Brockmeier, Sermon, & Hope, 2005).

The state of Texas uses the Texas Teacher School Technology and Readiness (STaR) Chart as a self-assessment tool to measure, encourage, and develop technology integration across the curriculum. The purpose of the online survey is to assess needs and to set goals for the use of technology in the classroom to support student achievement (Texas Education Agency [TEA], 2006). The STaR Chart began as a voluntary tool in the 2004-2005 school year, but it was required for all public school teachers starting in the 2006-2007 school year (TEA, 2006).

The various questions that comprise the STaR Chart come from the four areas of the Texas Long-Range Plan for Technology, 2006-2020: (a) teaching and learning; (b) educator preparation and development; (c) leadership, administration, and instructional support; and (d) infrastructure technology. Within each category are six focus areas, and for each focus area within a given category, teacher responses to the survey categorize them into one of four levels: early tech (the lowest), developing tech, advanced tech, or high tech. Tables 2.1 and 2.2 show these categories. Table 2.1 shows the four categories and six areas of focus for each. Table 2.2 show an example of how a given category may be subdivided into teacher levels of progress.

Table 2.1. The Four Key Areas and Focus Areas of the Texas Teacher STaR Chart

Key Area I: Teaching & Learning Focus Area	Key Area II: Educator Preparation & Development Focus Area	Key Area III: Leadership, Administration, & Instructional Support Focus Area	Key Area IV: Infrastructure for Technology Focus Area
Patterns of classroom use	Professional development experiences	Leadership and vision	Leadership and vision
Frequency/design of instructional setting using digital content	Models of professional development	Planning	Planning
Content area connections	Capabilities of educators	Instructional support	Instructional support
Technology applications (TA) TEKS implementation	Technology professional development participation	Communication & collaboration	Communication & collaboration
Student mastery of TA/TEKS	Levels of understanding and patterns of use	Budget	Budget
Online learning	Capabilities of educators with online learning	Leadership and support for online learning	Leadership and support for online learning

Table 2.2. Example of Texas Teacher STaR Chart Level of Progress

Key Area I: Teaching & Learning						
Focus Area / Level of progress	Patterns of Classroom Use	Frequency/Design of Instructional Setting Using Digital Content	Content Area connections	Technology Applications (TA) TEKS Implementation	Student Mastery of TA TEKS	Online Learning
Early tech						
Developing tech						
Advanced teach						
Target tech						

Focus area I (teaching and learning) deals most directly with classroom instruction that impacts student achievement. Within this focus area, teacher levels of progress increase according the level of critical thinking and student-led activity employed in the use of technology in the classroom. This graduated increase in levels of progress may be seen in the following performance descriptions from focus area 1, patterns of classroom use:

> *Early tech*: I occasionally use technology to supplement instruction, streamline management functions, and present teacher-centered lectures; my students use software for skill reinforcement.
>
> *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.
>
> *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.
>
> *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 high education; learning is transformed as my students propose, assess, and implement solutions to problems. (TEA, 2006, p. 8ff)

These performance descriptions reflect a movement from the early tech level of teacher-led classrooms ("teacher-centered lectures") and student rote activity ("skill reinforcement"), to the advanced tech level with more "student-centered learning activities" and the "higher-order thinking skills" used when students "evaluate information, analyze data, and solve problems." A teacher reaches the target tech level when students themselves lead the learning and "learning is transformed as my students propose, assess, and implement solutions to problems" (TEA, 2006, p. 6). This progression of levels reflect practices that are consistent with a constructivist approach to learning, described below in section 3, and they focus on the classroom instructional strategies used to impact student engagement and learning within a constructivist context.

Focus area II (educator preparation and development) helps to identify areas of need and effectiveness for staff development. Focus areas III and IV- leadership, administration, and instructional support and infrastructure for technology - deal with campus-level factors of technology integration. Thus, the STaR Chart as a technology integration measurement tool is meant to provide information about teachers' technology integration in the classroom as well as teacher perceptions of the state of campus-wide technology and needs for integration.

Another instrument for measuring teacher technology integration is the Levels of Technology Implementation (LoTi), a survey of 40 questions designed as a teacher self-rating to gauge Current Instructional Practice (CIP), Patterns of Computers Use (PCU), and Levels of Technology Implementation (LoTi). The framework, designed and developed by Dr. Chris Moersch, focuses on the use of technology as a tool within the context of student-based instruction with an emphasis on higher-order thinking. A CIP score reports, on a scale from 0-7, what methods the teacher uses to deliver instruction. How involved are the students in the classroom decision-making process? Do students help determine the problem being studied or have input in the final product that is produced? A PCU score reports, on a scale of 0-7, how comfortable teachers are in using the technology tools involved in technology integration. A LoTi score reports, on a scale of 0-6, the degree to which the respondent supports and implements instructional uses of technology in a classroom setting. The LoTi scores correspond to the following categories: 0 = Nonuse; 1 = Awareness; 2 = Exploration; 3 = Infusion; 4A = Mechanical Integration; 4B = Routine Integration; 5 = Expansion; and 6 = Refinement.

The progression up the levels of LoTi scores is fueled by constructivist practices, similar to the Texas Teacher STaR Chart levels of progress within the teaching and learning focus area, mentioned above. Within the LoTi framework, the LoTi level rises as classroom practices move from teacher-led instruction to student-centered activity, from low-level thinking and rote activities to higher-level critical thinking. Table 2.3 describes how these levels vary within the LoTi framework according to pedagogical emphasis, technology focus, and instructional focus.

Table 2.3. Levels of Technology Implementation (LoTi) Levels

LoTi Level	Pedagogical Emphasis	Technology Focus	Instructional Focus
0	Learner-centered or teacher-centered	• No technology use • Technology perceived as unrelated to student achievement • Environmental variables prevent technology use	• Instructional approach either didactic or inquiry-based • Use of print materials is pervasive in the classroom
1	Teacher-centered	• Technology is used mostly by teacher • Computer serves as a reward station for non-content related work • Teacher use of productivity tools	• Instruction emphasizes information dissemination to students (e.g. lecture) • Supports concept-attainment model of teaching
2	Teacher-centered	• Student use of technology for lower cognitive skills • Pervasive use of student multimedia to present content understanding • Drill and practice; tutorial programs	• Focus is strictly on content understanding • Emphasis on lower order thinking skills (i.e., knowledge, comprehension) • Student products emphasize "research and reporting"
3	Teacher-centered	• Student use of technology for high cognitive skills • Student use of web-based and non-web-based productivity tools (e.g. spreadsheets, concept maps, databases, online surveys, online simulations)	• Focus is on both the content and the process • Emphasis on higher-order thinking skills (i.e., application, analysis, synthesis, evaluation) • Student products emphasize complex thinking strategies (e.g., problem-solving, decision-making, reasoning)
4a	Student-centered	Same as above	• Focus is on applied learning to the real world • Student products are authentic, relevant and embed complex thinking strategies • Student-generated questions dictate the content, process, and product • Teacher experiences management concerns with pedagogy
4b	Student-centered	Same as above	Same as above, except teacher is within his/her own comfort zone with pedagogy
5	Student-centered	Same as above, with the addition of multiple technologies in use toward product completion	Same as above, with the addition of two-way collaboration with community for student problem-solving

Table 2.3 (continued)

LoTi Level	Pedagogical Emphasis	Technology Focus	Instructional Focus
6	Student-centered	• Student use of technology for high cognitive skills • Student use of web-based and non-web-based productivity tools (e.g. spreadsheets, concept maps, databases, online surveys, online simulations) • Multiple technologies in use toward product completion • No limit to technology availability or use • Technology perceived as a process, product, and tool	Same as above

Differences in key terms between successive LoTi levels reveal the emphasis on higher-order thinking, student-centered instruction, authentic learning tasks, and flexible use of technology. Instructional focus moves from didactic lecture, student knowledge, and comprehension to collaboration in problem-solving, analysis, synthesis, and evaluation.

Further, the LoTi framework was designed to be consistent with a constructivist approach to teaching and learning. Moersch (as cited in Stoltzfus, 2006) explains:

> Computer technology is employed as a tool that supports and extends students' understanding of the pertinent concepts, processes and themes involved . . . [and] heavy reliance on textbooks and sequential instructional materials is replaced by the use of extensive and diversified resources determined by the problem area under discussion. (p. 41)

That is, "as a teacher progresses from one level to the next, a series of changes to the instructional curriculum is observed. The instructional focus shifts from being teacher-centered to being learner-centered" (Moersch, as cited in Stoltzfus, 2006, p. 41) as in a constructivist learning environment. One may note that this constructivist language is consistent with findings in the literature, noted below in section 3, of the connection between constructivist methods, technology integration, and student achievement. The LoTi framework, then, uses a constructivist lens to measure teacher implementation of technology as an instructional tool (Corbin, 2003; Denson, 2005; Griffin, 2003; MacDonald, 2003; Schechter, 2000).

Dr. Jill Stoltzfus of Temple University conducted a validation study of the LoTi survey (Stoltzfus, 2006). The validation study addressed three areas. The first area was the extent to which the survey demonstrated internal consistency or reliability as an assessment tool. That is, how well did the different parts of the survey correlate with each other, an important quality of a survey claiming to gauge common traits or indicators like levels of technology implementation (Cohen & Swerdlick, 2004). The second area was the extent to which the survey demonstrates content validity. This type of validity tries to determine how well the content of the survey reflects levels of technology implementation, the domain that this particular survey tries to measure (Cohen & Swerdlick, 2004). The third area was the extent to which the survey demonstrates construct validity. This type of validity looks at the extent to which the traits and indicators of levels of technology implementation are measurable and the extent to which this survey instrument accurately reflects those traits (Cohen & Swerdlick, 2004).

The results of the validation study revealed three results. First, each of three measures in the survey, LoTi, CIP, and PCU, achieved content validity. Second, PCU and CIP were statistically reliable. Third, LoTi level 0 as a base point was statistically reliable. To be sure, the study also pointed out the need for research on the LoTi survey's criterion validity. This validity would show the extent to which the LoTi survey correlates with external, objective criteria of levels of technology use. The survey as it is administered is still subject potential bias and subjective responses of teacher participants.

Research on technology and student achievement varies in its content focus, grade level focus, scope, and findings (Arbuckle, 2005; Armfield, 2007; Bayraktar, 2002; Bielefeldt, 2005; Bozeman & Baumbach, 1995; Clark, 2005; DiLeo, 2007; Fields, 2004; Floyd, 2006; Glennan, 1996; Guest, 2005; Jones, Valdez, Nowakowski, & Rasmussen, 1994; Lowther, Ross, & Morrison, 2003; MacDonald, 2003; Martin, 2005; Martindale, Pearson, Curda, & Pilcher, 2005; Micheaux-Gordon, 2006; Morrell, 1992; Odom, 2006; Petersen, 2005; Phalen, 2004; Queener, 2007; Ringstaff & Kelley, 2002; Scheidet, 2003; Sulser, 2006; Torossian, 2005; Wendt, 2007; Wilson, 2006). Because of this variety, taken as a whole, studies on technology and student achievement have limitations (Wenglinsky, 1998). First, studies often treat technology as a monolithic item without differentiating between types of technology programs. Thus, studies may end up comparing apples to oranges while still underneath the technology-in-education umbrella. Secondly, studies often focus on a particular school or district, such as the record of study at hand, thus, the findings may not be neatly generalized from city-to-city or state-to-state. Thirdly, the assessments that measure academic achievement vary from one study to the next and have not been validated against each other, thereby creating another potential comparison between apples and oranges in terms of these assessment measures. Finally, children in studies are not often randomly assigned to groups to control for *a priori* conditions of being technologically adept or in a technologically rich environment to begin with. Given the wide variety of studies, the many influencing factors make it difficult to make general conclusions with certainty (McCabe & Skinner, 2002).

These various limitations of the current research on technology and student achievement are not necessarily prohibitive factors in gaining insight into the field. Instead, they caution educators to apply findings judiciously and mindfully according to population used, sample size, and focus of the research problem (Ringstaff & Kelley, 2002). Nevertheless, some trends do arise out of research that has identified technology's positive impact on student achievement.

> Technology is best used as one component in a broad-based reform effort. Teachers must be adequately trained to use technology. Teachers may need to change their beliefs about teaching and learning. Technological resources must be sufficient and accessible. Effective technology use requires long-term planning and support. [And] technology should be integrated into the curricular and instructional framework. (Ringstaff & Kelley, 2002)

These factors appear repeatedly in the literature as important elements for using technology effectively to impact student achievement.

Pedagogical and Philosophical Basis of Technology's Impact on Student Achievement

Research varies on instructional practice that positively impact student achievement (Marzano, Pickering, & Pollock 2001). Still, some generalizations serve to guide educational decision-making in this regard. In 2001, Marzano, Pickering, and Pollock published the results of a meta-analysis of quantitative research on the impact of general instructional strategies and student achievement. The analysis revealed that nine categories of instructional strategies have been shown to have impacted student achievement to a statistically significant degree: (a) identifying similarities and differences; (b) summarizing and note taking; (c) reinforcing effort and providing recognition; (d) homework and practice; (e) nonlinguistic representations; (f) cooperative learning; (g) setting objectives and providing feedback; (h) generating and testing hypotheses; and (i) cues, questions, and advance organizers. The common themes of these nine strategies are that they are student-centered, involve the teaching of critical-thinking skills, and involve the use of hands-on activities all of which, as mentioned below, have particular relevance for the effective use of technology for instruction. To be sure, an exhaustive explanation of these nine research-based instructional strategies would exceed the bounds of the record of study at hand. Nevertheless, one may examine these nine strategies in conjunction with the findings mentioned below about technology use and constructivism, cognitive research on learning, and higher-order thinking. If these nine categories represent current research-based best practice for instructional strategies that positively impact student achievement, then educators may use them to guide technology use as part of instruction.

In the literature, information and communications technology (ICT) is often linked to constructivism, a learning approach in which classrooms are student-centered, active places where informed decision-making takes place using higher-order thinking, as opposed to a traditional learning approach, which is teacher-centered, passive, and devoted to factual, knowledge-based learning (ISTE, 2007; Kim, 2006; Perry, 2004; Robertson, 2003a; Siegle & Foster, 2001; Singhanayok & Hooper, 1998; Wilson, 2007). To be sure, as some researchers have noted, "constructive learning can be integrated in classrooms with or without computers, [but] the characteristics of computer-based technologies make them a particularly useful tool for this type of learning" (Roschelle, Pea, Hoadley, Gordin, & Means, 2000, p. 79). For example, computer labs that graph data engage kids in immediate feedback that, in turn, may engage them in constructing their own knowledge about the processes under exploration. Electronic bulletin boards and web logs (blogs) facilitate active engagement between students in conversations, even those less likely to speak in a traditional class setting, such as a shy student. Simulations in English, math, science, and social studies create virtual situations that engage students in authentic learning experiences that mirror real world situations. Software programs that offer real-time feedback on practice may similarly engage students. In general, then, characteristics of computer-based technologies facilitate the conditions for a constructivist learning environment for students.

In one qualitative study, researchers broke down the constituent parts of constructivist learning into fundamental characteristics of learning, gleaned from cognitive research. These fundamental characteristics of learning were then applied to several examples of computer-based learning (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). According to the researchers, "cognitive research has shown that learning is most effective when four fundamental characteristics are present: (a) active engagement, (b) participation in groups, (c) frequent interaction and feedback, and (d) connections to real-world contexts" (Roschelle, Pea, Hoadley, Gordin, & Means, 2000, p. 79). Traditional classrooms, however, often lack these four characteristics, while technology may enhance them. The researchers write,

> As scientists have understood more about the fundamental characteristics of learning, they have realized that the structure and resources of traditional classrooms often provide poor support for learning whereas technology – when used effectively – can enable ways of teaching that are a much better match to how children learn. (Roschelle, Pea, Hoadley, Gordin, & Means, 2000, p. 79)

Believing that computer technology can support and enhance each of these four characteristics of learning, many stakeholders feel that computer technology could transform education. The belief is that by making teaching and learning more effective and efficient, computer technology will thereby increase student achievement. Technology, they argue, can provide new instructional options for students, transforming curricular and instructional processes into active engagement in learning (Brockmeier, Sermon, & Hope, 2005).

Mere Use Versus Appropriate Use

A teacher's use of technology as an appropriate tool for instruction depends not only on expertise in educational technology and content information, but also a working knowledge of pedagogy and best practice processes during the integration of technology into classroom instruction (Deacon, 1999; Denson, 2005; Griffin, 2003; Margerum-Leys & Marx, 2004; Romano, 2004; Royer, 2002; Woodridge, 2003; Yang, 2004). Technology use in the classroom can be seen in different stages. Teachers first learn basic technology skills, then they find value in technology as an instructional tool, and, finally, teachers reconfigure the structure and goals of lessons. The development of these lessons takes shape in different ways, but one point remains. When teachers use technology integration as an effective tool for learning, they must constantly consider existing teaching practices and modify classroom learning to increase effectiveness (Otero & Peressini, 2005). That is, the mere use of technology is not enough to impact student learning. The appropriate use of technology must be instructionally driven, by such language as, “how, when, and why should we use technology in the classroom?” (Otero & Peressini, 2005, p. 12). Below is one framework that seeks to answer such questions in a way that drives the appropriate use of technology for instruction:

1. Technology used as a cognitive tool helps students understand concepts and solve problems.

2. Technology used as a communication tool fosters discourse and collaboration among educators, students, parents, and the community.

3. Technology used as a management tool increases efficiency for teachers and students.

4. Technology used as an evaluation tool helps teachers reflect on instruction and provides feedback on student learning.

5. Technology used as a motivational tool encourages and engages students in learning. (Otero & Peressini, 2005, p. 12)

Using a frame like this one, in one qualitative study, teachers inserted technology meaningfully into already meaningful activity to enhance the effectiveness or the efficiency of that activity. The theoretical grounding of such a framework comes from Leo Vygotsky, who argues that language mediates and structures our activities in fundamental ways. As such, the language of a framework for technology use, like the one mentioned above, establishes a common language to impose meaning and structure upon our ideas technology. Absent this effort to impose meaning on the instructional use of technology, ICT becomes mere use instead of appropriate use (Schechter, 2000; Truett, 2006; Veltman, 2005).

Beyond the theoretical foundations for appropriate use, research also suggests what appropriate use looks like in broad categories. Generally speaking, the use of technology that engages students in higher-order thinking skills positively impacts student achievement more than technology use that requires rote activity in lower-order thinking. In one study, a researcher drew data from the 1996 National Assessment of Educational Progress (NAEP) in mathematics, which included 6, 227 fourth-graders and 7,146 eighth-graders (Wenglinsky, 1998). Among other things, the study found a high correlation between the use of technology for applications and simulations (i.e., higher-order thinking) and student test scores among eighth-graders, while those that reported the primary use of technology for drills scored lower on the NAEP in mathematics. Additionally, the benefits for fourth-graders did not seem to correspond as strongly. The researcher suggests that this difference might be explained by the fact that primary-aged students need to master basic math skills more than eighth-graders, so their use of technology would necessarily need to accommodate those age-appropriate factors. Regardless of the explanation for the differences in eighth-grade and fourth-grade scores, the findings of this study remain: appropriate use of technology for secondary students, in terms of positively impacting student achievement, should rely on higher-order thinking activities.

Technology and the Digital Divide

Since the mid-1990s, the public focus on student achievement has come to settle on the achievement gap between the rich and the poor. Equal access to computer technology, likewise, became a priority for school funding in low income areas (Robertson, 2003b), and “savage inequalities” became known as a “digital divide” when the term applied to the technology gap between rich and poor school children (Chen & Price, 2006; Warschauer, Knobel, & Stone, 2004). In the past decade, however, this digital divide in terms of access has closed significantly (Warschauer, Knobel, & Stone, 2004). That is, students from impoverished homes no longer attend schools that lag significantly behind more affluent schools in terms of the number of computers per pupil and access to the Internet. In fact, home computer use by impoverished kids is not as big a gap as it once was, even though “research suggests that home ownership of computers alone does not level out inequalities in terms of technology’s contribution to student learning” (Warschauer, Knobel, & Stone, 2004, p. 563). In terms of access to computers, the digital divide and the gap between the rich and the poor has narrowed.

This narrowing of the access gap, however, has not been accompanied by a closing of the gap in the quality of teacher training and technology leadership offered to students from impoverished homes. The divide extends past mere access to the appropriate use of that computer technology integrated as a tool for classroom instruction. As mentioned above, appropriate use of computers, in terms of classroom instruction, requires students to engage in higher-order thinking skills (Barrett, 2007; Chen, 2005; DiCinto & Gee, 1999; Margerum-Leys & Marx, 2004; Olina & Sullivan, 2002; Page, 2002; Wenglinsky, 1998). Researchers note that students of low socio-economic status (SES) “actually use computers more than high-SES students in math and English courses, where computer-based drills are common, but high-SES students are the main users of technology in science courses, where computers are often used for simulations and research” (Warschauer, Knobel, & Stone, 2004, p. 564). While many factors may contribute to this difference in types of use, the research suggests two main culprits. First, schools with a large number of low SES students tend to have low levels of support for technology and resources dedicated to the training of teachers in the effective and appropriate use of technology for instruction. Research suggests that with effective supports and training, teachers in schools with an impoverished clientele can significantly increase teacher expertise and effectiveness in using technology as an instructional tool (Chen & Price, 2006). Secondly, schools in which the principal lacks technology leadership exhibited less effective technology implementation for instruction (Anderson & Dexter, 2005; Duncan, 2004; Jacoby, 2006; Kozloski, 2006; Matthews, 2006; Persaud, 2006; Scanga, 2004; Yoho, 2006) and there was lower overall technology leadership when the number of poor students was greater at a school (Anderson & Dexter, 2005). Thus, research suggests that a gap remains between poor and affluent kids in terms of school leadership, teacher training, and teacher support for effective technology use.

While research has tried to link appropriate technology use to student learning in general, it also has examined the impact of technology on those that particularly struggle in school: students at risk of dropping out. One researcher notes that,

> The reform initiatives of the 1990s required educators to rethink America's traditional model of schooling, in which all students are taught the same information in the same way. An increasing number of educators and researchers are calling for higher standards and more challenging activities, especially for students who at risk of failure due to poverty, race, language, or other factors. Yet despite 10 years of research offering plausible strategies for at-risk instruction, classrooms and teaching practice look virtually the same as in the past, and schools wrestle with the same difficulties in teaching at-risk students. (Day, 2002, p. 20)

Narrow curricula, rigid instructional strategies, and pull-out programs have been ways that schools deal with at-risk students. Those types of interventions, however, may actually hurt the academic achievement of these at-risk students, so computer technology offers an opportunity for some schools to infuse the fundamentals of learning, mentioned above, into efforts to teach at-risk students. The research on the use of computer technology by at-risk students suggests that when used in the context of cooperative, student-centered, and authentic learning, at-risk students improved their motivation to learn, earned higher grades in those classes, and began to accept more responsibility for their own learning (Dunkel, 1990; Merino, Legarreta, Coughran, & Hoskins, 1990). It is the effective use of technology to teach higher-order thinking that can be linked to higher levels of student achievement for students who are at risk of failing (Dunkel, 1990; Merino, Legarreta, Coughran, & Hoskins, 1990). In fact, the use of technology in classroom instruction has been shown to have a positive impact on student engagement in learning, a particular concern for students at risk of dropping out of school (Day, 2002; Shelly, 2002).

Conclusion

The five areas of this review of the literature were meant to establish a context within which the record of study may become meaningful for practicing teachers and administrators. The first section, the historical context and development of the use of computer technology in education, established the development of computer technology in education as, in part, as a result of the larger school reform movement that arose in the 1980s. Lessons learned from that development about possible “red herrings,” misguided diagnoses, and market-driven forces remind practitioners to use technology in ways that directly deal with classroom instruction informed by the research on best instructional practices. The second section defines technology outcomes, as documented in the research, and identifies the technology outcomes that will most directly impact student learning. The third section placed the effective use of computer technology within constructivist philosophy as well as within an overarching framework of current best pedagogical practices, as documented in research. The fourth section further delineated this position of technology use within best instructional practice by cautioning practitioners to avoid the mistake of confusing mere use with the appropriate use of computer technology in education, a distinction that will help to focus on the impacts of technology on student achievement. The final section identified the particular issues of poor technology leadership, poor teacher preparation, and a lack of teacher support for the use of technology as particular obstacles for low SES students and at-risk learners who have been shown to benefit from the effective use of technology in the classroom.

CHAPTER III

METHODOLOGY

The purpose of this chapter was to describe the sampling, testing, and statistical procedures used in the study. In addition, the original two questions the study addresses are reintroduced for continuity:

1. Is there a relationship between teacher LoTi ratings and student TAKS scores as reported in student records at Alamo Heights High School, San Antonio, Texas?
2. Does a relationship between teacher LoTi ratings and student TAKS scores differ according to students' economically disadvantaged status as reported in student records at Alamo Heights Independent School District, San Antonio, Texas?

Starting with the 2006-2007 school year, Alamo Heights ISD has used Dr. Chris Moersch's instrument called Levels of Technology Implementation (LoTi), a teacher survey of 40 questions designed as a teacher self-rating to gauge Current Instructional Practice (CIP), Patterns of Computers Use (PCU), and Levels of Technology Implementation (LoTi). The framework focuses on the use of technology as a tool within the context of student-based instruction with an emphasis on higher-order thinking. A CIP score reports, on a scale from 0-7, what methods the teacher uses to deliver instruction. How involved are the students in the classroom decision-making process? Do students help determine the problem being studied or have input in the final product that is produced? A PCU score reports, on a scale of 0-7, how comfortable teachers are in using the technology tools involved in technology integration. A LoTi score reports, on a scale of 0-6, the degree to which the respondent supports and implements instructional uses of technology in a classroom setting. The LoTi scores correspond to the following categories: 0 = Nonuse; 1 = Awareness; 2 = Exploration; 3 = Infusion; 4A = Mechanical Integration; 4B = Routine Integration; 5 = Expansion; and 6= Refinement.

Further, the LoTi framework was designed to be consistent with a constructivist approach to teaching and learning. Moersch (as cited in Stoltzfus, 2006) explains:

> Computer technology is employed as a tool that supports and extends students' understanding of the pertinent concepts, processes and themes involved . . . [and] heavy reliance on textbooks and sequential instructional materials is replaced by the use of extensive and diversified resources determined by the problem area under discussion. (p. 41)

That is, "as a teacher progresses from one level to the next, a series of changes to the instructional curriculum is observed. The instructional focus shifts from being teacher-centered to being learner-centered" (Moersch, as cited in Stoltzfus, 2006, p. 41) as in a constructivist learning environment. One may note that this constructivist language is consistent with findings in the literature, noted in the previous chapter, of the connection between constructivist methods, technology integration, and student achievement. The LoTi framework, then, uses a constructivist lens to measure teacher implementation of technology as an instructional tool.

The goal of using the LoTi framework is to inform teachers and campus administrators of the current status of technology implementation to plan for staff development to improve student academic achievement. To date, however, no formal attempts have been made to assess the correlation between these teacher perceptions of technology implementation and actual student achievement.

To help Alamo Heights ISD in measuring a correlation between technology implementation and student achievement, the study sought answers to the following questions:

1. Is there a relationship between teacher LoTi ratings and TAKS scores as reported in student records at Alamo Heights High School, San Antonio, Texas?
2. Does a relationship between teacher LoTi ratings and TAKS scores differ according to students' economically disadvantaged status as reported in student records at Alamo Heights Independent School District, San Antonio, Texas?

To answer these questions, existing student data and teacher data were placed into a database so that statistical tests could be conducted on the data to infer generalizations about relationships between and among the groups within the data. Existing TAKS data with appropriate demographic and scheduling data, such as socio-economic status, the names of a student's core content area teacher and TAKS scale scores, were downloaded using the district's AEIS IT software, a database program installed with records onto administrator computers. The specific procedures that were used are described in the following sections. Given that there is only one year of complete LoTi teacher data (2006-2007), the population for the study was limited to 9th, 10th, and 11th grade students who took the reading/English Language Arts (ELA), math, science, and/or social studies TAKS exams.

Population

For the purposes of this study, both school and student performance analysis include only Alamo Heights High School in the Alamo Heights Independent School District (AHISD). The student data in the study came from 946 9th, 10th, and 11th graders who took the reading/ELA TAKS test; 979 9th, 10th, and 11th graders who took the math TAKS test; 509 10th and 11th graders who took the science TAKS test; and 603 10th and 11th graders who took the social studies TAKS test. A total of 12 English teachers, 14 math teachers, 11 science teachers, and 14 social studies teachers (51 total teachers) from this campus made up the population under study. The composition of this population for the study is summarized in Table 3.1.

Table 3.1. Summary of Population Comprising the Study From Alamo Heights High School in Alamo Independent School District, San Antonio, Texas

Population	ELA	Math	Science	Social Studies
Students	946	979	509	603
Teachers	12	14	11	14

Alamo Heights Independent School District encompasses the communities of Alamo Heights, Olmos Park, Terrell Hills, and a part of north San Antonio. The district was founded in 1909 as a rural district and became an independent district in 1923. Approximately 29,737 people live in the district which covers 9.4 square miles. Five campuses comprise the district: one early childhood center, two elementary schools, one junior school, and one senior school. The district enrollment is 4,604 students, and about 1,500 are the high school. Approximately 94% of Alamo Heights High School's graduates continue their formal education by attending college, 80% in four-year colleges and 14% in junior or community colleges.

To describe the sample population for the study in more detail, demographic data are listed in Tables 3.2-3.6 about the school from which the sample was taken. Additionally, information about years of service of the teachers at the high school is also listed in Tables 3.7-3.8. With both the student demographic data and the teacher years of service data, state data are listed for comparison to the high school's data. The data begin with 2003 because that is the first year that the Texas Assessment of Knowledge and Skills (TAKS) was administered in Texas as part of the state accountability system. Because the study uses student TAKS data as the dependent variable, 2003 was chosen as the starting pointing for listing this data. Likewise, the data about teacher years of service are listed because the independent variable of teacher LoTi scores may be impacted by that factor, as will be addressed as an item for further study in Chapter V.

Table 3.2. Alamo Heights High School and Texas Demographic Composition in Terms of Percentage of Enrollment Since the Inception of TAKS Testing in 2003

	2003		2004		2005		2006		2007	
	AHHS	State	AHHS	State	AHHS	State	AHHS	State	AHHS	State
African American	1.5	14.3	1.9	14.3	1.9	14.2	2.1	14.7	Not available at time of printing	Not available at time of printing
Hispanic	25.3	42.7	25.1	43.8	23.5	44.7	24.9	45.3		
White	72.3	39.8	71.9	38.7	73.6	37.7	72.0	36.3		
Economically disadvantaged	11.9	51.9	14.8	52.8	10.5	54.6	11.0	55.6		

Table 3.3. Alamo Heights High School and Texas English Language Arts (ELA) Texas Assessment of Knowledge and Skills (TAKS) Percentage Passing With a Scale Score of 2100 by Demographic Group Since the Inception of TAKS Testing in 2003

	2003		2004		2005		2006		2007	
	AHHS	State	AHHS	State	AHHS	State	AHHS	State	AHHS	State
All	85	72	92	80	91	83	95	87	97	Not available at time of printing
African American	57	61	58	71	89	76	87	82	93	
Hispanic	72	63	80	72	80	77	89	82	92	
White	89	83	96	89	94	91	97	94	99	
Economically disadvantaged	58	61	73	70	77	76	80	81	84	

Table 3.4. Alamo Heights High School and Texas Math Texas Assessment of Knowledge and Skills (TAKS) Percentage Passing With a Scale Score of 2100 by Demographic Group Since the Inception of TAKS Testing in 2003

	2003		2004		2005		2006		2007	
	AHHS	State	AHHS	State	AHHS	State	AHHS	State	AHHS	State
All	71	57	80	66	85	71	85	75	86	Not available at time of printing
African American	38	41	42	49	63	55	47	61	47	
Hispanic	52	47	58	57	68	63	69	68	71	
White	77	71	87	78	90	83	91	86	92	
Economically disadvantaged	39	46	44	55	57	61	53	66	59	

Table 3.5. Alamo Heights High School and Texas Science Texas Assessment of Knowledge and Skills (TAKS) Percentage Passing With a Scale Score of 2100 by Demographic Group Since the Inception of TAKS Testing in 2003

	2003		2004		2005		2006		2007	
	AHHS	State	AHHS	State	AHHS	State	AHHS	State	AHHS	State
All	70	42	83	56	89	63	90	70	88	Not available at time of printing
African American	20	24	29	38	*	45	57	54	45	
Hispanic	47	27	57	41	72	50	75	59	77	
White	78	59	91	73	93	79	95	85	93	
Economically disadvantaged	34	25	42	39	60	48	65	58	64	

*Results are marked by TEA due to small numbers to protect student confidentiality.

Table 3.6. Alamo Heights High School and Texas Social Studies Texas Assessment of Knowledge and Skills (TAKS) Percentage Passing With a Scale Score of 2100 by Demographic Group Since the Inception of TAKS Testing in 2003

	2003		2004		2005		2006		2007	
	AHHS	State	AHHS	State	AHHS	State	AHHS	State	AHHS	State
All	87	76	95	84	97	87	96	87	98	Not available at time of printing
African American	67	66	>99	77	>99	81	86	81	100	
Hispanic	75	66	81	76	89	80	86	80	96	
White	92	86	98	92	99	94	99	94	99	
Economically disadvantaged	63	64	72	74	80	79	81	79	97	

Table 3.7. Average Years of Teacher Service Since the Inception of TAKS Testing in 2003 for Alamo Heights High School (AHHS) and the State

	2003		2004		2005		2006		2007	
	AHHS	State	AHHS	State	AHHS	State	AHHS	State	AHHS	State
Average Years of service	15.1	11.8	14.7	11.8	14.1	11.5	15.3	11.5	Not available at time of printing	Not available at time of printing

Table 3.8. Percentage of Teachers in Years of Experience Since the Inceptions of TAKS Testing in 2004 for Alamo Heights High School (AHHS) and the State

	2003		2004		2005		2006		2007	
	AHHS	State	AHHS	State	AHHS	State	AHHS	State	AHHS	state
Beginning	2.4	7.8	6	6.5	2.5	7.7	0.0	7.5	Not available at time of printing	Not available at time of printing
1-5 years	19.8	28.2	15.1	29.0	11.1	28.7	12.7	29.0		
6-10 years	20.9	18.3	22.9	18.9	29.3	19.4	21.2	19.4		
11-20 years	24.2	24.4	26.2	24.8	34.5	24.5	38.3	24.2		
Over 20 years	32.7	21.3	29.8	20.9	22.7	19.7	27.9	19.9		

In summary, the sample population of Alamo Heights High School differs from the general population in at least three important ways. First, the percentage of all Alamo Heights High School students passing TAKS each subject area test is generally higher that the state averages of all students passing those tests. The same holds true for many but not all of the subgroup comparisons with the state in terms of percentage of a subgroup passing subject area TAKS tests. Second, the percentage of economically disadvantaged students at Alamo Heights High School is considerably less than the state percentage of economically disadvantaged students. For each year in the comparison, the smallest gap between the Alamo Heights and the state of about 35% for this group. Finally, the average years of experience for teachers at Alamo Heights High School is longer than the state's average by at least nine years over the span of time compared in the tables above. These three areas of difference should be taken into account when applying the conclusions and findings of the study.

Instrumentation

The data collected for the purposes of this study was derived from teacher LoTi information and student data from TAKS scores for reading/English Language Arts (ELA), math, science, and social studies for the 9th, 10th, and 11th grades on the Spring 2007 state administration of those tests. All 10th and 11th graders take all 4 TAKS tests (reading/ELA, math, science, and social studies), while 9th graders take only the reading and math TAKS tests.

The teacher data consisted of three teacher scores on a Levels of Technology Implementation (LoTi) survey administered by Alamo Heights High School in February 2007 as part of yearly district requirements that teachers take the survey. Each English, math, science, and social studies teacher had three scores from the survey: CIP, PCU, and LoTi scores. For the purposes of this analysis, only the LoTi score was used because, of the three, only it deals specifically with technology implementation, the focus of the research questions for the study. The teacher LoTi data were exported into a Microsoft Excel spreadsheet.

Student data came from the Spring 2007 results of TAKS testing. Alamo Heights ISD puts this data into a database onto each administrator's laptop accessible using software called AEIS- IT. The results are reported as a scale score per student. Each student's name and student identification number remained unpublished and confidential. Student data included a student's scale score in reading/ELA, math, science, and social studies TAKS tests, socio-economic status, and core content area teacher. This data were exported from AEIT-IT into a Microsoft Excel spreadsheet.

Procedures

The procedures for collecting the data were coordinated with the Alamo Heights ISD Central Office. Written permission was granted by the district for this research study during the Spring of 2007. The first step was to use AEIS IT software to download existing student TAKS and economic status data into an Excel spreadsheet. Then, teacher class rosters of students were gathered from existing records on campus and placed into an Excel spreadsheet. Next, teacher LoTi ratings were placed into an Excel file. Student data from the Excel file were merged with teacher data from the Excel file using FileMaker Pro database software. The resulting merged data set was then exported back into a master Excel file that contained the student socio-economic status, TAKS information for each of the four relevant tests, the content area teacher for each of those tests, and the teacher LoTi rating. This master Excel spreadsheet provided the data string to be used in the Statistical Package for Social Studies (SPSS) analysis.

The study examined two variables: teacher LoTi scores and student TAKS scores. The problem being investigated dealt with the extent to which teacher levels of technology implementation has an effect on student TAKS scores. Teacher LoTi scores, then, comprised the independent variable, while the student TAKS scores comprised the dependent variable. Both the independent variable of teacher LoTi scores and the dependent variable of student TAKS scores predated the study, so an ex post facto non-experimental design was used (Graziano, 2007). The study involved a systematic inquiry in which the researcher did not have control over the independent variable. Further, the design was descriptive in that the study looked at multiple cases across two variables relating one variable to another, but without demonstrating causality. As a consequence of the design, findings of the study demonstrate inferences at best and not causality.

The design of the study also depended on the participant scores. With seven possible LoTi scores, the independent variables could have been spread out evenly, thus spreading the dependent variable of student TAKS scores around and lowering the number (N) in each group. This matrix is seen below in Table 3.9.

Table 3.9. Independent Variable (IV) and Dependent Variable (DV) Possible Combinations for Teacher LoTi Score IV and Mean Student TAKS Score DV

Group	Independent Variable (IV)	Dependent Variable (DV)
7	Teachers with LoTi 6	Mean of Student TAKS scores in class of Teachers with LoTi 6
6	Teachers with LoTi 5	Mean of Student TAKS scores in class of Teachers with LoTi 5
5	Teachers with LoTi 4	Mean of Student TAKS scores in class of Teachers with LoTi 4
4	Teachers with LoTi 3	Mean of Student TAKS scores in class of Teachers with LoTi 3
3	Teachers with LoTi 2	Mean of Student TAKS scores in class of Teachers with LoTi 2
2	Teachers with LoTi 1	Mean of Student TAKS scores in class of Teachers with LoTi 1
1	Teachers with LoTi 0	Mean of Student TAKS scores in class of Teachers with LoTi 0

Constructing the design by grouping teachers into clusters allowed for comparison of student performance on TAKS in term of varying levels of technology implementation. Grouping teachers according to LoTi scores does not guarantee criterion validity, as teacher responses to the survey were still subject to potential personal bias and subjectivity in interpreting the survey questions. Without validating the instrument using some external standard, the instrument remains susceptible to bias and subjectivity, as noted in Chapter II's discussion of the LoTi instrument (Stoltzfus, 2006).

Using the LoTi survey instrument as the measure for the independent variable meant that the population for the study was highly unique because not all high schools in Texas are required to participate in the LoTi survey like they are required to participate in the Texas STAR chart, mentioned in Chapter II. This highly unique nature of the variable is one justification for the use of purposive sampling for the study, a method of sampling generally used for qualitative research (Patton, 1990). The researcher picked the subjects to participate in the study based on identified variables under consideration. In the case of this study, English, math, science, and social studies teachers who had taken the LoTi survey were picked because they had the independent variable score from the LoTi survey, and they taught students with a TAKS score that provided the dependent variable.

Another justification for using purposive sampling for this study was that it helped to focus the study on testing the viability of constructivism as a theoretical framework that defined high impact technology use on student learning. As discussed in Chapter II, the LoTi framework was premised on a constructivist theoretical framework. The study was able to test the constructivist framework through the LoTi survey instrument, and purposive sampling allowed the study to hone its focus on that because it had handpicked the members of the study to be teachers who had completed the LoTi survey. To be sure, purposive sampling is a nonrandom method of sampling, so one cannot be assured that every element available is fairly represented in the sample for this study. Consequently, one must apply findings from this study with caution.

Data Analysis

The data were analyzed using the appropriate quantitative techniques outlined in *Educational Research: An Introduction* by Gall, Borg, and Gall (1996). Using version 11/5/1 of the Statistical Package for Social Studies (SPSS) computer program, a variety of one-way and two-way Analysis of Variance (ANOVA) tests and t-tests for independent samples were run. When three groups were compared, an ANOVA test or a t-test was run to compare mean TAKS scale scores for all students assigned to a particular teacher. When two groups were compared, an independent samples t-test was run. The teachers in each content area, then, were grouped into distinct groups based on their LoTi rating. If a significant difference was found after an ANOVA test was run, a Scheffe's test was run for further analysis. Using an ANOVA or t-test for each of the four relevant content area TAKS tests, mean scale scores of students in a teacher's class with a low LoTi rating were compared to those mean scale scores of the students in a teacher's class with a middle and high LoTi rating. Additionally, a two-way ANOVA was run in a similar fashion to compare the differences between the mean scale scores of students of low socio-economic status (low SES) and non-low SES students, within a given teacher LoTi rating group (i.e., low, middle, or high LoTi). If a significant difference was found using an ANOVA, then a Scheffé post hoc test was used to determine between which of the three groups the difference occurred. A Scheffé post hoc test was used because of its relatively conservative nature in determining significance when compared to other post hoc tests (Kerlinger, 1986).

CHAPTER IV

PRESENTATION OF FINDINGS

This study investigated the relationship of teacher Levels of Technology Implementation (LoTi) scores and student Texas Assessment of Knowledge and Skills (TAKS) scores at Alamo Heights High School in Alamo Heights Independent School District in San Antonio, Texas. The study examined whether there was a relationship between teacher LoTi scores and student TAKS scores in reading (9th grade), English Language Arts (ELA, 10th and 11th grades), math (9th-11th grades), science (10th and 11th grades), and social studies (10th and 11th grades). If a relationship existed in a particular content area, the second purpose of the study was to determine whether such a relationship differed according to a student's economic status. That is, the study examined whether teacher LoTi scores affect student TAKS scores of economically disadvantaged, or low socioeconomic status (low SES), students differently than they affected student TAKS scores of non-low SES kids.

Research Questions

Thus, the intent of the research was to answer two questions regarding teacher LoTi scores and student TAKS scores. The following research questions were posed:

1. Is there a relationship between teacher LoTi ratings and student TAKS scores as reported in student records at Alamo Heights High School, San Antonio, Texas?
2. Does a relationship between teacher LoTi ratings and student TAKS scores differ according to students' economically disadvantaged status as reported

in student records at Alamo Heights Independent School District, San Antonio, Texas?

Research Question 1

In order to determine whether or not there was a relationship between teacher LoTi scores and student TAKS scores, teacher LoTi data and student TAKS and demographic data were gathered for each content area. For each content area, students were categorized into discreet groups by their teacher's LoTi score. For example, all students within a particular content area, like math, who had a teacher in that content area with a LoTi score of 2 were considered a group. All students within a particular content area who had a teacher in that content area with a LoTi score of 3 were considered a different group, and so on. A mean score for each group within a particular content area was calculated to compare one group mean to another, and the appropriate inferential statistical test was performed to analyze the data.

Teacher LoTi Scores and English Language Arts TAKS Scores

The total number of students tests scored for the 9th grade reading TAKS test and 10th-11th grade English Language Arts (ELA) TAKS test was 946. A student test was scored unless as a student who was absent, was exempt from the test, or took a different test instead of TAKS because of stipulations in a special education student's Individual Education Plan (IEP). This procedure resulted in a total of 946 students for this particular statistical analysis. Table 4.1 shows the distribution of English teacher LoTi scores and the number of students who comprised each group defined by the teacher LoTi score. As the table indicates, two distinct groups arose: (a) English teacher LoTi score of 2 and (b) English teacher LoTi score of 3. Accordingly, a t-test for independent samples was performed using the Statistical Package for the Social Sciences (SPSS) software, version 11.0. Table 4.2 shows the group statistics for this t-test, and Table 4.3 shows the results of the t-test for the independent samples of students in group 1 comprised of students with a teacher whose LoTi score was 2 and students in group 2 comprised of students with a teacher whose LoTi score was 3.

Table 4.1. Distribution in Groups, by English Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took Reading and English Language Arts (ELA) Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

ELA Teacher LoTi	Students N
2	536
3	410
Total	946

Table 4.2. Descriptive Statistics for Groups, by Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took Reading and English Language Arts (ELA) Texas Assessment of Knowledge and Skills (TAKS) Tests in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

ELA Teacher LoTi	Students N	TAKS Scale Score Mean	Standard Deviation	Standard Error Mean
2	536	2323.66	139.283	6.016
3	410	2360.38	109.117	5.389

Table 4.3. Summary of Inferential Statistics Test Independent Samples t-test of Groups, by Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took Reading and English Language Arts (ELA) Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% confidence interval of the difference	
		F	Sig.	t	Degrees of freedom	Significance *(2-tailed)	Mean difference	Standard error difference	Lower	upper
ELA scale score	Equal variances assumed	21.791	.000	-4.40	944	.000	-36.71	8.339	-53.076	-20.347
	Equal variances not assumed			-4.54	943.455	.000	-36.71	8.007	-52.562	-20.861

*Significant at the 0.05 level.

Before advancing to an analysis of the results of this t-test, it is instructive to point out the high F value in Table 4.3 under Levene's Test for Equality of Variances. A significance level of less than .05 indicates that the two groups do not have equal variance on the dependent values of student TAKS scores. That means that the distribution of the scores in one of the groups may be skewed. This violation of the assumption of homogeneity of variance suggests that one interpret the results below with extreme caution.

In order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with ELA TAKS scores. When two distinct groups were found of students who had English teachers with a LoTi score of 2 and students with a LoTi score of 3, then a t-test for independent samples was determined to be the appropriate test to use to gauge whether a relationship existed because it tests the differences between the means of two groups.

Teacher LoTi Scores and English Language Arts TAKS Scores – Results

The difference between the two ELA groups was found to be significantly different at the .05 level. The t-test for independent samples compares the level of significance generated by the inferential procedure against the critical level of significance, which in this case is .05. As seen in Table 4.3, under the columns for t-test for Equality of Means, the 2-tailed significance measures less than .000, less than the critical level of significance at .05. Based on this level of comparison, the null hypothesis that there is no relationship between an English teacher's LoTi score and student ELA TAKS scores is rejected. Rejecting the null hypothesis suggests that within the student population from which this study took a sample, the mean of students who had an English teacher whose LoTi score is 2 is significantly different from the mean of students whose English teacher LoTi score is 3. Thus, a relationship between an English teacher's LoTi score and student ELA TAKS scores may be inferred.

Teacher LoTi Scores and Math TAKS Scores

A student's TAKS test was scored unless a student who was absent, exempt from the test, or took a different test instead of TAKS because of stipulations in special education student's Individual Education Plan (IEP). There were a total of 979 students this particular statistical analysis. Table 4.4 shows the distribution of teacher math LoTi scores and the number of students who comprised each of those groups. As the table indicates, three distinct groups arose: (a) math teacher LoTi score of 1, (b) math teacher LoTi score of 2, and (c) math teacher LoTi score of 3. Accordingly, a one-way Analysis of Variance (ANOVA) was performed using SPSS software. Table 4.5 shows the group statistics for the ANOVA, and Table 4.6 shows the results of the ANOVA for the independent samples of students in each group.

Table 4.4. Distribution in Groups, by Math Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Math Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Math Teacher LoTi	Students N
1	206
2	370
3	403
Total	979

Table 4.5. Descriptive Statistics of Math 2007 TAKS Scale Scores for Groups of Students Formed by Math Teacher Level of Technology Implementation (LoTi) Scores of Students at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

					95% confidence interval for mean			
Math teacher LoTi	Students N	TAKS scale score mean	Standard deviation	Standard error	Lower Bound	Upper bound	Minimum	Maximum
1	206	2273.30	184.917	12.884	2247.90	2298.70	1881	2967
2	370	2259.46	212.321	11.038	2237.76	2281.17	1742	2967
3	403	2402.45	204.020	10.163	2382.47	2422.43	1950	2967
Total	979	2321.23	214.315	6.850	2307.79	2334.68	1742	2967

Table 4.6. Summary of Inferential Statistics Test Analysis of Variance (ANOVA) Math Scale Scores From the Spring 2007 Administration of TAKS and Math Teacher Level of Technology Implementation (LoTi) Scores at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

	Sum of squares	Degrees of freedom	Mean square	F	Significance*
Between groups	4543155	2	2271577.438	54.908	.000
Within groups	40377387	976	41370.274		
Total	44920542	978			

*Significant at the 0.05 level.

In order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with math TAKS scores. Three distinct groups were found: (a) students who had a math teacher with a LoTi score of 1, (b) students who had a math teacher with a LoTi score of 2, and (c) students who had a math teacher with a LoTi score of 3. An Analysis of Variance (ANOVA) was determined to be the appropriate test to gauge whether a relationship existed because it tests the differences between the means of two or more groups.

Teacher LoTi Scores and Math TAKS Scores – Results

There was a statistically significant difference at the .05 level for the math group comparison after running the ANOVA test. The ANOVA compares the level of significance generated by the inferential procedure against the critical level of significance (in this case .05). As seen in Table 4.6, under the significance column, the measure was less than .000, less than the critical level of significance at .05. Thus, there was a statistically significant difference between at least one of the three group means and at least one other of the group means. Based on this level of comparison, the null hypothesis that there is no relationship between a math teacher's LoTi score and student math TAKS scores is rejected.

Given that there are three groups, however, the ANOVA alone does not indicate which group mean varied from another group mean to a statistically significant degree. Thus, the researcher conducted a Scheffe post hoc test to compare the differences of all three group means. Table 4.7 shows the results of the Scheffe post hoc test and reveals that no statistically significant difference exists between groups 1 and 2, but the difference between the mean of group 3 was statistically significant from the means of groups 1 and 2. Thus, rejecting the null hypothesis and conducting the Scheffe post hoc test suggests that within the student population from which this study took a sample, the mean of students with a math teacher whose LoTi score is 2 or 1 is significantly different from the mean of students with a math teacher whose LoTi score is 3. Thus, a relationship between a math teacher's LoTi score and student math TAKS scores may be inferred.

Table 4.7. Summary of Scheffe Post Hoc Test, by Math Teacher Level of Technology Implementation (LoTi) Score of Students Who Took the Spring 2007 TAKS Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

		Subset for alpha= .05	
Math Teacher LoTi	Students N	1	2
2	370	2259.46	
1	206	2273.30	
3	403		2402.45
Significance		.708	1.000

Teacher LoTi Scores and Science TAKS Scores

The total number of students who had a scored test for the 10th and 11th grade science TAKS test at Alamo Heights High School was 509. A student's test was scored unless a student was absent, exempt from the test, or took a different test instead of TAKS because of stipulations in a special education student's Individual Education Plan. The procedure yielded a total of 509 students for this particular statistical analysis.

Table 4.8 shows the distribution of science teacher LoTi scores and the number of students who comprised each group. As the table indicates, two distinct groups arose: science teacher LoTi score of 2 and science teacher LoTi score of 3. Accordingly, a t-test for independent samples was performed using SPSS software. Table 4.9 shows the group statistics for this t-test, and Table 4.10 shows the results of the t-test for the independent samples of students. Group 1 contains students with a science teacher whose LoTi score was 2. Group 2 contains students whose science teacher's LoTi score was 3.

Table 4.8. Distribution in Groups, by Science Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Science Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Science Teacher LoTi	Students N
2	170
3	339
Total	509

Table 4.9. Descriptive Statistics for Groups, by Science Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Science Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Science Teacher LoTi	Students N	TAKS Scale Score Mean	Standard Deviation	Standard Error
2	271	2264.17	159.705	9.701
3	207	2354.19	168.829	11.734

Table 4.10. Summary of Inferential Statistics Test Independent Samples t-test of Groups, by Science Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Science Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Degrees of freedom	Sig.* (2-tailed)	Mean difference	Standard error dif.	95% confidence interval of the difference Lower	upper
Science scale score	Equal variances assumed	.396	.530	-5.95	476	.000	-90.02	15.112	-119.71	-60.327
	Equal variances note assumed			-5.91	430.423	.000	-90.02	15.225	-119.94	-60.097

*Significant at the 0.05 level.

In order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with science TAKS scores. When two distinct groups were found, students who had a science teacher with a LoTi score of 2 and students who had a science teacher with a LoTi score of 3, a t-test for independent samples was determined to be the appropriate test to gauge whether a relationship existed because it tests the differences between the means of two groups.

Teacher LoTi Scores and Science TAKS Scores – Results

There was a statistically significant difference between the two science groups. The t-test for independent samples compares the level of significance generated by the inferential procedure against the critical level of significance of .05. As seen in Table 4.10, under the columns for t-test for Equality of Means, the significance measures less than .000, which is less than the critical level of significance at .05. Based on this level of comparison, the null hypothesis that there is no relationship between a science teacher's LoTi score and student science TAKS scores is rejected. Rejecting the null hypothesis suggests that within the student population from which this study took a sample, the mean of students with a science teacher whose LoTi score is 2 is significantly different from the mean of students with a science teacher whose LoTi score is 3. Thus, a relationship between a science teacher's LoTi score and student science TAKS scores may be inferred.

Teacher LoTi Scores and Social Studies TAKS Scores

The total number of students who had a TAKS test scored for the social studies TAKS test grades 10 and 11 was 603. A student's test was scored unless a student who was absent, exempt from the test, or took a different test instead of TAKS because of stipulations in a special education student's Individual Education Plan. The procedure yields a total of 603 students for this particular statistical analysis. Table 4.11 shows the distribution of teacher LoTi scores and the number of students who comprised each group. As the table indicates, three distinct groups arose: (a) social studies teacher LoTi score of 1, (b) social studies teacher LoTi score of 3, and (c) social studies teacher LoTi score of 4. Accordingly, a one-way Analysis of Variance (ANOVA) was performed using SPSS software.

Table 4.11. Distribution in Groups, by Social Studies Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Social Studies Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Social Studies Teacher LoTi	Students N
1	218
3	138
4	247
Total	603

Table 4.12 shows the group statistics for ANOVA, and Table 4.13 shows the results of the ANOVA for the independent samples of students in groups 1, 2, and 3.

Table 4.12. Descriptive Statistics for Groups, by Social Studies Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Social Studies Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Social Studies teacher LoTi	Students	TAKS scale score mean	Standard deviation	Standard error	95% confidence interval for mean Lower Bound	95% confidence interval for mean Upper bound	Minimum	Maximum
1	218	2430.04	166.093	11.249	2407.87	2452.21	2020	2783
3	138	2379.80	124.861	10.629	2358.78	2400.81	2048	2752
4	247	2485.34	187.808	11.950	2461.80	2508.87	1915	2783
Total	603	2441.19	172.088	7.008	2427.43	2454.96	1915	2783

In order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with social studies TAKS scores. Three distinct groups were found: (a) students who had a social studies teacher with a LoTi score of 1, (b) students who had a social studies teacher with a LoTi score of 3, and (c) students who had a social studies teacher with a LoTi score of 4. Thus, an Analysis of Variance (ANOVA) was determined to be the appropriate test to gauge whether a relationship existed because it tests the differences between the means of two or more groups.

Teacher LoTi Scores and Social Studies TAKS Scores – Results

There was a statistically significant difference at the .05 level between the three social studies groups after running the ANOVA test. The ANOVA compares the level of significance generated by the inferential procedure against the critical level of significance of .05. As seen in Table 4.13, under the significance column, the measure was less than .000, which is less than the critical level of significance at .05. Thus, there was a statistically significant difference between at least one of the three group means and at least another mean. Based on this level of comparison, the null hypothesis that there is no relationship between a social studies teacher's LoTi score and student social studies TAKS scores is rejected.

Table 4.13. Summary of Inferential Statistics Analysis of Variance (ANOVA) Test, by Social Studies Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Social Studies Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance*
Between groups	1028602	2	514300.814	18.369	.000
Within groups	16799096	600	27998.493		
Total	17827698	602			

*Significant at the 0.05 level.

Given that there are three groups, however, the ANOVA alone does not indicate which group means varied from one another to a statistically significant degree. Thus, the researcher conducted a Scheffe post hoc test to compare the differences of all three group means. Table 4.14 shows the results of the Scheffe post hoc test and reveals that a statistically significant difference exists between groups 1, 2, and 3. Rejecting the null hypothesis and conducting the Scheffe post hoc test suggest that within the student population from which this study took a sample, the mean of students with a social studies teacher whose LoTi score is 1, differs significantly from the mean of students with a social studies teacher whose LoTi score is 3, and both of those means differ significantly from the mean of students with a social studies teacher whose LoTi score is 4. Thus, a relationship between a social studies teacher’s LoTi score and student social studies TAKS scores may be inferred.

Table 4.14. Summary of Scheffe Post Hoc Test, by Social Studies Teacher Level of Technology Implementation (LoTi) Score, of Students Who Took the Social Studies Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

		Subset for alpha= .05		
Social Studies Teacher LoTi	Students N	1	2	3
3	138	2379.80		
1	218		2430.04	
4	247			2485.34
Significance		1.000	1.000	1.000

Research Question 2

In order to determine whether the relationship between teacher LoTi scores and student TAKS scores differed according to students' economically disadvantaged status, teacher LoTi data and student TAKS and demographic data were gathered for each content area. The method for answering question 2 began the same way that answering questioned 1 began. For each content area, students were categorized into groups by their teacher's LoTi score. For example, all students who had a math teacher with a LoTi score of 2 were considered a group for that particular content area comparison. All students who had a math teacher with a LoTi score of 3 were considered a different group for that particular content area, and so on. A mean score for each group was calculated to compare one group mean to another, and the appropriate inferential statistical test was performed to analyze the data.

To answer research question 2, an additional step examined students in terms of their socio-economic status. For each content area, students within a teacher LoTi score group were subdivided into two categories: low socioeconomic status (low SES) and non-low socioeconomic status. District demographic data identified a student as being on the free lunch program (low SES), the reduced lunch program (low SES), or the full lunch program (non-low SES).

Teacher LoTi Scores, English Language Arts TAKS Scores, and Student Socio-Economic Status

The total number of students who had a TAKS test scored for the 9th grade reading TAKS test and 10th-11th grade English Language Arts TAKS test was 946. Table 4.1, mentioned above, shows the distribution of English teacher LoTi scores and the number of students who had teachers of a certain LoTi score. As the table indicates, two distinct groups arose: English teacher LoTi score of 2 and English teacher LoTi score of 3. Accordingly, a t-test for independent samples was performed using SPSS software. Table 4.2 shows the group statistics for this t-test, and Table 4.3 shows the results of the t-test for the independent samples of students in groups 1 and 2.

Table 4.15 shows the further subdividing of students who took the ELA TAKS test by their socio-economic status. Within the first category, students whose English teacher had a LoTi score of 2, the total number of students was 536, with 476 in the non-low SES sub-category and 60 in the low SES sub-category, which included students on the free or reduced lunch program. Within the second category, students whose teacher had a LoTi score of 3, the total number of students was 410, with 386 in the non-low SES sub-category and 24 in the low SES category.

Table 4.15. Descriptive Statistics for Groups, by English teacher Level of Technology Implementation (LoTi) Score and Student Economic Status, of Students Who Took Reading and English Language Arts (ELA) Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

ELA Teacher LoTi	Economic Status	TAKS Mean Scale Score	Standard Deviation	Students N
2	Not economically disadvantaged	2338.31	136.193	476
	Economically disadvantaged	2207.48	105.474	60
	Total	2323.66	139.283	536
3	Not economically disadvantaged	2363.74	105.784	386
	Economically disadvantaged	2306.33	145.522	24
	Total	2360.38	109.117	410
Total	Not economically disadvantaged	2349.69	124.084	862
	Economically disadvantaged	2235.73	125.675	84
	Total	2339.58	128.326	946

As mentioned above, for question 1, in order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with ELA TAKS scores. When two distinct groups were found, students who had a English teacher with a LoTi score of 2 and students who had an English teacher with a LoTi score of 3, a t-test for independent samples was determined to be the appropriate test to use to gauge whether a relationship existed because it tests the differences between the means of two groups.

For question 2, the data were further divided into two sub-groups of students classified as low socio-economic and those who were not classified as low socio-economic status i.e., students who were not on the free or reduced lunch program. An

Analysis of Variance (ANOVA) was determined to be the appropriate test to gauge whether the relationship, established by the t-test in question 1, differed according to students' economically disadvantaged status.

Before advancing to an analysis of the results below, it is instructive to point out the low number (N) of low SES students in each group listed in Table 4.15. LoTi 2 group had 60 low SES students, while the LoTi 3 group had only 24. With such small numbers involved in this phase of the study, sample size becomes an issue. Thus, one must exercise caution when drawing conclusions from the results discussed below.

Teacher LoTi Scores, English Language Arts TAKS Scores, and Student Socio-Economic Status – Results

As mentioned above in the section for question 1, the t-test for independent samples compares the level of significance generated by the inferential procedure against the critical level of significance of.05. As seen in Table 4.3, under the columns for t-test for Equality of Means, significance measures less than .000, which is less than the critical level of significance at .05. Based on this level of comparison, the null hypothesis that there is no relationship between an English teacher's LoTi score and student ELA TAKS score means is rejected. Rejecting the null hypothesis suggests that within the student population from which this study took a sample, the mean of students with an English teacher whose LoTi score is 2 is significantly different from the mean of students with an English teacher whose LoTi score is 3. Thus, a relationship between an English teacher's LoTi score and student ELA TAKS scores may be inferred.

An ANOVA test was used to answer question 2 as to whether the relationship between teacher LoTi scores and student TAKS scores differed according to students' economically disadvantaged status. An ANOVA compares the level of significance generated by the inferential procedure against a critical level of significance of .05. As seen in Table 4.16, in the significance column, there was a statistically significant difference between student means on the ELA TAKS for those whose English teacher had a LoTi score was 2 and those whose English teacher had a LoTi score of 3. The significance level of less than .001 is recorded in Table 4.16 in the source row "ELA teacher LoTi." The source row "Economic Disadvantaged" also records a significance level of less than .001, suggesting that there is a statistically significant difference between the student means on the ELA TAKS test for those who were classified as low SES and those who were classified as non-low SES.

Table 4.16. Summary of Analysis of Variance (ANOVA) Test, by English Teacher Level of Technology Implementation (LoTi) Score and Student Socio-Economic Status, of Students Who Took the Reading/English Language Arts (ELA) Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Source	Degrees of Freedom	F	Significance*
ELA teacher LoTi	1	16.186	.000
Economically Disadvantaged	1	37.130	.000
ELA teacher LoTi by Economically Disadvantaged	1	5.650	.018

*Significant at the 0.05 level.

Finally, the source row that answers question 2 is “ELA teacher LoTi by Economically Disadvantaged,” which looks at any possible interaction between the variables of student ELA TAKS score, teacher LoTi score, and student SES status. The significance level for this row was .018, less than the critical level at .05. This means that there is a statistically significant difference between the student means on the ELA TAKS for students in the low SES group whose English teacher had a LoTi score of 2 and student means on the ELA TAKS in the low SES group whose English teacher had a LoTi score of 3. The null hypothesis for question 2 is that there is no relationship between mean student scores on ELA TAKS, teacher LoTi scores, and student socio-economic status. Because the ANOVA suggests an interaction between those three variables at the .018 level, the null hypothesis is rejected. A relationship may be inferred between mean student scores on ELA TAKS, teacher LoTi scores, and student socio-economic status. This relationship is illustrated in a Figure 4.1.

Teacher LoTi Scores, Math TAKS Scores, and Student Socio-Economic Status

The total number of students who had a test scored for the math TAKS test grades 9-11 was 979. Table 4.4 shows the distribution of math teacher LoTi scores and the number of students who had math teachers of a certain LoTi score, revealing three groups. Accordingly, a one-way Analysis of Variance (ANOVA) was performed using SPSS software. Table 4.5 shows the group statistics for ANOVA, and Table 4.6 shows the results of the ANOVA for the independent samples of students in groups 1, 2, and 3.

Figure 4.1. Results of analysis of variance (ANOVA) test for interaction between English teacher level of technology implementation (LoTi) score, student ELA TAKS score means, and student socio-economic status, for students who took the math Texas Assessment of Knowledge and Skills (TAKS) test in the spring 2007 administration with a score code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas.

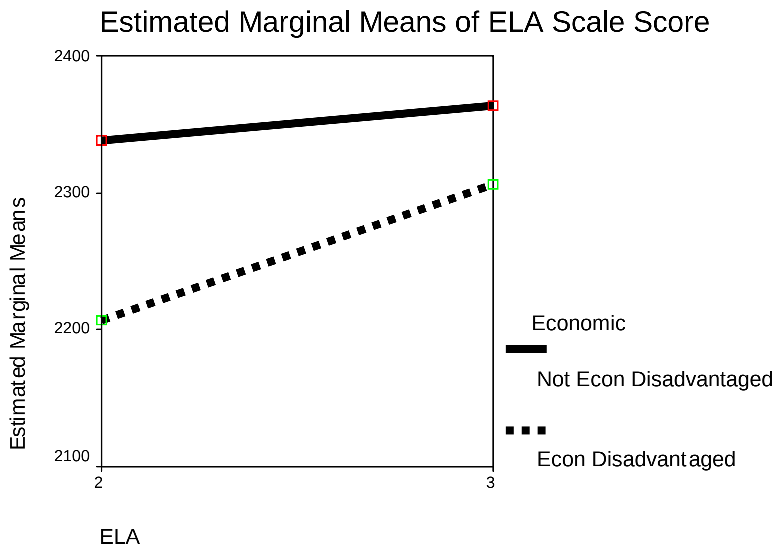


Table 4.17 shows the further subdividing of students who took the math TAKS test by their socio-economic status. Within the first category, there were 206 students whose math teacher had a LoTi score of 1 with 175 in the non-low SES sub-category and 31 in the low SES sub-category. Within the second category, there were 370 students whose math teacher had a LoTi score of 2 with 324 in the non-low SES sub-category and 46 in the low SES category. Within the third category, there were 403 students whose math teacher had a LoTi score of 3 with 384 in the non-low SES sub-category and 19 in the low SES category.

In order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with math TAKS scores. Three distinct groups were found: (a) students who had a math teacher with a LoTi score of 1, (b) students who had a math teacher with a LoTi score of 2, and (c) students who had a math teacher with a LoTi score of 3. Thus, an Analysis of Variance (ANOVA) was determined to be the appropriate test to gauge whether a relationship existed because it tests the differences between the means of two or more groups.

Table 4.17. Descriptive Statistics for Groups, by Math Teacher Level of Technology Implementation (LoTi) Score and Student Economic Status, of Students Who Took Math Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Math Teacher LoTi	Economic Status	TAKS Mean Scale Score	Standard Deviation	Students N
1	Not economically disadvantaged	2294.38	185.271	175
	Economically disadvantaged	2154.32	131.743	31
	Total	2273.30	184.917	206
2	Not economically disadvantaged	2288.27	205.559	324
	Economically disadvantaged	2056.57	135.308	46
	Total	2259.46	212.321	370
3	Not economically disadvantaged	2404.89	205.420	384
	Economically disadvantaged	2353.05	170.401	19
	Total	2402.45	204.020	403
Total	Not economically disadvantaged	2340.20	209.282	883
	Economically disadvantaged	2146.81	179.231	96
	Total	2321.23	214.315	979

Before advancing to an analysis of the results below, it is instructive to point out the low number (N) of low SES students in each group listed in Table 4.17. LoTi 1 group had 31, LoTi 2 group had 46 low SES students, while the LoTi 3 group had only 19. With such small numbers involved in this phase of the study, sample size becomes an issue. Thus, one must exercise caution when drawing conclusions from the results discussed below.

Teacher LoTi Scores, Math TAKS Scores, and Student Socio-Economic Status – Results

The ANOVA compares the level of significance generated by the inferential procedure against the critical level of significance of .05. As seen in Table 4.18 under the significance column, the measure was less than .000, which is less than the critical level of significance of .05. Thus, there was a statistically significant difference between at least one mean of the three groups and at least another mean of the groups. Based on this level of comparison, the null hypothesis that there is no relationship between a math teacher's LoTi score and student math TAKS score means is rejected.

Given that there are three groups, however, the ANOVA alone does not indicate which group means varied from one another to a statistically significant degree. Thus, the researcher conducted a Scheffe post hoc test to compare the differences of all three group means. Table 4.7 shows the results of the Scheffe post hoc test and reveals that no statistically significant difference exists between groups 1 and 2, but the difference between the mean of group 3 was statistically significant from the means of both groups 1 and 2. Thus, rejecting the null hypothesis and conducting the Scheffe post hoc test suggest that within the student population from which this study took a sample, the mean of students with a math teacher whose LoTi score is 2 or 1 is significantly different from the mean of students with a math teacher whose LoTi score is 3. Thus, a relationship between a math teacher's Loti score and student math TAKS scores may be inferred.

Table 4.18. Summary of Analysis of Variance (ANOVA) Test, by Math Teacher Level of Technology Implementation (LoTi) Score and Student Socio-Economic Status, of Students Who Took the Math Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

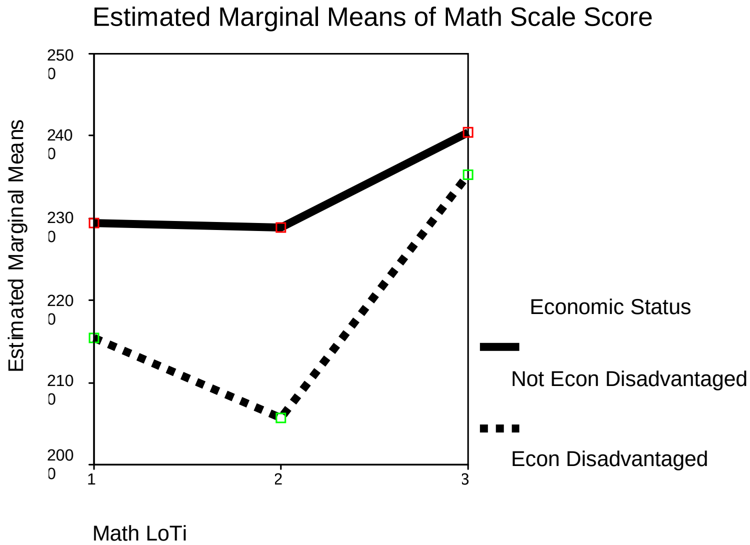
Source	Degrees of Freedom (df)	F	Significance*
Math teacher LoTi	2	27.682	.000
Economically Disadvantaged	1	39.288	.000
Math teacher LoTi by Economically Disadvantaged	2	5.523	.018

*Significant at the 0.05 level.

An ANOVA test was used to answer question 2 as to whether the relationship between teacher LoTi scores and student TAKS scores differed according to students' economically disadvantaged status. An ANOVA compares the level of significance generated by the inferential procedure against a critical level of significance of .05. As seen in Table 4.18, in the significance column, there was a statistically significant difference between student means on the math TAKS for those whose math teacher had a LoTi score was 1 or 2 and those whose math teacher had a LoTi score of 3. The significance level of less than .001 is recorded in Table 4.18 in the source row "Math teacher LoTi." Conversely, as mentioned above in the section on question 1, Table 4.7 shows that there was no statistically significant difference between student means on the math TAKS for those whose teacher had a LoTi score of 1 from those whose teacher had a LoTi score of 2. The source row "Economically Disadvantaged" also records a significance level of less than .001, suggesting that there is a statistically significant difference between the student means on the math TAKS test for those who were classified as low SES and those who were classified as non-low SES.

Finally, the source row "Math teacher LoTi by Economically Disadvantaged" answers question 2 as to whether the relationship between teacher LoTi scores and student TAKS scores differed according to students' economically disadvantaged status. This source row reported any possible interaction between the variables of student math TAKS score, math teacher LoTi score, and student SES status. The significance level for this row was .004, which is less than the critical level of .05. This means that there is a statistically significant difference between math TAKS score means for students in the low SES group whose math teacher had a LoTi score of 1 or 2 and student means on the math TAKS in the low SES group whose teacher had a LoTi score of 3. The null hypothesis for question 2 is that there is no relationship between mean student scores on math TAKS, math teacher LoTi scores, and student socio-economic status. Because the ANOVA suggests an interaction between those three variables at the .004 level, the null hypothesis is rejected. A relationship may be inferred between mean student scores on math TAKS, math teacher LoTi scores, and student socio-economic status. This relationship is illustrated in a Figure 4.2.

Figure 4.2. Results of analysis of variance (ANOVA) test for interaction between math teacher level of technology implementation (LoTi) score, student math TAKS score means, and student socio-economic status, for students who took the math Texas Assessment of Knowledge and Skills (TAKS) test in the spring 2007 administration with a score code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas.



Teacher LoTi Score, Science TAKS Scores, and Student Socio-Economic Status

The total number of students who had a test scored for the 10th-11th grade science TAKS test was 509. Table 4.8 mentioned above shows the distribution of science teacher LoTi scores and the number of students who had a science teacher with a particular LoTi score. As the table indicates, two distinct groups arose: (a) science teacher LoTi score of 2 and (b) science teacher LoTi score of 3. Accordingly, a t-test for independent samples was performed using SPSS software. Table 4.9 shows the group statistics for this t-test, and Table 4.10 shows the results of the t-test for the independent samples of students in groups 1 and 2.

Table 4.19 shows descriptive statistics for students who took the science TAKS test in terms their socio-economic status. Within the first category, there were 170 students whose science teacher had a LoTi score of 2 with 167 in the non-low SES sub-category and 3 in the low SES sub-category. Within the second category, there were 339 students whose science teacher had a LoTi score of 3 with 303 in the non-low SES sub-category and 36 in the low SES category.

Table 4.19. Descriptive Statistics for Groups, by Science Teacher Level of Technology Implementation (LoTi) Score and Student Economic Status, of Students Who Took the Science Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration with a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Science Teacher LoTi	Economic Status	TAKS Mean Scale Score	Standard Deviation	Students N
2	Not economically disadvantaged	2420.83	155.693	167
	Economically disadvantaged	2368.33	314.656	3
	Total	2419.90	158.208	170
3	Not economically disadvantaged	2243.43	141.936	303
	Economically disadvantaged	2105.28	152.848	36
	Total	2228.76	149.118	339
Total	Not economically disadvantaged	2306.46	169.636	470
	Economically disadvantaged	2125.51	178.247	39
	Total	2292.60	176.819	509

As mentioned above in the section on question 1, in order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with science TAKS scores. When two distinct groups were found, students who had a science teacher with a LoTi score of 2 and students who had a science teacher with a LoTi score of 3 a t-test for independent samples was determined to be the appropriate test to gauge whether a relationship existed because it tests the differences between the means of two groups.

For question 2, the data were divided further into two sub-groups of students classified as low socio-economic status i.e., students on the free or reduced lunch program and those who were not classified as low socio-economic status. An Analysis of Variance (ANOVA) was determined to be the appropriate test to gauge whether the relationship established by the t-test in question 1 differed according to students' economically disadvantaged status.

Before advancing to an analysis of the results below, it is instructive to point out the low number (N) of low SES students in each group listed in Table 4.19. LoTi 2 group had only 3 low SES students, while the LoTi 3 group had 36. With such small numbers involved in this phase of the study, sample size becomes an issue. Thus, one must exercise caution when drawing conclusions from the results discussed below.

Teacher LoTi Scores, Science TAKS Scores, and Student Socio-Economic Status – Results

As mentioned above in the section on question 1, the t-test for independent samples compares the level of significance generated by the inferential procedure against the critical level of significance of .05. As seen in Table 4.10, under the columns for t-test for Equality of Means, significance 2-tailed measures less than .000, which is less than the critical level of significance of .05. Based on this level of comparison, the null hypothesis that there is no relationship between a science teacher's LoTi score and science TAKS mean scores for groups of students is rejected. Rejecting the null hypothesis suggests that within the student population from which this study took a sample, the mean of student scores with a science teacher whose LoTi score is 2 is significantly different from the mean of student scores with a science teacher whose LoTi score is 3. Thus, a relationship between a science teacher's LoTi score and student science TAKS scores may be inferred.

An ANOVA test was used to answer question 2. An ANOVA compares the level of significance generated by the inferential procedure against a critical level of significance of .05. As seen in Table 4.20, in the significance column, there was a statistically significant difference between student means on the science TAKS for those whose science teacher had a LoTi score of 2 and those whose science teacher had a LoTi score of 3. The significance level of less than .000 is recorded in Table 4.20 in the source row "Science teacher LoTi." The source row "Economically Disadvantaged" also records a significance level of .035, suggesting that there is a statistically significant difference between the student means on the science TAKS test for those who were classified as low and those who were classified as non-low SES.

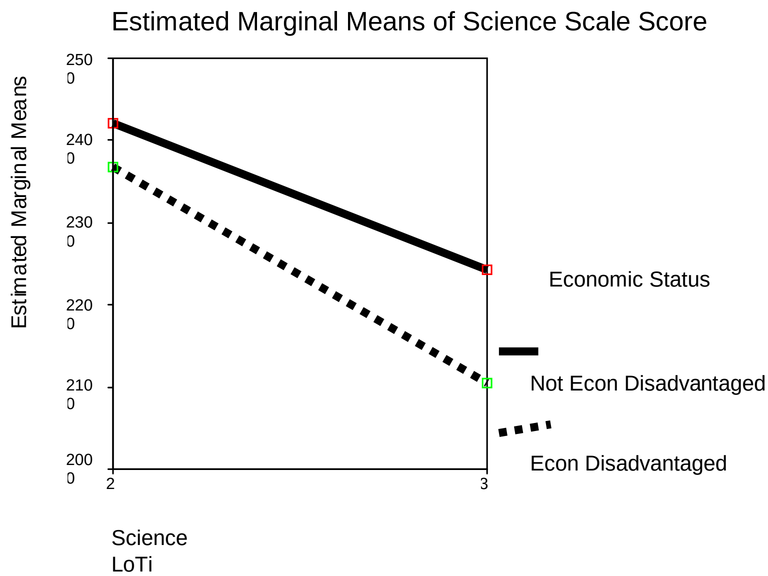
Table 4.20. Summary of Analysis of Variance (ANOVA) Test, by Science Teacher Level of Technology Implementation (LoTi) Score and Student Socio-Economic Status, of Students Who Took the Science Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Source	Degrees of Freedom	F	Significance* N
Science teacher LoTi	1	23.778	.000
Economically Disadvantaged	1	4.455	.000
Science teacher LoTi by Economically Disadvantaged	1	.899	.343

*Significant at the 0.05 level.

Finally, the source row that answers question 2, is “Science teacher LoTi by Economically Disadvantaged.” This row records any interaction between the variables of student science TAKS score, science teacher LoTi score, and student SES status. The significance level for this row was .343, which was not less than the critical level at .05. This means that there is no statistically significant difference between the student means on the science TAKS for students in the low SES group whose teacher had a LoTi score of 2 and student means on the science TAKS in the low SES group whose teacher had a LoTi score of 3. The null hypothesis for question 2 is that the relationship between mean student scores on science TAKS and teacher LoTi scores does not vary according to student socio-economic status. Because the ANOVA results do not suggest an interaction between those three variables, the null hypothesis cannot be rejected. A relationship may not be inferred between mean student scores on science TAKS, teacher LoTi scores, and student socio-economic status. This result is illustrated in Figure 4.3.

Figure 4.3. Results of analysis of variance (ANOVA) test for interaction between science teacher level of technology implementation (LoTi) score, student science TAKS score means, and student socio-economic status, for students who took the science Texas Assessment of Knowledge and Skills (TAKS) test in the spring 2007 administration with a score code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas.



Teacher LoTi Scores, Social Studies TAKS Scores, and Student Socio-Economic Status

The total number of students who had a test scored was 603 for the social studies TAKS test grades 10-11. Table 4.11 shows the distribution of social studies teacher LoTi scores and the number of students who had a social studies teacher of a particular LoTi score. As the table indicates, three distinct groups arose: (a) social studies teacher LoTi score of 1, (b) social studies teacher LoTi score of 3, and (c) social studies teacher

LoTi score of 4. Accordingly, a one-way Analysis of Variance (ANOVA) was performed using SPSS software. Table 4.12 shows the group statistics for the ANOVA test, and Table 4.13 shows the results of the ANOVA for the independent samples of students in LoTi groups 1, 2, and 3.

Table 4.21 shows the students who took the social studies TAKS test in terms of their socio-economic status. Within the first category there were 218 students whose social studies teacher had a LoTi score of 1 with 200 in the non-low SES sub-category and 18 in the low SES sub-category. Within the second category there were 138 students whose social studies teacher had a LoTi score of 3 with 129 in the non-low SES sub-category and 9 in the low SES category. Within the third category there were 247 students whose social studies teacher had a LoTi score of 4 with 224 in the non-low SES sub-category and 23 in the low SES category.

In order to analyze the data logically, the determination needed to be made as to how many discreet groups existed in the data set of students with social studies TAKS scores. Three distinct groups were found: (a) students who had a social studies teacher with a LoTi score of 1, (b) students who had a social studies teacher with a LoTi score of 3, and (c) students who had a social studies teacher with a LoTi score of 4. Thus, an Analysis of Variance (ANOVA) was determined to be the appropriate test to gauge whether a relationship existed because it tests the differences between the means of two or more groups.

Table 4.21. Descriptive Statistics for Groups, by Social Studies Teacher Level of Technology Implementation (LoTi) Score and Student Economic Status, of Students Who Took Social Studies Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Social Studies Teacher LoTi	Economic Status	TAKS Mean Scale Score	Standard Deviation	Students N
1	Not economically disadvantaged	2444.44	161.884	200
	Economically disadvantaged	2270.11	125.895	18
	Total	2430.44	166.093	218
3	Not economically disadvantaged	2383.98	123.491	129
	Economically disadvantaged	2319.78	136.548	9
	Total	2379.80	124.861	138
4	Not economically disadvantaged	2497.65	182.509	224
	Economically disadvantaged	2365.39	200.455	23
	Total	2485.34	187.808	247
Total	Not economically disadvantaged	2451.89	168.487	553
	Economically disadvantaged	2322.88	168.692	50
	Total	2441.19	172.088	603

Before advancing to an analysis of the results below, it is instructive to point out the low number (N) of low SES students in each group listed in Table 4.21. LoTi 1 group had 18, LoTi 3 group had 9 low SES students, and the LoTi 4 group had only 23. With such small numbers involved in this phase of the study, sample size becomes an issue. Thus, one must exercise caution when drawing conclusions from the results discussed below.

Teacher LoTi Scores, Social Studies TAKS Scores, and Student Socio-Economic Status – Results

The ANOVA compares the level of significance generated by the inferential procedure against the critical level of .05. As seen in Table 4.13, under the significance column the measure was less than .000, which was less than the critical level of significance at .05. Thus, there was a statistically significant difference between at least one mean of the three groups and at least another mean of the groups. Based on this level of comparison, the null hypothesis that there is no relationship between a social studies teacher's LoTi score and student mean social studies TAKS scores is rejected.

Given that there are three groups, however, the ANOVA alone does not indicate which group mean varied from another group mean to a statistically significant degree. Thus, the researcher conducted a Scheffe post hoc test to compare all three group means. Table 4.14 shows the results of the Scheffe post hoc test and reveals a statistically significant difference between groups 1 and 2, 2 and 3, and 1 and 3. Thus, rejecting the null hypothesis and conducting the Scheffe post hoc test suggest that within the student population from which this study took a sample, the mean of students with a social studies teacher whose LoTi score is 1 is significantly different from the mean of students with a social studies teacher whose LoTi score is 3, and both of those means are significantly different from the mean of students with a social studies teacher whose LoTi score is 4. Thus, a relationship between a social studies teacher's LoTi score and student social studies TAKS mean scores may be inferred.

An ANOVA test was used to answer question 2. An ANOVA compares the level of significance generated by the inferential procedure against a critical level of .05. As seen in Table 4.22, in the significance column, there was a statistically significant difference between student means on the social studies TAKS for those whose social studies teacher had a LoTi score of 1, 3, or 4. The significance level of less than .007 is recorded in Table 4.22 in the source row "Social Studies teacher LoTi." The source row "Economically Disadvantaged" also records a significance level of less than .000, suggesting that there is a statistically significant difference between the student means on the social studies TAKS test for those who were classified as low SES and those who were classified as non-low SES.

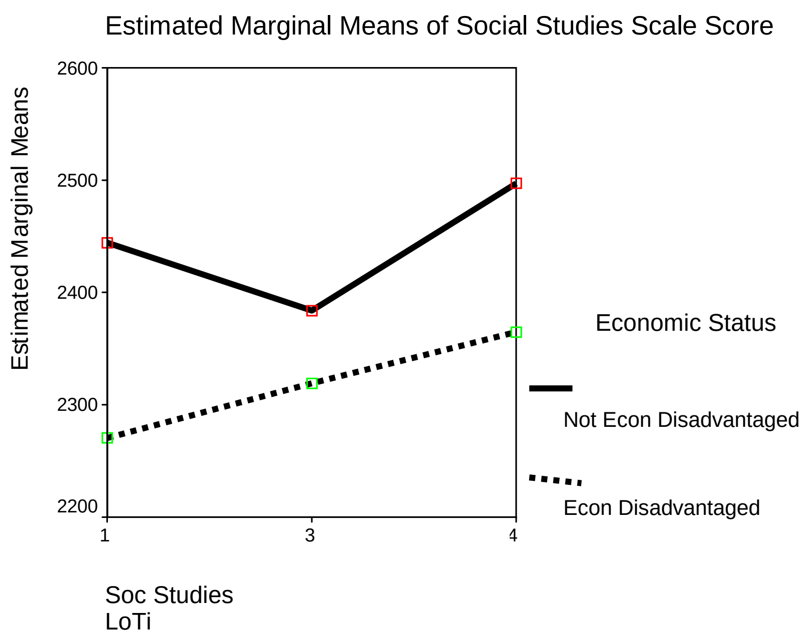
Table 4.22. Summary of Analysis of Variance (ANOVA) Test, by Social Studies Teacher Level of Technology Implementation (LoTi) Score and Student Socio-Economic Status, of Students Who Took the Social Studies Texas Assessment of Knowledge and Skills (TAKS) Test in the Spring 2007 Administration With a Score Code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas

Source	Degrees of Freedom	F	Significance*
Social Studies teacher LoTi	2	4.947	.007
Economically Disadvantaged	1	22.708	.000
Social studies teacher LoTi by Economically Disadvantaged	2	1.274	.280

*Significant at the 0.05 level.

Finally, the source row that answers question 2 is “Social studies teacher LoTi by Economically Disadvantaged.” This data report any interaction between the variables of student social studies TAKS mean score, social studies teacher LoTi score, and student SES status. The significance level for this row was .280, which is not less than the critical level of .05. This means that there is not a statistically significant difference between the student mean scores on the social studies TAKS for students in the low SES group whose social studies teacher had a LoTi score of 1, 3, or 4 and student mean scores on the social studies TAKS in the low SES group whose teacher had a LoTi score of 1, 3, or 4. The null hypothesis for question 2 is that the relationship between mean student scores on social studies TAKS and social studies teacher LoTi scores does not vary according to student socio-economic status. Because the ANOVA does not suggest an interaction between those three variables at the .05 level, the study failed to reject the null hypothesis. A relationship may not be inferred between mean student scores on social studies TAKS, social studies teacher LoTi scores, and student socio-economic status. This result is illustrated in a Figure 4.4.

Figure 4.4. Results of analysis of variance (ANOVA) test for interaction between social studies teacher level of technology implementation (LoTi) score, student social studies TAKS score means, and student socio-economic status, for students who took the social studies Texas Assessment of Knowledge and Skills (TAKS) test in the spring 2007 administration with a score code at Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas.



Summary of Findings

The intent of the research was to answer two questions regarding teacher LoTi scores and student TAKS scores. The following research questions were posed:

1. Is there a relationship between teacher LoTi ratings and student TAKS scores as reported in student records at Alamo Heights High School, San Antonio, Texas?

2. Does a relationship between teacher LoTi ratings and student TAKS scores differ according to students' economically disadvantaged status as reported

in student records at Alamo Heights Independent School District, San Antonio, Texas?

The findings of the study in the case of question 1 yield data that led the researcher to reject the null hypothesis for ELA, math, science, and social studies content area. Consequently, in each of those content areas a relationship may be inferred between teacher LoTi ratings and student TAKS scores. The level of technology implementation used by a teacher had an impact on student achievement on TAKS.

The findings of the study in the case of question 2 yield data that led the researcher to reject the null hypothesis in the two cases of ELA and math content areas. The study, however, yielded data that failed to reject the null hypothesis in the two cases of science and social studies. Consequently, in ELA and math, the relationship between teacher LoTi ratings and student TAKS scores did vary according to students' economically disadvantaged status. The level of technology implementation had the greatest impact on student achievement on ELA and math TAKS for economically disadvantaged students. In science and social studies, the relationship between teacher LoTi ratings and student TAKS scores did not appear to vary according to students' economically disadvantaged status.

Conclusions drawn from the research findings, recommendations for educators, and recommendations for further study will be discussed in Chapter V.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter is divided into three major sections. The first section presents a summary of the study, the procedures, and the author's findings based upon the research questions that were posted. The second section presents the conclusions that were derived from the data. Section three is comprised of the recommendations for educational leaders and the recommendations for future study.

Summary

The primary goal of the study was to examine the relationship between teacher Levels of Technology Implementation (LoTi) scores and student scores on the Texas Assessment of Knowledge and Skills (TAKS) exams. The teachers and students who comprised the study were from Alamo Heights High School in Alamo Heights ISD in San Antonio, Texas. The study examined whether there was a relationship between teacher LoTi scores and student TAKS scores in reading (9^{th} grade), English Language Arts (ELA, 10^{th} and 11^{th} grades), math (9^{th}-11^{th} grades), science (10^{th} and 11^{th} grades), and social studies (10^{th} and 11^{th} grades).

In order to determine whether or not there was a relationship between teacher LoTi scores and student TAKS scores, teacher LoTi data and student TAKS and demographic data were gathered. For each of the four content areas, students were categorized into groups by their teacher's LoTi score. For example, all students within a particular content area, like math, who had a teacher in that content area with a LoTi score of 2 were considered a group. All students within a particular content area who had a teacher in that content area with a LoTi score of 3 were considered a different group, and so on. A mean score for each group within a particular content area was calculated to compare one group mean to another, and the appropriate inferential statistical test was performed to analyze the data.

Within a given content area, if a relationship was found to exist between a teacher's LoTi score and student TAKS scores, then the second purpose of the study was to determine whether such a relationship differed according to a student's economic status. That is, the study examined whether teacher LoTi scores affect student TAKS scores of economically disadvantaged, or low socioeconomic status (low SES), students differently than they affected student TAKS scores of non-low SES kids.

Data were collected from Alamo Heights ISD and compiled in Excel spreadsheets and a FileMaker Pro database for statistical analysis. Student scores on the TAKS reading/English Language Arts (ELA), math, science, and social studies tests were collected and entered from existing records in the district. Similarly, teacher LoTi scores for English, math, science, and social studies teachers were compiled from existing records in the district. In addition, the Public Education Information Management System (PEIMS) was used to gather data on student economically disadvantaged status.

Data were collected from 946 9^{th}, 10^{th}, and 11^{th} graders who took the reading/ELA TAKS test; 979 9^{th}, 10^{th}, and 11^{th} graders who took the math TAKS test; 509 10^{th} and 11^{th} graders who took the science TAKS test; and 603 10^{th} and 11^{th} graders who took the social studies TAKS test. A total of 12 English teachers, 14 math teachers, 11 science teachers, and 14 social studies teachers (51 total teachers) from this campus made up the population under study. This sample was determined as a sample of convenience. Finally, using the Statistical Package for Social Studies (SPSS) version 11/5/1 computer program, independent samples t-tests and Analysis of Variance (ANOVA) tests were run to gather the necessary statistical comparison analyses. Independent samples t-tests were run when exactly two groups could be compared in a given content area. In this study, independent samples t-tests were run for the English Language Arts (ELA) and science content areas to answer the primary research question. An Analysis of Variance (ANOVA) test was run when more than two groups could be compared in a given content area. In this study, ANOVAs were run for the math and social studies content areas to answer the primary research question. To answer the secondary question about whether a relationship varied according to a student's economic status, ANOVAs were run for each of the four content areas because each case involved more than two groups.

Conclusions

Research Question 1

Research question 1 asked, "Is there a relationship between teacher LoTi ratings and TAKS scores as reported in student records at Alamo Heights High School, San Antonio, Texas?"

The results of this study indicate that there was a relationship between teacher LoTi scores and student TAKS scores for each of the four content areas of English, math, science, and social studies. Furthermore, in each content area, the students in the highest teacher LoTi score group had highest mean scores on the TAKS compared to students in the lower teacher LoTi score groups, and this difference was recorded as statistically significant. A significance level of less than .05 indicated that the two groups do not have equal variance on the dependent values of student TAKS scores. That means that the distribution of the scores in one of the groups may be skewed. This violation of the assumption of homogeneity of variance suggests that one interpret the results below with extreme caution in the case of the ELA content area conclusions.

The meaning for educators of this finding arises from the three main components of the LoTi framework. First, a teacher's LoTi score indicates the level of technology implementation that the teacher used in the classroom on a scale of 0 to 6: 0 = Nonuse; 1 = Awareness; 2 = Exploration; 3 = Infusion; 4A = Mechanical Integration; 4B = Routine Integration; 5 = Expansion; and 6 = Refinement. Second, these levels of technology implementation are characterized as teacher-centered levels 0 to 3 and student-centered at levels of 4-6 within the LoTi framework. Finally, the levels also increase according to the extent to which technology is used for higher-level thinking of application, analysis, synthesis, and evaluation. Thus, the finding that each of the inferential statistics test results show that the students in the highest teacher LoTi score group had highest mean scores on the TAKS compared to students in the lower teacher LoTi score groups means at least three things. The students had a teacher whose higher teacher LoTi score meant that (a) technology was infused into the classroom instruction to a greater extent than at lower teacher LoTi levels, (b) classroom activity was more student centered than at lower teacher LoTi levels, and (c) technology was used for higher levels of thinking than at lower teacher LoTi levels. One may infer that the higher TAKS scores for these groups of students were a result of these three characteristics of a classroom in which a teacher had the higher LoTi scores in each content area.

This conclusion about the impact of the level of technology implementation on student achievement is consistent with the literature about constructivist pedagogy and appropriate technology use. In the literature, information and communications technology (ICT) is often linked to constructivism, a learning approach in which classrooms are student-centered, active places where informed decision-making takes place using higher-order thinking, as opposed to a traditional learning approach that is teacher-centered, passive, and devoted to factual, knowledge-based learning (ISTE, 2007; Robertson, 2003a). To be sure, as some researchers have noted, “constructive learning can be integrated in classrooms with or without computers, [but] the characteristics of computer-based technologies make them a particularly useful tool for this type of learning” (Roschelle, Pea, Hoadley, Gordin, & Means, 2000, p. 79). For example, computer labs that graph data engage kids in immediate feedback that, in turn, may engage them in constructing their own knowledge about the processes under exploration. Electronic bulletin boards and web logs (blogs) facilitate active engagement between students in conversations, even those less likely to speak in a traditional class setting, such as a shy student. Simulations in English, math, science, and social studies create virtual situations that engage students in authentic learning experiences that mirror real world situations. Software programs that offer real-time feedback on practice may similarly engage students. In general, then, characteristics of computer-based technologies facilitate the conditions for a constructivist learning environment for students. The study demonstrates that student-centered technology implementation that involves higher-order thinking impacts student achievement in terms of performance on TAKS tests.

The main conclusion for the primary research question is that students in the highest teacher LoTi score group had the highest mean scores on the TAKS test within a given content area. This conclusion notwithstanding, the data analysis does not support the conclusion that teacher LoTi scores have a positive impact on student TAKS scores in all cases. For example, the results for social studies reveal this caveat. Students with a social studies teacher who had a LoTi score of 1 at the “awareness” level actually performed better on TAKS than students with a social studies teacher who had LoTi score of 3 at the “infusion” level. If there was a positive correlation between teacher LoTi score and student TAKS scores, one would expect to see the mean of student TAKS scores increase the higher the teacher LoTi score, but the findings in social studies do not indicate a positive correlation. Additionally, the findings for math shows that students with a math teacher who had a LoTi score of 1 at the “awareness” level performed no better or worse, statistically, than students with a math teacher who had a LoTi score of 2 at the “exploration” level, which is actually higher on the scale of technology implementation. In terms of statistical significance, these two groups of math students performed at essentially the same level. Similar to the social studies example, if there was a positive correlation between teacher LoTi score and student

TAKS scores, one would expect to see the mean of student TAKS scores increase the higher the teacher LoTi score, but the math findings do not indicate a positive correlation.

Research Question 2

Research question 2 asked, “Does a relationship between teacher LoTi ratings and student TAKS scores differ according to students’ economically disadvantaged status as reported in student records at Alamo Heights Independent School District, San Antonio, Texas?” As mentioned above, there was a relationship between teacher LoTi scores and student TAKS scores for each of the four content areas of English, math, science, and social studies. The findings suggest that a relationship between teacher LoTi ratings and student TAKS scores indeed differed according to students’ economically disadvantaged status for ELA and math. That is, while the impact of a teacher’s level of technology implementation was statistically significant for all of her students, the impact was even greater for economically disadvantaged student performance on TAKS. The findings also show, however, that the relationship between teacher LoTi ratings and student TAKS scores did not differ according to students’ economically disadvantaged status for science and social studies.

For ELA and math, the findings were that there was a statistically significant interaction between the three variables of teacher LoTi score, student TAKS score, and a student’s economically disadvantaged status. As mentioned above in the section on research question 1, a relationship was found in ELA and math between the two variables of teacher LoTi score and student TAKS score. This relationship means that the more a teacher implemented technology into classroom instruction, the more student-centered the classroom instruction was, and the higher the thinking level required of the students while using that technology, the higher students scored on the TAKS test. Research question 2 then probed the possibility that the effect of a teacher LoTi score might have a bigger, smaller, or the same impact on the TAKS scores of economically disadvantaged students. The findings showed that economically disadvantaged students underperformed non-economically disadvantaged students at all teacher LoTi levels. The findings also show, however, that the TAKS performance gap in ELA and math between economically disadvantaged students and non-economically disadvantaged students closed to a statistically significant degree in the higher teacher LoTi 3 levels of “infusion.” The conclusion is that in ELA and math, economically disadvantaged students performed better on TAKS when (a) their teacher implemented more technology in their classroom, (b) their classroom instruction was more student centered, and (c) technology was used for higher levels of thinking.

This conclusion that the level of technology implementation impacts student achievement of economically disadvantaged students greatest in English and math is consistent with the findings in the literature. The research on the use of computer technology by at-risk students suggests that when used in the context of cooperative, student-centered, and authentic learning, at-risk students improved their motivation to learn, earned higher grades in those classes, and began to accept more responsibility for their own learning (Dunkel, 1990; Merino, Legarreta, Coughran, & Hoskins, 1990). It is the effective use of technology to teach higher-order thinking that can be linked to higher levels of student achievement for students who are at risk of failing (Dunkel, 1990; Merino, Legarreta, Coughran, & Hoskins, 1990). In fact, the use of technology in classroom instruction has been shown to have a positive impact on student engagement in learning, a particular concern for students at risk of dropping out of school (Day, 2002; Shelly, 2002). The LoTi study affirms these findings for ELA and math, but the study's results for science and social studies are not consistent with the research. Levels of technology implementation did not impact on economically disadvantaged students to the same extent that it did for ELA and math.

Recommendations Based on the Study

This study was intended to serve as basic research for Alamo Heights ISD to investigate teacher implementation of technology and its impact of student achievement. This study's primary focus was to determine whether or not there was a relationship between teacher LoTi scores and student performance on TAKS exams. A secondary goal was to determine if any relationship between teacher LoTi scores and student TAKS scores differed according to student economically disadvantaged status.

The following are recommendations offered for consideration based upon the findings and conclusions of this study:

1. The data in this study, as gathered from Alamo Heights High School, in Alamo Heights ISD, clearly indicate that a teacher's level of technology implementation has an impact on student achievement. In each of the inferential statistical tests run for each of the four core content areas, the relationship between a teacher's level of technology implementation and

student TAKS scores was statistically significant. The more a teacher implemented technology into classroom instruction, the better students tended to perform on the TAKS test. As a result, the district is affirmed in its efforts, in terms of student outcomes, to increase the availability of technology to teachers and students for integration into classroom instruction and should continue those efforts.

2. While there was a statistically significant relationship between teacher levels of technology implementation and student performance, that relationship did not correlate positively for each successive level of teacher technology implementation in each content area. In some cases, the lowest teacher LoTi of 1 at the "awareness" level actually yielded higher student performance on TAKS than the higher teacher LoTi of 3. In other cases, student performance with the lowest teacher LoTi of 1 at the "awareness" level scored statistically the same as students with the next highest teacher LoTi of 2 at the "exploration" level. Multiple and varied explanations may account for this. One such explanation could be that perhaps the actual classroom practices of these teachers did not match their reported practice for the survey in terms of (a) amount of technology used, (b) amount of student-centered instruction, and/or (c) the level of thinking required in the technology use. Perhaps their actual technology use did not match their reported technology use. Based on these findings for social studies and math, the recommendation is made to the campus principal to train these high school teachers more

comprehensively on the performance standards implicit in the levels of technology implementation, beyond the basic explanation that comes with the directions. Such comprehensive training may yield more consistent results in teacher responses to the survey in particular. More importantly, such comprehensive training may improve classroom practice in the three key areas of the LoTi framework of (a) amount of technology use, (b) extent of student-centered instruction, and (c) higher-ordering thinking to impact on student performance.

3. Based on the review of the literature, the LoTi survey instrument is consistent with a constructivist model of learning, and this model is linked to high levels of student achievement. As such, a recommendation is made to the campus principal to use the LoTi framework for staff development in general, as it encompasses general aspects of best practice and scientifically based research on best classroom instructional practice.
4. Given that the findings show a relationship between technology implementation and student performance, the recommendation is made that all campus level administrators be trained yearly on observational protocols for the LoTi framework to use in their formal and information observations of teachers and in their ongoing professional conversations with teachers about classroom practice. Such increased awareness of the three key areas of the LoTi framework of (a) amount of technology use, (b) extent of student-centered instruction, and (c) higher-ordering thinking may increase the

capacity of campus administrators to facilitate classroom practice to impact student performance.

5. The data from this study suggest that, for English and math, higher teacher levels of technology implementation impact the student performance of economically disadvantaged students the most. A recommendation is made to the campus to assess current interventions with struggling economically disadvantaged learners and to investigate effective ways of including technology in strategies for instruction and remediation.

Recommendations for Further Study

The following are recommendations for further research related to this topic:

1. Research is needed to investigate how technology implementation varies in classroom practice according to content area.
2. Research is needed to investigate whether any variance in technology implementation in the classroom by content area may account for differences in student achievement.
3. Research is needed to examine the effect of staff development about the LoTi framework on teacher responses to the LoTi survey.
4. Research is needed to examine the effect of teacher staff development about the LoTi framework on classroom practice.
5. Research is needed to examine the effect of teacher staff development about the LoTi framework on student performance in general and economically disadvantaged students in particular.

6. Research is needed to investigate the extent to which a teacher's years of experience affects his or her relative level of technology implementation.

Conclusion

The primary goal of this study was to examine the relationship between teacher Levels of Technology Implementation (LoTi) scores and student scores on the Texas Assessment of Knowledge and Skills (TAKS) exams. The findings revealed that there is a relationship between the level of technology implementation in the classroom and student performance on the TAKS test. Further, the findings showed that this relationship impacts economically disadvantaged students the most in some content areas. Given these encouraging results for the role of technology in fostering student learning, educators are recommended to invest time, resources, and energy to refine their efforts at technology implementation for the benefit of all students.

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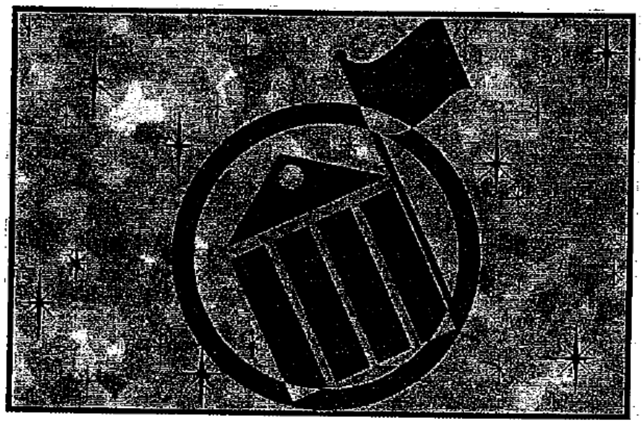
APPENDIX A

LoTi QUESTIONNAIRE

Level of Technology Implementation (LoTi) Questionnaire



Version 5.0

Inservice Teachers

LoTi Questionnaire

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

The LoTi Questionnaire (LoTiQ) takes about 20-25 minutes to complete. The purpose of this questionnaire is to determine your Level of Technology Implementation (LoTi) based on your current position (i.e., pre-service teacher, inservice teacher, building administrator, instructional specialist, media specialist, higher education faculty) as well as your perceptions regarding your Personal Computer Use (PCU), and Current Instructional Practices (CIP).

THIS IS NOT A TEST!

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

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

Name of State*: ______________________________

Name of Intermediate Unit *: ______________________________

Name of School District*: ______________________________

Name of School*: ______________________________

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

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

Do you have computer access at school?*

☐**Yes**

☐**No**

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

LoTi Questionnaire

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

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

1 Score ____________
I frequently engage students in learning activities that require them to analyze information, think creatively, make predictions, and/or draw conclusions using the classroom technology resources.

2 Score ____________
I frequently present information to students using multimedia presentations or electronic "slideshows" to reinforce the content standards that I am teaching and better prepare students to take standardized tests.

3 Score ____________
I have trouble managing a student-centered classroom using the available technology resources and would welcome the help of a peer coach or mentor.

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

5 Score ____________
I frequently assign web-based projects to my students as a means of emphasizing specific complex thinking skill strategies aligned to the content standards.

6 Score ____________
My students collaborate with me in setting both group and individual academic goals that provide opportunities for them to direct their own learning aligned to the content standards.

7 Score ____________
Using the most current and complete technology infrastructure available, I have maximized the use of the learning technologies in my classroom and at my school.

8 Score ____________
Problem-based learning is common in my classroom because it allows students to use the classroom technology resources as a tool for higher-order thinking and personal inquiry.

9 Score ____________
I use the classroom technology resources exclusively to take attendance, record grades, present content to students, and/or communicate with parents via email.

10 Score ____________
My students identify important school/community issues or problems, then use multiple technology resources as well as human resources beyond the school building (e.g., partnerships with business professionals, community groups) to solve them.

11 Score ____________
My students use the classroom technology resources most frequently to improve their basic math and literacy skills via practice testing software, integrated learning systems (ILS), or tutorial programs.

12 Score ____________
Constant technical problems prevent me and/or my students from using the classroom technology resources during the instructional day.

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

14 Score ____________
My students frequently discover innovative ways to use our school's advanced learning technologies to make a real difference in their lives, in their school, and in their community.

15 Score ____________
I can solve most technical problems with our classroom's technology resources during the instructional day without calling for technical assistance.

16 Score ____________
Locating quality software programs, websites, or CD's to supplement my curriculum and reinforce specific content standards is a priority of mine at this time.

17 Score ____________
Though I may use technology for teacher preparation, I am not comfortable using my classroom technology resources as part of my instructional day.

18 Score ____________
I am comfortable training others in using basic software applications, browsing/searching the Internet, and using specialized technologies unique to my grade level or content area.

19 Score ____________
Computers and related technology resources in my classroom are not used during the instructional day, nor are there any plans to include them at this time.

20 Score ____________
I consistently provide alternative assessment opportunities that encourage students to "showcase" their understanding of the content standards in nontraditional ways.

21 Score ____________
My students use the Internet for (1) collaboration with others, (2) publishing, (3) communication, and (4) research to solve issues and problems of personal interest that address specific content standards.

LoTi Questionnaire

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

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

22 Score ___________
My students participate in online collaborative projects (not including email exchanges) with other students, government agencies, or business professionals to solve their self-selected problems or issues.

23 Score ___________
Given my current curriculum demands and class size, it is much easier and more practical for my students to learn about and use computers and related technology resources outside of my classroom (e.g., computer lab, resource center).

24 Score ___________
I use the classroom technology resources most frequently to locate lesson plans I can use in class that are appropriate to my grade level and are aligned with our content standards.

25 Score ___________
My current instructional program is effective without the use of technology; therefore, I have no current plans to change it to include any technology resources.

26 Score ___________
I use our technology resources daily to access the Internet, send email, and/or plan classroom activities.

27 Score ___________
Due to time constraints and/or lack of experience, I prefer using instructional units recommended by my colleagues that emphasize complex thinking skills, student technology use, content standards, and student relevancy to the real world.

28 Score ___________
My students' creative thinking and authentic problem-solving opportunities are supported by the most advanced and complete technology infrastructure available.

29 Score ___________
My personal professional development involves investigating and implementing the newest innovations in instructional design and learning technologies that take full advantage of my school's most current and complete technology infrastructure.

30 Score ___________
I can locate and implement instructional units that emphasize students using the classroom technology resources to solve "real-world" problems or issues, but I don't usually create them myself.

31 Score ___________
I have an immediate need for some outside help with designing student-centered performance assessments using the available technology that involve students applying what they have learned to make a difference in their school/community.

32 Score ___________
Students' use of information and inquiry skills to solve problems of personal relevance guides the types of instructional materials used in and out of my classroom.

33 Score ___________
My instructional use of our classroom technology resources is frequently altered according to the latest innovations and research in the areas of instructional technology, teaching strategies, and/or learning theory.

34 Score ___________
I regularly implement a student-centered approach to teaching that takes advantage of our classroom technology resources to engage students in their own learning.

35 Score ___________
I frequently consider (1) my students' interests, experiences, and desire to solve relevant problems and (2) the available human resources outside of the school when planning student-centered learning activities that include technology.

36 Score ___________
Students taking meaningful action at school or in the community relating to the content standards learned in class is an essential part of my approach to using the classroom technology resources.

37 Score ___________
I have an immediate need for professional development opportunities that place greater emphasis on using my classroom technology resources with challenging and differentiated learning experiences rather than using specific software applications to support my current lesson plans.

38 Score ___________
My students create their own web pages or multimedia presentations to showcase what they have learned in class rather than preparing traditional reports.

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

40 Score ___________
My students frequently use the classroom technology resources for research purposes that require them to investigate an issue/problem, think creatively, take a position, make decisions, and/ or seek out a solution.

41 Score ___________
Having students apply what they have learned in my classroom to the world they live in is a cornerstone to my approach to instruction and assessment.

LoTi Questionnaire

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

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

42 Score ___________
Curriculum demands, scheduling, and/or budget constraints at our school have prevented me from using any of the available technology resources during the instructional day.

43 Score ___________
I am skilled in merging the classroom technology resources with relevant and challenging, student-directed learning experiences that address the content standards.

44 Score ___________
Though I currently use a student-centered approach when creating instructional units, it is still difficult for me to design these units on my own to take full advantage of our classroom technology resources.

45 Score ___________
My immediate professional development need is to learn how my students can use our classroom technology resources to achieve specific outcomes aligned to the content standards.

46 Score ___________
It is easy for me to identify and implement software applications, peripherals, and web-based resources that support student's complex thinking skills and promote self-directed problem solving.

47 Score ___________
My students have immediate access to all forms of the most advanced and complete technology infrastructure available that they use to pursue problem-solving opportunities surrounding issues of personal and/or social importance.

48 Score ___________
I need access to more resources and/or training to begin using the available technology resources as part of my instructional day.

49 Score ___________
I regularly use different technology resources for personal or professional communication and planning.

50 Score ___________
Students' questions and previous experiences heavily influence the content that I teach as well as how I design learning activities for my students.

VITA

Frank Eduardo Alfaro
Alamo Heights Independent School District
7101 Broadway
San Antonio, Texas 78209

EDUCATION

2008	Doctor of Education, Educational Administration Texas A&M University, College Station, Texas
2001	Master of Arts, Educational Leadership The University of Texas at San Antonio, San Antonio, Texas
1994	Bachelor of Arts, History Trinity University, San Antonio, Texas

CERTIFICATIONS

Standard Principal, Grades EC-12 (valid 12-01-07-11-30-13)
Provisional Secondary English, Grades 6-12 (life)
Provisional Secondary English Language Arts, Grades 6-12 (life)
Provisional Secondary Speech Communications, Grades 6-2 (life)

EXPERIENCE

2007-Present	Director of Curriculum and Instruction Alamo Heights Independent School District San Antonio, Texas
2001-2007	Assistant Principal Alamo Heights High School Alamo Heights Independent School District San Antonio, Texas
1994-2000	Teacher, English and Speech Lytle High School Lytle Independent School District Lytle, Texas

This record of study was typed and edited by Marilyn M. Oliva at Action Ink, Inc.