A COMPARATIVE STUDY OF MATHEMATICS ACHIEVEMENT THROUGH THE USE OF TECHNOLOGY IN ENHANCING EDUCATION THROUGH TECHNOLOGY (EETT) GRANT AND NON-GRANT SCHOOL DISTRICTS IN KENTUCKY

by

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## ABSTRACT

The Enhancing Education Through Technology (EETT) Act makes funding available for elementary and secondary school districts with the primary goal of improving students' academic achievement through the use of technology. The main purpose of this comparative analysis study is to show the impact of EETT competitive grants on mathematics achievement scores in elementary and secondary schools. A second purpose is to show the connection between effective use of technology and students' achievement in mathematics. Participants of this study included 162 of the school districts in Kentucky. This study utilized the comparative-analysis approach to examine archival data within the context of Data Summary Reports conducted by the Center for Research in Education Policy (CREP), Kentucky Performance Reports, and Commonwealth Accountability Testing System (CATS) School Report Cards results, along with state and national reports on technology education. The Formative Evaluation Process for School Improvement (FEPSI) Data Summary Reports used in this study consisted of the School Observation Measure (SOM) instrument and the Survey of Computer Use (SCU) instrument, both developed by the CREP. The researcher conducted both inferential and descriptive data analyses. The researcher used a 1-tail, 2-sample t-test to determine whether the gain scores for each group was different. The researcher used a 1-way ANOVA for differences among means to determine whether the gain scores among the groups was different. Descriptive analysis determined whether or not the data showed a relationship between specific items. Finally, the researcher used a qualitative narrative to interpret literature/research that supports the findings of this study. The results indicated that there was not enough evidence to state that EETT grant school districts had higher average CATS mathematics scores than the non-grant school districts. Differences between grant vs. non-grant schools within each round resulted in similar

conclusions. This research will provide teachers and administrators data on research-based instructional methods and best practices in schools that integrate technology across the curriculum and have shown promising results in increasing students' mathematics achievement, using technology that can be widely implemented in elementary and secondary schools.

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# CHAPTER I

## INTRODUCTION

Even before the inception of the No Child Left Behind Act of 2001, schools and school districts have sought ways to improve student academic achievement. More than two decades of investments from public, private, and government agencies have helped to integrate school-based technologies in teaching and learning (U.S. Department of Education; Office of Planning, Evaluation and Policy Development; Policy and Program Studies Service, 2007) in efforts to enhance educational practices. Billions of dollars in infrastructure, professional development, and technical support have been spent to improve the quality and accessibility of technology in schools to support and enhance the educational process. Because technology is such an integral element of present-day society, schools have the responsibility of infusing technology throughout the classroom curriculum.

The Enhancing Education Through Technology (EETT) Act makes funding available for elementary and secondary school districts with the primary goal of improving students' academic achievement through the use of technology. States receive formula grants for promoting the use of technology to improve academic achievement through the No Child Left Behind (NCLB) Act's EETT program. States then allocate funds to school districts through the means of both formula and competitive grants. Rod Paige, former Secretary of the United States Department of Education, stated that although significant changes are being made, schools have lagged behind in exploring the various technological advances that the business world has utilized (U.S. Department of Education, Office of Eduational Technology, 2004). He suggests that there must be continued support to facilitate these efforts with ongoing investments in educational technology in order to expand and develop in the next decade.

Various educational agencies such as the Association of Mathematics Teacher Educators (AMTE) and the International Association for the Evaluation of International Achievement (IEA) champion the belief that ongoing support for teachers in preparing them to effectively integrate technology is essential to increase student achievement. According to the National Council of Teachers of Mathematics (NCTM) Principles for School Mathematics, technology is essential in teaching and learning mathematics; it influences the mathematics taught and enhances students' learning (National Council of Teachers of Mathematics, 2000). Therefore, school districts that received competitive grant funding through the EETT grant program should show increased mathematics achievement through the use of technology as compared to school districts that did not receive EETT competitive grant funding.

## Statement of the Problem

The Enhancing Education Through Technology Grant (EETT) has provided for teacher preparation and research-based implementation strategies to incorporate technology in the curriculum and to aggressively prepare young people to succeed in a technologically advanced, globalized nation. In doing so, schools and school districts must identify best practices in schools that integrate technology across the curriculum (Cooper, 1998) and implement those programs that have shown promising results in increasing students' mathematics achievement, using technology. This is significantly difficult because there are no published effective technology integration correlates to guide schools in implementing this task. Although computer integration has been the primary focus of many studies, systematic, usable data on individual student performance and progress at the classroom level is lacking. Most research on general outcomes measure (GOM) or Curriculum-Based Measurement (CBM) of student achievement has been at the level of individual students rather than at classroom, school-wide, or district-wide levels (Ysseldyke & Bolt, 2007). Although school districts receiving competitive grant funding must report their progress toward achieving program objectives, the statewide data have not been aggregated.

## Background

The Enhancing Education Through Technology grant program offers competitive and formula grants under Title II, Part D, of the No Child Left Behind (NCLB) Act, which is the reauthorization of the Elementary and Secondary Education Act (ESEA) of 1965. Many changes have been made to the ESEA over the decades, but its original intent of providing equal access to education for disadvantaged students has remained its purpose. (See Appendix A.)

The primary goal of the Enhancing Education Through Technology Act of 2001 is to improve student achievement through the use of technology in elementary and secondary schools. Other goals include aiding all students in becoming technology-literate by the end of eighth grade and establishing research-based instructional methods that can be widely implemented through teacher training and curriculum development (U.S. Department of Education, 2008). The U.S. Department of Education provides grants to State Educational Agencies (SEAs) on the basis of their proportionate share of funding under Part A of Title I of the EETT program. The SEAs are to appropriate funds to assist in the implementation of technology and to establish initiatives with public/private partnerships to increase access to technology, particularly in elementary and secondary schools serving disadvantaged students.

In June of 2008 MasterCard made a commitment to donate $750,000 of its $1 million, three-year pledge to advance mathematics education in St. Louis, Missouri, by engaging national and international expertise, deepening involvement with local districts, developing regional partnerships, sharing intellectual resources, and providing technology donations. “We want to help provide visibility and resources to math education experts who have the power to foster change in the classroom," states Rod Reeg, president, Global Technology and Operations, MasterCard Worldwide (Allen, 2008, p. 1). As more involvement from community partnerships and policymakers become more prevalent in school reform, countless studies have been done on which school variables (school size, class size, funding, resources, or teacher qualifications/preparation) have a greater influence on students' achievement. One such research suggests that effective teachers can make a difference in students' learning and students' achievement.

According to the Association of Mathematics Teacher Educators (AMTE), "Mathematics teacher preparation programs must ensure that all mathematics teachers and teacher candidates have opportunities to acquire the knowledge and experiences needed to incorporate technology in the context of teaching and learning mathematics" (Association of Mathematics Teacher Educators, 2006). M. L. Niess suggests that very few teachers learned to teach their subject matter using technology. He also notes that, "Learning subject matter with technology is different from learning to teach that subject matter with technology", and that, "How teachers learned their subject matter is not necessarily the way their students will need to be taught in the 21st century" (Niess, 2005). Preparing teachers to effectively integrae technology skills along with content knowledge into lessons may be difficult for teachers who have not had personal experiences similar to these in their own educational career. We cannot hope to improve student academic achievement through the use of technology without improving teacher technology efficacy. In order to enhance the learning opportunities of students, we must equip our teachers with the necessary skills to prepare them for the evolving classrooms of today and the future.

Recent efforts have been made to strengthen the capacity of teacher-preparation programs to prepare teachers to use instructional technology through the establishment of Unit Standards developed by the National Council for Accreditation of Teacher Education (NCATE). The NCATE Unit Standards include guidelines that address content and pedagogical studies for initial teacher preparation and faculty qualifications. They also address resources for teaching and scholarship, along with information pertaining to facilities for operating pre-service teacher education, schools, colleges, and departments of education (SCDEs) accredited by the NCATE. (See Appendix B.) Basic elements such as collaboration, shared decision making, open communication, and purposeful engagement, as illustrated in the NCATE Unit Standards, move teacher-education institutions toward achievement of excellence in teacher education. By using these standards, universities and colleges can create a network of excellence in teacher education, which can lead to achievement of both state and national accreditation. (See Appendix B.)

These NCATE Unit Standards reflect the goals of the National Educational Technology Standards for Teachers (NETS-T, 2008) and Students (NETS-S) developed by the International Society of Technology in Education (ISTE). (See Appendixes C and D.) Although an abundance of research and many updates have been made to these standards neither the NETS-T nor the NETS-S provide content-specific ideas that address what teachers and students should know about using technology for learning mathematics (Niess, et al., 2009). Abdul-Haqq believes that pre-service teacher education schools, colleges, and departments of education should require increased technology use among teacher-educators and that teacher educators must model appropriate use of computers for instructional purposes throughout courses and field experiences. They also must incorporate technology across the curriculum, focusing more on electronic networks, integrated media, and problem-solving applications, which support the development of students' higher-order thinking and problem-solving skills. Lastly, schools, colleges, and departments of education should consider integrating computer instruction into existing methods and foundations courses and phasing out computer-literacy courses that primarily teach pre-service teachers how to use basic computer tools and introduce them to K-12 computer applications (Abdal-Haqq, 1995).

States interested in improved student achievement must begin by hiring well qualified individuals, teachers who have completed accredited teacher-preparation programs that adhere to NCATE standards. By implementing policies that influence the hiring standards of school districts, such as giving incentives and sanctions at the state level, the acquisition of a force of qualified teachers will be at the disposal of the schools and school districts (Darling-Hammond, 1999).

## Purpose

The purpose of this study is to (1) aggregate statewide data on mathematics achievement in Enhancing Education Through Technology (EETT) competitive grant and non-grant school districts in Kentucky elementary, middle, and high schools; (2) show the impact of Enhancing Education Through Technology (EETT) competitive grants on mathematics achievement scores in elementary, middle, and high schools; and (3) provide insight to schools administrators on research-based instructional methods that can be widely implemented to increase mathematics achievement in elementary, middle, and high schools.

## Rationale

This study serves as a comparison of the Enhancing Education through Technology (EETT) competitive grant recipient school districts and non-grant school districts in Kentucky.

In 2006 Kentucky entered its third round of multi-year funding from the EETT competitive grant program. The EETT grant program is the only federally funded program of the Department of Education designed to improve students' academic achievement through the use of educational technologies in high-poverty elementary and secondary schools. The program is part of the NCLB Act and supports the broad goals of the Elementary and Secondary Education Act (ESEA) through the use of technology. This study can be used as a guide to schools striving to improve the capacity of teachers to integrate technology effectively into the curriculum and instruction, thereby improving students' mathematics achievement. This study also may serve as a guide to schools in the implementation of long-term changes in the way schools educate students, in an effort to prepare young people to thrive in a technologically advanced and economically driven nation.

## Research Questions

The primary goal of the Enhancing Education Through Technology (EETT) Act of 2001 is to improve students' academic achievement through the use of technology in elementary and secondary schools. Advanced technology skills and knowledge are needed for students to succeed in an increasingly technology-savvy society, now that digital technologies have become ingrained into the everyday work and play of people all over the world. This fact along with the opening of international borders for free trade, has been the motivating power for economic and technological competition among nations (Ngwudike, 2009).

For nations to stay economically and politically stable, they must depend upon the competitive advantages they possess over others. These advantages are gained through the availability of a skilled and efficient workforce. This workforce can only be sustained through the high quality of students produced by that nation. Chubb and Moe (1990) agree that a skilled workforce is a key component of economic stability and further argue that, “Mathematics is crucial to the future of sophisticated technology and international competition.” However, the question remains: Do school districts awarded EETT competitive grants have higher mathematics gain scores than non-grant school districts? The researcher will use descriptive research to organize data into patterns that emerge during analysis of CATS Mathematics Achievement Scores and computer usage, as defined by the CATS Mathematics Student Questionnaire. Two specific research questions guide this study:

1. Will there be significantly higher average gains for EETT competitive grant school districts over non-grant school districts in Kentucky on the CATS Mathematics Achievement Scores?
2. Will there be significant differences in average gain scores among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky?

Question 1 and Question 2 examine, using quantitative methods, technology use and mathematics scores of students in Enhancing Education Through Technology (EETT) competitive grant and non-grant school districts in order to aggregate the data and evaluate the effects that the EETT competitive grant program has on mathematics achievement scores. Lastly, the researcher employs qualitative research methods to assess the state of technology education both locally and nationally. The researcher uses the Formative Evaluation Process for School Improvement (FEPSI) Data Summary Reports along with NCLB State Strategies and Practices for Educational Technology: Volumes I and II to see how the results of this study compare to state and national reports on technology education.

## Delimitations

The study limits its examination to public schools since a larger number of Enhancing Education Through Technology (EETT) competitive grants exist for the public school systems than for the private school systems. Because research indicates that success at the elementary school level increases success at higher grade levels (Wittrock, 1986 & Hunter, 1982), this research will concentrate on elementary, middle, and high schools.

## Limitations

The researcher focuses on schools that received Enhancing Education Through Technology (EETT) competitive grants and their counterparts beginning in 2002 and ending in 2008, because 2002 was the first year the NCLB Title II-D competitive awards were granted in the state of Kentucky and 2008 was the last year that state documentation was available for the EETT competitive grant program.

The researcher is limited to the information contained in the 2005-2006 Formative Evaluation Process for School Improvement (FEPSI) Data Summary Report for Kentucky State Technology Project because this was the only year the state conducted this type of formative evaluation report. EETT grant specifications were changed in 2007, refocusing efforts and allocating money for hiring Technology Integration Specialists and limiting analysis of the focus areas previously required for grant approval.

Because of other factors that may influence students' achievement on the Commonwealth Accountability Testing System (CATS), limitations exist to the correlations that are identified. Additional factors may include, but are not limited to, other programs implemented throughout the school district in an effort to raise test scores; after-school tutoring programs that may be offered; as well as teaching experience and the major or area of concentration teachers had during their college experience. The researcher also acknowledges that data collected from respondents on the Student Mathematics Questionnaire found in the Kentucky Performance Report (KPR) did not come from observations and for this reason may not be accurate in the frequency of technology use.

## Assumption

Each Local Education Agency (LEA)/School District that applies for EETT competitive grant funding must complete an application that details how they will evaluate the impact of technology on student achievement as part of their overall program. School Districts must self-report their progress toward stated goals, based on their initial plan set forth in their application. The Department of Education examines the extent to which LEAs and eligible local entities have effectively used funds to meet the goals of the program. An assumption of this study is that schools are self-reporting students' improved mathematics achievement on the applications for EETT competitive grant renewal based on effective usage of computer technology (U.S. Department of Education, Education Technology Expert Panel, 2002).

As part of the data-collection process of the Commonwealth Accountability Testing System (CATS), all students in Grades Five, Eight, and Eleven receive and complete a Mathematics Questionnaire. The Mathematics Questionnaire can be found in the Kentucky Performance Report (KPR), which contains detailed information on results from the Kentucky Core Content Test (KCCT), Writing Portfolio, Norm-Referenced Test, and other components of CATS (Kentucky Department of Education, 2009). Students respond to 13 questions total, 10 questions that ask the respondents to determine to what extent (never; sometimes, but not every week; once a week; two or three times a week; or four or five times a week) they do the following:… Two questions relate directly to technology use, with one of the two asking the respondents to rate how often in their mathematics class they use a computer. Another assumption of this study is that students reported accurately the number of times they used technology in their mathematics class.

## Definition of Terms

*Academic Index* - scores that schools have to report that compare them to other schools in the state. All schools are required to reach 100% proficiency for all students on reading and mathematics state assessments by 2014.

*Accountability* - The responsibility for actions, decisions, and policies that directly affect test scores which schools are obligated to report, explain, and be answerable for resulting academic standards

*Adequate Yearly Progress (AYP)* - Statewide accountability system used to determine the achievement of each school district and school in a particular state (U.S. Department of Education, 2002). The accountability system was required to be based on academic standards and assessment set by each state according to its lowest-achieving demographic group or lowest-achieving school, whichever was higher (U.S. Department of Education, Education Technology Expert Panel, 2002). Therefore, each state sets a bar that each individual school must achieve every biennium and this progress is checked annually. AYP is intended to highlight where a school district/school needs improvement and is used to focus its resources. If the goal was reached or exceeded, then the school was scored as having reached AYP.

*Best Practice(s)* - highly effective teaching strategies (planning, procedures, and reflection/evaluation) that lead to superior performance and/or academic achievement

*Commonwealth Accountability Testing System (CATS)* - the testing/assessment program used to test/assess the progress being made by Kentucky schools. The program is made up of five parts:

a. Kentucky Core Content Test at Grades 4, 5, 7, 8, 10, 11, and 12
b. Norm-Referenced Test assessing reading, language arts, and mathematics at the end of Primary and Grades 6 and 9

c. Writing Portfolios at Grades 4, 7, and 12

d. Alternate Portfolios at Grades 4, 8, and last anticipated year

e. Non-academic index, which includes:

- Attendance and retention at the elementary level
- Attendance, retention, and dropout rates at the middle school level
- Attendance, retention, dropout rates, and successful transition to adult life at the high school level

The Kentucky Core Content Test, Norm-Referenced Tests, and Writing and Alternate Portfolios produce individual student information. Non-academic data components produce data only at the school and district level ( Kentucky Department of Education, 2003).

*Enhancing Education Through Technology (EETT)* - competitive technology grants funded by the U.S. Department of Education as a component of the No Child Left Behind Act (Title II D); designed to help schools improve students' academic achievement through the implementation and evaluation of technology projects and professional development

*Elementary and Secondary Act of 1965 (ESEA)* - Public Law 89-10 passed on April 9, 1965, as a part of President Lyndon B. Johnson's "War on Poverty"; designed to address the problem of inequality in education that existed after the passing of the Civil Rights Act of 1964

*FEPSI* - Formative Evaluation Process for School Improvement Data Summary Report containing surveys of teachers' computer use and observations of students' computer use

*Grants* - Enhancing Education Through Technology grants funded by the U.S. Department of Education through the No Child Left Behind Act of 2001

- *Formula grants* - The U.S. Department of Education provides grants to State Educational Agencies (SEAs) on the basis of their proportionate share of funding under the No Child

Left Behind Act (NCLB) Title I, Part A. States may retain up to 5% of their allocations for state-level activities and must distribute one-half of the remainder, by formula, to eligible local educational agencies (U.S. Department of Education, 2008).

- *Competitive grants* - A competitive grant process provides funding to assist eligible Local Educational Agencies (LEAs) in using technology to enhance teaching and learning. LEAs must complete an application, which is scored and ranked against other competitors. The top-scoring applications are funded from the remaining one-half of 95% of the U. S. Department of Education's NCLB title I-A allocations. A minimum of 25% of the awarded funds through the competitive grant application must be spent on professional-development activities. (U.S. Department of Education, 2008).

*Grant school districts* - school districts that received EETT competitive grant funding

- *Round 1* - Kentucky's school districts that were awarded multi-year EETT competitive grant funding in the academic years of 2002-2003 and 2003-2004 to hire technology resource teachers
- *Round 2* - Kentucky's school districts that were awarded multi-year EETT competitive grant funding in the academic years of 2004-2005 and 2005-2006 to purchase hardware and educational software applications that satisfied the requirements that focused on one of the top 10 priorities listed in the Kentucky Education Technology System (KETS) Master Plan for Education Technology FY2001-FY2006
- *Round 3* - Kentucky's school districts that were awarded multi-year EETT competitive grant funding in the academic years of 2006-2007 and 2007-2008 to hire Technology Integration Specialists

*NAPD Descriptions* - categories used in reporting student results within the Commonwealth Accountability Testing System. The Proficient level is the long-term goal for all students.

*Novice*

- Student demonstrates minimal, limited, underdeveloped, and at times inaccurate content knowledge and reasoning.
- Student's communication is ineffective and lacks detail with no evidence of connections within or between content areas.
- Student uses strategies that are inappropriate.

*Apprentice*

- Student demonstrates some basic content knowledge and reasoning ability.
- Student communicates reasonably well but draws weak conclusions or only partially solves or describes.
- Student attempts appropriate strategies with limited success.

*Proficient*

- Student demonstrates broad content knowledge and is able to apply it.
- Student's communication is accurate, clear, and organized with relevant details and evidence.
- Student uses appropriate strategies to solve problems and make decisions.
- Student demonstrates effective use of critical-thinking skills.

*Distinguished*

- Student's demonstrates an in-depth, extensive, or comprehensive knowledge of content.

- Student communication is complex, concise, and sophisticated with thorough support, explicit examples, evaluations, and justifications.
- Student uses and consistently implements a variety of appropriate strategies.
- Student demonstrates insightful connections and reasoning ( Kentucky Department of Education, 2003).

*Kentucky Education Technology System (KETS)* - both a Master Plan and Implementation Plan developed as a result of the Kentucky Education Reform Act of 1990 which guides educational technology in the Kentucky School Systems

*KETS Master Plan for Education Technology FY2001-FY2006* - released May 2000 detailing how Kentucky's Education Technology plan had fared in the first eight years of implementation; and gives specific details on the top priorities for the next six years, funding requirements, eligibility, equity, standards-based planning, and accountability

*No Child Left Behind* - Public Law 107-110 is an act to close the achievement gap with accountability, flexibility, and choice, so that no child is left behind.

*No Child Left Behind State Strategies and Practices for Educational Technology: Volume I-Examining the Enhancing Education Through Technology Program* – detailed strategies and practices for states nationwide for the EETT program

*No Child Left Behind State Strategies and Practices for Educational Technology: Volume II-Supporting Mathematics Instruction with Educational Technology* - detailed strategies and practices for states nationwide for the EETT program as it relates to classroom use in mathematics

*Non-grant school districts* - school districts in Kentucky that did not receive EETT competitive grant awards, neither in Round 1, Round 2, or Round 3 of their distribution.

*Performance Levels /No Child Left Behind Tier Levels* - For the purposes of this study, tier levels indicate that adequate yearly progress has not been achieved for two or more years. No tier indicates one of two things - either the school has made adequate yearly progress or the school has not met the standard for at least one year. Each year that the goals are not met means that the school is subject to consequences, which propels a school to a higher tier. Each tier level indicates harsher consequences for a school.

*Secondary Schools* - a school for young people, usually between the ages of 10 and 19, that is intermediate in level between elementary/primary school and college. General, technical, vocational, or college-preparatory curricula are usually offered at this level.

*Technology Integration Strategies (TIS)* - are long-term strategies, according to the literature, that improve the capacity of teachers to integrate technology effectively into the curricula and instruction.

*Title I* - an act which details federal programs resulting from the Elementary and Secondary Education Act of 1965. This act was set up by the United States Department of Education to provide additional funding to schools and school districts with poverty rates of 40% or higher (U.S. Department of Education, 2002). Schools receiving Title I are regulated by the federal government's No Child Left Behind Act. These funds may be used for teachers' professional development, extended school programs, and/or supplemental instruction.

## Summary

Because mathematics is crucial to the future of sophisticated technology and international competition, school districts must guide students to acquire the skills necessary to compete in a technologically advanced, globalized nation. With the vast amount of research and funding that has been focused on effectively integrating technology into the curriculum and instruction, as well as student-achievement research in vital subjects such as mathematics, what remains to be seen is, whether or not a connection exists between effective use of technology and student achievement and what research-based instructional methods can be widely implemented to increase students’ mathematics achievement in elementary, middle, and high schools? Lastly, we must determine how we can increase the capacity of teachers to integrate technology effectively into the curricula and instruction.

# CHAPTER II

## Literature Review

The researcher examines descriptions of technology in the school systems, including past teacher training and how technology has traditionally been used in schools, first in this chapter. Next, the researcher documents a look at outside influences that affect the NCLB Act, along with teaching strategies used to increase student achievement. In the third section of this chapter, the researcher looks at how a change in ideals, such as implementing ongoing learner-centered and content-focused professional development that works toward changing educational technologies and how they are integrated into the curriculum and instruction, is taking place and how school restructuring that incorporates technology as a major focus can bring about positive change. Lastly, the researcher reviews literature focused on mathematics achievement as it relates to technology-integration programs both nationally and locally, including technology integration within the mathematics classroom. This section also includes technology education acts, laws, programs, and grants. Specific details of funding, implementation, and evaluation of these programs are contained in this chapter as further justification of the need for this study.

### Technology in Schools

In the past, teaching about computers and their uses was solely the responsibility of the computer teacher and/or the librarian/media center coordinator. With societal needs growing--as far as the need for highly trained computer-skilled employees and the demand for the United States to increase its standing in the educational arena--the importance for students to become more adept in computer use and applications has risen significantly. Over the last quarter-century, society has made profound changes, including a rapid shift from a blue-collar, industrial economy to a knowledge economy, which directly affects how students now need to be educated.

New skills for work, citizenship, and college-readiness are now required to better prepare students to compete in a technological-based society. Traditional lecture-style curriculum for preparing students for college is not connected to the current world from which many students come, nor does it align with the world in which students must be prepared to compete (Wagner, 2002). Research shows that although K-12 schools have spent millions of dollars in the last 20 years equipping their schools with the latest technology in order to meet this need, most schools have failed to significantly increase test scores (Barnett, 2001).

### Teacher Training

McDermott and Murray (2000), comparing the dramatic increase of the number of computers in the classrooms over the last decade, with its non-effective use as documented by teacher surveys, student self-assessments, technology sign-out sheets, and a classroom computer-use checklist, concluded that the probable cause of ineffective technology use was that teachers did not feel comfortable integrating technology into the curriculum (U.S. Department of Education, Education Technology Expert Panel, 2002). The studies of Abdal-Haqq (1995) and Tozoglu and Varank (2001) champion the studies of McDermott and Murray (2000), citing that the majority of teachers do not fully exploit computer capabilities in the classroom due to certain environmental (extrinsic) and personal (intrinsic) factors. Some of these barriers cause school teachers to feel less than enthusiastic toward the notion of implementing technology in the classroom. Depending on a teacher's past training and experiences with technology, the teacher's beliefs about the appropriate use of technology may vary. Prospective teachers may see technology tools as simply a means by which mathematics can be performed more quickly and easily without meaningful experiences that model appropriate use of technology (Wachira, Keengwe, & Onchwari, 2008). Despite the fact that 80% of public, four-year colleges make course-management tools available to their faculties, they are only being used in 20% of courses by professors. Many faculty members are hesitant to embrace technology because it is perceived as a source of stress (Lynch, Altschuler, & McClure, 2002).

McDermott and Murray (2000) point out that one reason teachers feel ill-prepared to integrate technology into the curriculum is due to the lack of ongoing teacher training. This may have an adverse effect on many students who are not receiving opportunities to use the available technology to its fullest potential. The students see themselves as not-competent technology users. Researchers such as Yildirim, Beyerbach, et al.; Lin; and Hardy have shown that with adequate training both pre-service and in-service teachers feel more competent in using technology in their instruction of mathematics classes and how to use technology to aid in student achievement. After an educational computing course, Yildirim found that pre-service and in-service teachers' attitudes toward computers improved (Yildirim, 2000). In addition, Beyerbach found that pre-service teachers changed their view from thinking that they would teach and learn about technology to thinking they would use technology to support student learning after having completed a technology-rich mathematics methods course (Beyerbach, Walsh, & Vannatta, 2001); Lin found that Web-based workshops on mathematics education fostered positive attitudes toward instructional technology and teaching mathematics with computers among elementary pre-service teachers (Lin, 2008). Along with changes in attitudes toward teaching mathematics using technology, Michael Hardy found that the Technology in Mathematics Education (TIME) Project positively impacted participants' perceptions of their knowledge base of technology resources and methods of using the resources to teach mathematics. The methods used in the TIME Project may be useful in preparing middle level and secondary mathematics teachers to infuse technology into their instructional practice (Hardy M. , 2008).

## Technology Use

Finally, after looking at the continual advancements in technology and technology use in America's schools, researchers Abdal-Haqq (1995); Jones (1998); McDermott and Murray (2000); and Tozoglu and Varank (2001) have concluded that the lack of training is one of many reasons teachers are resistant to integrating technology in the curriculum. The National Center for Education Statistics found that only 20% of current public school teachers feel comfortable using technology in their teaching (Rosenthal, 1999). Another reason for the resistance is that teachers' technology use varies from survival, mastery, impact, and innovation according to Barnett (2001). Furthermore, the studies of Lonergan (2001) and Davidson and Schofield (2002) suggested that most often teachers in economically disadvantaged schools teach about the computer itself; any computer use is for drill and practice. In wealthier schools using computers for research, inquiry, and communication is often the practice. The assumption is that disadvantaged children must master basic skills before they can move on to higher-order thinking activities. The reality is that many of these children do not progress to higher-order problem solving using this practice. The President's Committee of Advisors on Science and Technology Panel on Educational Technology (1997) found that effective teaching should combine both lower-order and higher-order thinking, as it occurs this way in real-life situations.

The lack of computer training for teachers required to integrate technology into the curriculum has slowed the advancement of technology integration in schools. Traditionally teacher-preparation programs incorporated one basic computer course that focused on learning about technology and introduced the student to technology software used in K-12 classrooms.

More recently, teacher-preparation programs are including pedagogical content into the computer class and expanding methods courses to include teaching with technology (Niess, 2005).

For teachers to be successful they need a well-developed knowledge base in their subject area. Pre-service teachers' subject-area knowledge is usually developed with a focus on personal learning over many years. They have learned their subject area through lectures and other experiences that have promoted critical thinking. Many pre-service teachers have had limited experiences in learning their subject matter with technology and have not seen or experienced many instructional strategies and representations of their subject within a technology framework.

With the introduction of new Teacher and Student Technology Standards, teacher-preparation programs are now incorporating the development of knowledge of the subject area along with the development of the knowledge of technology. However, pre-service teachers often learn about teaching and learning with technology in a more generic manner, unconnected to the development of their knowledge of the subject matter. For technology to become an integral component or tool for learning, teachers must develop knowledge of their subject matter with respect to technology. Technology Pedagogical Content Knowledge (TPCK) is the integration of the development of knowledge of subject matter with the development of technology and of knowledge of teaching and learning. Teacher-preparation programs must provide specific directions to guide student teachers in expanding their understanding of the interactions of the knowledge of technology and the knowledge of their subject area (Niess, 2005). Teachers then must develop the expertise required to incorporate technology effectively to increase student achievement.

Sandholtz, Ringstaff, and Dwyer (1997) believe that just as technology is evolving teachers go through an evolutionary process as they continue to increase their use of technology. They described five phases of this evolutionary process:

1) Entry - Teachers adapt to changes in physical environment created by technology.
2) Adoption - Teachers use technology to support text-based instruction.
3) Adaptation - Teachers integrate the use of word processing and databases into the teaching process.
4) Appropriation - Teachers change their personal attitudes toward technology.
5) Invention - Teachers have mastered the technology and create novel learning environments.

Sheigold (1991) and Hardy (1998) champion this idea that teachers require a trial period before a level of comfort is felt with using technology in the classroom. They also note that it takes teachers five to six years of working with the technology before they feel comfortable enough to modify instructional strategies and dramatically change the classroom environment using that technology. The four stages of technology use employed by teachers new to technology are as follows: survival, mastery, impact, and innovation. The first stage a teacher employs is the survival stage. The teacher resists the use of technology, is invaded by problems that deter him or her from using the technology, and doesn't change the existing conditions in the classroom to allow for the use of the technology. In the survival stage, technology is only used for directed instruction because the teacher feels that he or she cannot possibly manage all of the students with so few computers. The survival teacher also may have unrealistic expectations that technology use alone will result in higher academic performance. A teacher in the mastery stage has increased tolerance to hardware and software problems and begins to use new forms of interaction with students and classroom practices. The teacher has increased technical competence and oftentimes can troubleshoot simple problems. In the third stage, the impact stage, the teacher regularly incorporates new working relationships and classroom structures, balances instruction and construction, and is rarely threatened by technology. The impact teacher is prone to creating technology enhanced instructional units. Lastly, a teacher who modifies his or her classroom environment to take full advantage of technology to enhance curriculum and learning activities is said to be in the innovation stage (Mandinach & Cline, 1992). It can take a teacher from three to five years to reach the mastery and impact stages, even with extensive professional development and coaching.

Studies also have found educational inequity, noting evidence of strong bias in assignment of students to teachers of different effectiveness levels (Jordan, Mendro, & Weerasinghe, 1997). Students who come from low-income minority backgrounds often have poor access to and utilization of technology while confronted with inferior-quality learning opportunities (Donahue, Finnergan, Lutkus, Allen, & Campbell, 2001). In 2005, the ratio of student to instructional computers with Internet access in public schools was 3.8:1 compared to 12.1:1 in 1998. Despite these improvements, schools with more minority enrollment still have higher students per computer than schools with lower minority enrollment (Wells & Lewis, 2006). As a result, their access to intellectually challenging curriculum material and instruction are limited (Darling-Hannond, 2004). Studies done by Sanders and Rivers (1996) and Murnane and Steele (2007) found that students who are economically disadvantaged and/or students of color are disproportionately assigned to teachers with the least preparation, indicating that African-American students are twice as likely to be assigned to the most ineffective teachers.

Becker (2001) suggests that low-income minority school students use computers for routine skills practice and are less likely to use computers to make presentations, do analytic work, revise and publish text, or engage in exploratory and problem-solving activities. This type of Computer Based Learning (CBL) is limited to close manipulation and/or monitoring by the teacher and is generally used only to enrich, not extend, the learning process. Questions are presented on the computer monitor; students click on an answer; and the students receive feedback as to whether or not they answered the question correctly (Murphrey, 1997). Even amidst an abundance of evidence to support the long-held theory that most students do not learn at the same pace and in the same way, the dominant structure for learning in the United States has been to teach this way. Low-income students have the most to lose from one-size-fits-all instruction and the most to gain from an individualized student-centered teaching approach. For all students to benefit from the educational experience, schools must utilize approaches that customize resources, content, and instruction (Newschools Venture Fund, 2011). The differences in one's skills can be the most important factor in determining who will prosper and who will struggle financially. These skill differences may be significantly influenced by the quality of K-12 education. Variations of the quality of teachers in a nation's classrooms are a vital part of this equation (Murnane & Steele, 2007).

Teachers need to integrate technology across the curriculum to enhance learning and promote inquiry and analytical thinking, rather than reinforce traditional ways of teaching where students act primarily as receivers of information to create real advancements in educational technology use (Donahue, Finnergan, Lutkus, Allen, & Campbell, 2001). The effective use of computers in the classroom can change what students learn by exposing them to ideas and experiences that otherwise would not be accessible. Opportunities such as this are particularly useful in developing the higher-order skills of critical thinking, analysis, and inquiry necessary for success in the twenty-first century (Rockman, 2003).

## Outside Influences

This section includes topics about outside influences that affect the NCLB Act and student-achievement issues. It also includes items regarding teaching strategies.

In 1965, President Lyndon B. Johnson created what was called the “Great Society.” It was comprised of several elements to increase the United States’ military, economic, and domestic strength. At the center of these elements was his education proposal, the Elementary and Secondary Education Act (ESEA). The ESEA was devised by Francis Keppel, Lyndon B. Johnson’s Commissioner of Education, as a compromise between those who opposed federal money to public, but not private, schools and the National Education Association (NEA), who opposed any diversion of federal education aid to private schools. Keppel’s plan involved distributing federal funding to a significant number of congressional districts, public and private schools, state education agencies, and linking ESEA to existing impact-aid programs. This would not only eliminate most of the potential political opposition to the program, but also retain strong congressional support from the earlier programs backers (McGuinn, 2006).

Most Americans, at this time, believed the public school system was adequate and considered government involvement to be intrusive and unwarranted. Therefore, the ESEA’s primary goals were designed as temporary programs to address an extraordinary crisis for a specific group of disadvantaged students. Various interest groups had views of what should take place. As one group placed their attention and focus on school inputs rather than on school outputs or governance issues, another group focused on eliminating any federal involvement because they believed it decreased local control of schools.  In the 1960s and 1970s interest groups defended the original ESEA policy intent and advocated for expanding existing programs. This argument of whether or not government should fund and set procedural compliances set the tone for future discussions of federal education policy throughout the next four decades.

McGuinn (2006) further notes that by 1980 federal presence in education was increasing. This is shown through the creation of the U.S. Department of Education by President Jimmy Carter in 1979, and then the extensive tax cuts and privatization conducted throughout President Ronald Reagan's administration, which included social welfare programs and federal education programs being targeted to be significantly reduced or eliminated altogether. In 1983, the release of the report, "A Nation at Risk," spawned even more debate on the issues and fueled public concern about the decline of public education and its impact on the nation's economic competitiveness. Other reports detailed the need to better prepare teachers, the poor quality of instruction in schools, as well as the lack of academic preparation of students (Carrier & Glenn, 1991).

Throughout the rest of the 1980s and into the 1990s interest groups remained on opposing sides of the debate. Some saw "A Nation at Risk" as a sign that federal funding should be expanded and there should be an increased control over schools by the government. Others viewed the document as proof that past federal programs and mandates, along with the public education system as a whole, was not working. As a result of this ongoing argument, the role of federal government in education between 1965 and 1994 remained limited (McGuinn, 2006).

In April 1991, President George H. W. Bush introduced his "America 2000" education reform plan. Although Bush's "America 2000" education standards plan received support from some, it lacked the support from others who believed in the old policy, and still others who argued against any federal role in education. The "America 2000" education reform plan was ultimately defeated (McGuinn, 2006). In the mid 1990's President Bill Clinton began the first steps in the direction of a greatly expanded federal role and increased funding while implementing school reform and improved student academic performance through standards and accountability measures with the passing of "Goals 2000," an adapted version of Bush's "America 2000" (McGuinn, 2006).

By the turn of the century, the debate was no longer about whether there should be a federal role in education but what the nature of that role should be. President George W. Bush adopted an education plan that allowed for a reformed role of the federal government in education that promoted school improvement. His plan included increased federal spending and involvement in exchange for expanded flexibility, accountability, and choice. This came to be what is now known as the No Child Left Behind Act (NCLB). The NCLB Act was created by policymakers, due to the perceived failure of lower levels of government in Washington, to improve student performance for disadvantaged students in urban schools. Although the total share of federal education funding remains relatively small, the vast majority of education reform is set in Washington (McGuinn, 2006). The NCLB Act was to ensure quality teachers for all students.

By the end of the 2005-2006 school year, all teachers must be "highly qualified," which means they will need to (1) have a four-year college degree; (2) have a full state teaching license; and (3) show that they know the subject they're teaching, either by majoring in that subject in college or by passing a rigorous subject-matter test or other state-mandated evaluation (Education Trust, 2003). In 2010, President Barack Obama outlined the Reauthorization of the Elementary and Secondary Education Act (ESEA), A Blueprint for Reform. The document aims not only to layout “a plan to renovate a flawed law, but is also an outline for a revisioned federal role in eduacation” (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2010). The priorites of A Blueprint for Reform are to not only raise standards so that graduating high school students are college-and career-ready, but also expand incentives for school districts that improve students’ outcomes. This includes high-performing public charter schools and innovative local and non-profit leaders investing in innovative ways to help our schools succeed (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2010).

Recently, with the Kentucky Education Reform Act, the federal No Child Left Behind Act, and the Blueprint for Reform, the Reauthorization of the Elementary and Secondary Education Act, a renewed interest in raising low test scores has surfaced. Strategies have been created and implemented in order to raise test scores in underachieving schools. Many teaching strategies have been researched and published during the last few decades.

Five Standards for Effective Pedagogy for improving learning outcomes for all students were identified by Tharp, Estrada, Dalton, and Yamauchi (2000). These standards are based on the socio-cultural principles that learning occurs best when (a) teachers and students work together and converse during collaboration to accomplish a common goal; (b) instructional activities are connected to students’ prior experience and knowledge in a meaningful way; and (c) instruction occurs within the learners’ zone of proximal development. These three indicators helped to improve attitudes towards academics, and higher retention of the learning occurred (Hilberg, Tharp, & DeGeest, 2000). The Five standards include: (1) Facilitating learning through joint production activity in which teachers and students work together on a common product or goal and have opportunities to converse about their work; (2) Developing language and literacy across the curriculum; that is, develop competence in the language and literacy of instruction and in the academic disciplines through extended reading, writing, and speaking activities; (3) Contextualizing instruction in the experiences and skills of students' homes and communities; (4) Teaching complex thinking through challenging activities requiring the application of content knowledge to achieve an academic goal, with clear standards and systemic feedback on performance; and (5) Teaching dialogically using planned, goal-directed instructional conversations between a teacher and a small group of students (Doherty, 2003). Faltz and Leake (1993) believe that even though student achievement and behavior may be altered, a strategy should only be deemed effective if it abridges the gap in students' achievement while increasing students' achievement proportionally.

With the many years of research and all the emphasis being placed on learning strategies with its relationship to student achievement, government agencies have now started to place a great deal of emphasis on requiring teachers to integrate technology throughout the curriculum. In 1997, a report by the Presidential Panel on Educational Technology argued that in order for education professionals to begin using technology extensively with traditional methods of instruction they must be provided in-depth, sustained assistance. This change in attitudes led to an emphasis on better preparing new teachers in the use of technology in the classroom, such as required proficiency in technology for teacher-preparation programs. The most recent change has come with the pledge of investments from the federal government to support programs whose graduates are succeeding in the classroom, based on student growth (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2010).

Burke (2002) notes that previously, most southern states have used technology training as professional development for current (in-service) teachers; however, technology competency of new (pre-service) teachers in state-approved teacher education programs is now the focus. Burke also found that examples of this are demonstrated in the changes that have taken place in Georgia, Kentucky, Texas, and Virginia. All four states have implemented State Professional Standards Board requirements to ensure that all new teachers are proficient in computer and other instructional technology applications and skills. According to Lonergan (2001), only four states require that all teachers have to demonstrate proficiency in technology for license renewal regardless of teaching field or subject certification. The question at hand is, when implemented, does computer technology use designed to increase student achievement work effectively?

## A Change in Ideals

Research done by Lonergan (2001) supports action taken by government agencies and teacher accreditation programs that affected the transformation of pre-service and in-service teacher training, especially the integration of technology across the curriculum. A critical assessment of this change finds that, although government agencies and teacher accreditation programs are requiring teachers to demonstrate proficiency, there has been little evidence that ongoing support of this technology training will continue to be provided. Along with Bauer (2002), Davidson and Schofield (2002) have shown in their research and surveys of teachers that continual, ongoing support would greatly effect change in how teachers integrate technology across the curriculum. Training along with ongoing support is necessary for the integration to become an integral part of the teachers' planning and instruction (Carrier & Glenn, 1991).

## Professional Development and Support

While conducting an intervention study, researchers Heath, Burns, Dimock, Burniske, Menchancha, and Ravitz (2000) found that in classrooms with high populations of traditionally underserved students, including economically disadvantaged, linguistically diverse, rural, American Indian, and Mexican American students, teachers who actively participated in technology planning and professional development, with follow-up assistance and support, felt that professional development enabled them to better implement technology in the classroom. The professional development was most effective when it was learner-centered and focused on the actual content to be integrated in the curriculum. However, the majority believed the ongoing support made the biggest difference. These results are further demonstrated in the research, curricular augmentation, and classroom projects in the elementary school done by Ruth Hubbard (1998). Hubbard contends that the most important element in increasing Internet usage among teachers was the continuous, ongoing support they received throughout their training, which lessened their anxiety about integrating the Internet in their lessons. Finally, Davidson and Schofield (2002) agree that if correctly implemented with continual support, the use of the Internet can greatly foster school improvement in achieving curriculum goals. Reports from the U.S. Department of Education's Office of Planning, Evaluation, and Policy Development show that from 2005 to 2007 about a third of teachers reported increases in their own use of technology stemmed from technology-related teacher professional development, yet effects on their instructional practices showed fewer reports of an increase. Additional teacher reports suggest that the extent of students' use of technology for academic purposes did not change between 2004–05 and 2006–07 (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service, 2009).

## Technology and School Restructuring

Sheingold (1991) agrees with Davidson and Schofield (2002) that technology can aid in improving student achievement but states that it must be part of the school's restructuring efforts. By combining the ideas of technology integration and learning when schools begin their restructuring plans, the expectations are for change. This can bring about a larger buy-in from those involved (Sheigold, 1991).

When new technology is presented to people they go through an adoption decision process in which they gather information, test the technology, and then consider whether it offers a sufficient improvement to warrant the time and energy investment that is required to add it to their skills knowledge base (Rogers, 1995). This is why it is important that during school-improvement planning, ways to use technology should be a major focus. Some ways to accomplish this are by having schools consider using technology to create or enhance a system to individualize students' schedules and activities; create a teacher network with computers on each teacher's desk, which would facilitate better communication and planning; make available loaner computers and accessories for teachers; create a multimedia lab with computers, videodiscs, CD-ROM players, and peripherals to enable students and teachers to create their own presentations and products; and have more classroom computers. Sheingold (1991) believes it is important to build on what resources you have.

> If half the teachers in a school are comfortable with using technology in their teaching and do so with some regularity in a variety of curricular areas, there would be a sufficient critical mass of expertise… take the same number of computers, provide software and peripherals so that they could be used in multiple ways, and place some in classrooms, in project work spaces for students and teachers, and on the desk of interested teachers. This configuration would give students and teachers the critical mass of technology-based experiences that they need to support active learning and adventurous teaching (p. 26).

In order to replace consistently low-performing schools with high-performing, new-generation schools, dramatic changes to a school's culture and instructional design must occur. School leaders must be given control over major decisions on a school's financial resources, hiring, evaluation and compensation of staff, curricula, pedagogy, school operations, student recruitment, enrollment and discipline, as well as parent and community engagement for effective approaches to school turnaround to succeed (Newschools Venture Fund, 2011). Sheingold (1991) believes that the overall image of the school can be transformed through the use of the media. By allowing local access cable channels to broadcast images of students discussing and inspecting scientific data on computers, interviewing and videotaping community members for history assignments, and both teachers and students discussing and evaluating students' portfolio work, including several different media products, the new image of school life will become comfortable and familiar to parents and the general public.

Effects on Learning

Hasselbring (1984), Neimic and Walberg (1985), and Bangert-Drowns, Kulik, & Kulik (1985) agree that some increases in student achievement can be made through the use of computer-based instruction. The use of traditional computer-based instruction, such as drills, tutorials, and simulations can produce positive effects on students' attitudes towards learning as well. Some evidence has been presented to show that the use of word-processing programs can improve the writing process and product of students (Murphy & Appel, 1984). Most students enjoy using technology, and, therefore, their attitudes have been consistently positive toward computer-based instruction. Many questions remain about how to most effectively use technology in the classrooms as a means to increase student achievement and create an environment that supports teachers in building the knowledge base and skills needed. By using Continuous Progress Monitoring and data-driven decision-making, higher test scores and enhanced progress toward meeting standards can be achieved (Ysseldyke & Bolt, 2007).

Research has shown that both Computer-Based Instruction (CBI) and Computer Aided Instruction (CAI) has demonstrated improved student outcomes (Kulik, 1994) & (Green, 2001).

On average, students who used CBI with a high level of implementation scored significantly higher on the test of achievement compared to students with low levels of implementation or no CBI. When students received CBI and/or CAI they learned more in less time (Ysseldyke & Bolt, 2007). A technology-rich environment has also been proved to have a positive effect on achievements in all major subject areas and has increased achievement across grade levels for regular and special-needs children (Sivin-Kachala, 1998). In 2005, 11 school districts in Kentucky were identified for significantly narrowing the gaps in achievement between economically disadvantaged students and their higher-performing classmates, while simultaneously raising the average proficiency rates of the student groups being compared. These districts included Allen County, Barren County, Estill County, Fleming County, Hancock County, Magoffin County, Mercer County, Owen County, Russell County, Simpson County, and Warren County (Standard & Poor's School Evaluation Services, 2005).

Research suggests that the benefits of a technology-rich environment have positive effects on learning in various ways. Kozma (1994) and Croninger (Kozma & Croninger, 1992) identified ways in which technology might help to address the cognitive, motivational, and social needs of at-risk students. The 1990-91 research conducted by Summers noted that technology seemed to help focus students' attention and encourage them to spend more time learning. McNeil and Wilson (1991) found that students with weak learning skills seemed to profit when teachers supplied structure to activities using hypertext and interactive videodisc applications. Later research found that instructional technology can make learning more meaningful to students when they use telecommunications technology to create their own projects. George (2000) found that technology can be vital in helping students achieve higher standards and perform better.

Effective use of Computer-Based Instruction (CBI) depends on how the computers are being used in the instruction. They have been found to be most effective when attention is given to incorporating the role of the teacher with the task provided by the computer. This works best because both the computer and the teacher are integral parts of the instructional process. Other aspects, such as suitable instructional approach and instructional design model, the appropriateness of content focus, and the unique characteristics of Web-based learning and implications on instructional processes, are also vital considerations when using CBI in the classroom to increase the learning process. Some evidence has also been presented to show that the use of word-processing programs can improve the writing process and product of students, thereby increasing the achievement of the students.

## Implications

A significant amount of research and analysis has been done on how to effectively overcome specific obstacles found in preparing teachers to incorporate and integrate technology throughout the curriculum in a meaningful way. Abdal-Haqq (1995) believes that many changes must occur in order to accomplish this goal. Among these are changing current practices and programs for pre-service preparation of teachers to provide: (1) integration of technology across the pre-service curriculum; (2) professional development and training for in-service teachers that is learner-centered and focused on the learner's curriculum; (3) appropriate instructional use of computers modeled by teacher educators; (4) exposure to and practice with newer, more sophisticated computer-based tools; and (5) continuous, ongoing support for both in-service and pre-service teachers. Many questions remain regarding the effectiveness of classroom practice and student achievement even with the changing practices and programs for pre-service teachers.

## Mathematics Achievement

Where mathematics is concerned, investigations of spreadsheet and dynamic geometry software on mathematics achievement and mathematics self-efficacy were performed. Results indicated that using technology effectively as a learning tool improves students' mathematics achievement (Isiksal & Askar, 2005). Students who did not have computers at home showed lower geometry scores. Therefore, Olkun suggests that schools should integrate more mathematical content and technology in a manner that enables students to explore and find the relationship between 2D geometric figures (Olkun, Altun, & Smith, 2005).

Often students who perform poorly initially, begin to doubt their self-efficacy. Studies have shown that differentiating lessons, where students are able to progress at their own pace, creates less stress on the individual to achieve, based on others' knowledge, and, therefore, the students are able to concentrate on the learning process. One way to accomplish this is by the use of Computer Algebra Systems (CAS) for learning mathematics. Students' attitudes were positive and they believed that the system aided their understanding (Pierce & Stacey, 2001). Another way is by using the Geometer's Sketchpad activities to help students notice geometric details, explore relationships, and develop reasoning skills related to geometric proof (Sinclair, 2004).

One way to increase mathematics achievement and bring about a competitive edge for a nation struggling economically is by looking to other nations that produce students with advanced skills in critical areas such as mathematics. Trends in International Mathematics and Science Study (TIMSS) assessment data were used to identify nations that have a competitive edge in the critical area of mathematics. In recent TIMSS reports, students in Japan outperformed students in the other participating G-8 countries in mathematics, with Japanese fourth and eighth graders reaching each of the four international benchmarks set by TIMSS. The advanced benchmark (the highest TIMSS benchmark) was reached by 26 percent of Japan's eighth-graders in mathematics, compared with only 6 percent of United States eighth-graders reaching the advanced benchmark. The United States was among the lowest percentages of first university degrees in mathematics of all the G-8 countries. With the Blueprint for Reform: the Reauthorization of the ESEA, an emphasis is being placed on the development and adoption of standards that prepare students to succeed in college and career after high school. School districts can either upgrade their existing standards or work cooperatively with other states to develop common standards based on strategies that have shown progress in raising the educational level of all students (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2010).

In the article, "What the United States Can Learn from Singapore's World-Class Mathematics System: An Exploratory Study," the authors noted that if students in the United States are to become as successful in the area of mathematics as their counterparts in Singapore they must obtain a strong foundation in core mathematics concepts and skills (American Institute for Research, 2005). This will mean that textbooks will need to be reorganized from the current spiraling format (students touch on a subject and then later add new knowledge to what they learned) to learning that is set forth for mastery of the subject matter before new concepts are introduced. Low-performing students in Singapore are offered an alternate framework, consisting of all the traditional material of the regular program given at a slower pace by expert teachers. Although teachers in the United States are expected to be certified in specific subject areas for some grade levels, Singapore's teachers must demonstrate a higher level of mathematics skills compared to teachers in the United States. They are then paid to take college training to become a teacher and receive a high level of professional development which includes more than 100 hours each year (American Institute for Research, 2005).

The following recommendations, among others, may be of benefit to low-performing countries in improving the achievement of their students in mathematics. A great deal can be learned by looking to nations that are succeeding academically for ways to model different aspects of their educational programs. Low-performing nations should also increase the requirements for teacher-education admission, curriculum, graduation, and certification requirements to improve the quality of teacher-education candidates. Secondly, teaching should be viewed as a critical profession. A fifth year post-certification internship should be required of all teacher-education programs, during which novice teachers will be gradually introduced to the profession of teaching. Last, teacher-education systems should establish new-teacher induction and support programs, including seminars and workshops, mentoring, observing veteran teachers in classrooms, team teaching, peer interactions, lighter teaching load, and assignment to less challenging classrooms. New-teacher induction and support programs should be used as a means of increasing new-teacher retention rates.

## Technology Integration

This section details national and local technology integration, along with a section on technology integration in the mathematics classrooms. Statistical information is included on what types of computer applications are being used in the classroom and the number of computers compared to the number of students, as well as information about technology-integration programs that have shown positive increases in students' achievement scores.

The National Center for Education Statistics (NCES) studied the integration of various technologies in the teaching/learning process; 44% of teachers used technology for classroom instruction, 42% for computer applications, 12% for drill and practice; 41% required their students to use computers for research using the Internet; 27% had students conduct research using CD-ROMs; 27% assigned multimedia reports/projects; 23% assigned graphical presentations of materials; 21% assigned demonstrations/simulations; 20% required students to use technology to solve problems and analyze data; and 7% assigned students to correspond with others over the Internet (National Center for Education Statistics, 2000).

A significant amount of data is now available about schools and school districts that are successfully integrating technology throughout the curriculum. One such example is Peabody Elementary School in St. Louis, Missouri, which serves almost entirely Title I students in an urban neighborhood with the lowest income families. Peabody has exceeded school and state goals by implementing technology throughout their curriculum. In 2001, only seven percent of Peabody third graders could read at grade level. By changing to a technology-rich environment, instruction is now personalized. A year later, 25 percent of the students were reading on grade level and by 2003 eighty percent of third graders were reading on grade level.

Similar results were seen in mathematics, science, and social studies. The United States Department of Education recognized the program's success and an $8.4 million grant to help create additional eMint (Enhancing Missouri's Instructional Networked Teaching Strategies) training and technology programs was funded. The eMints program is now available to schools nationwide (U.S. Department of Education, Office of Eduational Technology, 2004). In order to accomplish their goals, the program provided 200 hours of professional development, coaching and technical support for teachers. The teachers learned to use multimedia tools to promote problem-solving techniques and critical-thinking skills in their students. Students worked on desktop computers, proceeding at their own pace, based on the individual student's level of mastery of the curriculum. Regular online assessments were used to gauge the students' progress. Teachers were able to customize instruction to the specific needs of individual students. Through the use of online instruction and online tutoring programs, teachers assign activities based on the students' personal progress.

Many states have reported significant gains in meeting Adequate Yearly Progress (AYP) goals for the 2003-2004 academic school year. The Education Trust and the National Alliance of Black School Educators reported that in nine states, North Carolina, Pennsylvania, Maryland, California, Alaska, Georgia, Virginia, West Virginia, and Kentucky, the proportion of schools making AYP increased by at least ten percentage points (U.S. Department of Education, Office of Eduational Technology, 2004).

Mastery-measurements and general outcomes-measurements data have been used to plan and deliver mathematics instruction and to examine the extent to which they could lead to improved math skills and scores on math tests schoolwide. Significant improvements in mathematics performance were made when Brief Experimental Analysis (BEA) was used to specify intervention characteristics (Burns & VanDerHeyden, 2009). Studies also have shown that students whose teachers used continuous progress monitoring and instructional-management systems significantly outperformed those whose teachers solely used the mathematic curricula being used in their district (Ysseldyke & Bolt, 2007).

## Locally

In 1990, the Kentucky General Assembly mandated that all public school students in Kentucky receive high levels of learning as stated in the Kentucky Education Reform Act

(KERA). The student assessment system, Kentucky Instructional Results Information System (KIRIS), which was used to monitor student achievement was to be progress toward achieving this mandate. KIRIS provided public schools accountability indices, which were to be met or exceeded every biennium.

In order to establish biennium improvement goals and baseline scores, the KIRIS assessment tests were given to public school students in Grades Four, Eight, and Twelve in the spring of 1992. Monetary rewards were earned by schools that met or exceeded the Kentucky Department of Education's goals assigned to them. Professional-development support was provided to schools that failed to meet or show improvement toward their goals. After the initial KIRIS assessment in 1992, the tests were given every year to chart a school's progress toward their achievement goals. Every two years schools were assigned a reward, success, improving, decline, or crisis category classification (Davis, McDonald, & Lyons, 1997).

According to Miller (2004), schools that exceeded the KIRIS improvement goals that were set for that particular school were classified as Reward schools. Meeting the goals, but not exceeding them, meant that a school earned the classification of a Success school. Schools that improved their scores but did not meet their goals were Improving schools. Decline schools did not meet their goals and their scores did not increase. Once schools failed to meet their goals or improve their scores within two biennium assessment periods, they were labeled Crisis schools.

In section 1.3 of the Master Plan for Education Technology, it states that its goal is to bring about equitable and efficient use of technology in instruction and administration, improve teaching and learning, improve instructional outcomes for children, and enhance operation of the public school system (Kentucky Department of Education, 1992). A key aspect of the Master Plan for Education Technology is its vision for realizing a single system of education technology that integrates instruction and administration. The Master Plan's vision is to lower the total cost for education technology by truly integrating information at the state and local levels.

The 1998/2000 update to the Kentucky Education Technology System (KETS) Master Plan for Education Technology stated that every district was to receive an equitable share of state technology funds based on average daily attendance. This was Phase I of KETS, which included goals for obtaining funding; developing technical, product, and design standards; and distributing the funds equitably to school districts around Kentucky for the purpose of preparing children for the Information Age Workforce. At that time 83% of Kentucky students were more engaged in learning; 82.8% became more independent learners; 74.8% had a deepening of academic subject understanding; and Kentucky's Student Technology Leadership Program was listed at the highest level when compared to other states as stated in the Milken Foundation Survey of different states. By the end of the 1999-2000 school year, 84% of the school districts in Kentucky had 75% or more of their schools connected to the Internet; 61% of the districts had 100% of their schools connected. The student-to-computer ratio was 6.4:1 with a teacher-to-computer ratio of 1.4:1. In January 2000, Kentucky Department of Education (KDE) established the Kentucky Virtual High School. Students could opt to take classes through distance learning via the Web (Cole, 2000).

By May of 2000, the Kentucky Department of Education (KDE) implemented its KETS Master Plan for Education Technology FY 2001-FY 2006. EDTECH money was allocated to obtain Instructional Technology resource teachers to assist with basic technology skills and technology integration and instruction. KDE focused accomplishing the broad goals set by NCLB Title II, D by focusing on the following ten top priorities:

1. Develop the basic technology skills and certifications required for all educators.

2. Address the techniques of technology professional development required to more effectively reach a much higher percentage of teachers and administrators so they can more effectively integrate technology into what they do.
3. Develop the student technology skills required in all parts of the curriculum that will be part of the program of studies, core content, and CATS while also increasing the success, depth, and capabilities of our STLP program.
4. Address the technology talent (the people) required within and outside the district to maintain, operation and support the Phase 1 deployment.
5. Ensure education data, available through Munis, the School Student Management System (SSMS), and enterprise data base become a quality strategic asset for all levels of leadership.
6. Better integrate technology into comprehensive school planning and instruction.
7. Assist districts with resources/services and finding/developing resources (e.g., e-rate, TLCF, KETS Funds, STLP) to support their technology needs.
8. Highlight the need of increasing the availability of the school technology resources (e.g., virtual high school, virtual university, KTLN) after school hours for students, teachers, administrators, parents, and community members so they can improve and retool their skills.
9. Prepare our students for the information age and in parallel work with economic development representatives to ensure our economy is prepared to take advantage of our graduates so we won't lose them to other states.

10. Address the financial resources required and available each year to operate, maintain, incrementally replenish and expand the technology system that was installed across the state during the first eight years (Kentucky Department of Education, 2000).

This was also the year that the KIRIS Assessment was modified to become the Commonwealth Accountability Testing System (CATS). By the FY 2006, KDE determined that EETT money could be used to again assist in the recruitment and retention of Technology Integration Specialists.

Mathematics Classrooms

Along with many other states across the country, Kentucky has gone to great lengths to equip its schools with computers and connections to the Internet; establish new math curriculum programs; as well as acquire funding for additional updates in order to bring about change in the mathematics classroom. The job now lies in the hands of the teachers and administrators within each district to integrate this technology into its curriculum. Training sessions for hardware and software as well as training for integration into the classroom curriculum must be made available to teachers and administrators alike (Cole, 2000). Some school districts within Kentucky have taken the initiative to move forward in this endeavor. School districts such as Knott County, Hart County, and Jefferson County have made individualized efforts to change mathematics education by collaborating with outside agencies to foster change.

Both Knott County and Hart County, two high-need rural Kentucky school districts, have launched a mathematics mentoring and coaching effort with Collaborative for Teaching and Learning (CTL). CTL provides external coaching to teachers in both districts in order to build the capacity for increased mathematics instruction at the middle and high school levels; raise mathematics achievement; and prepare students for high school and college (GEAR UP

Kentucky: Math Mentoring and Coaching Project, 2005). Jefferson County Public Schools (JCPS) has partnered with the philanthropic organization of General Electric and various community organizations to establish mathematics curriculum programs, research best practices, revise standards, implement new mathematics software, and deepen the understanding of mathematics for all children (Jefferson County Public Schools, 2006). The ultimate goal of both collaborations is to raise student achievement in mathematics and increase the number of graduates enrolling in college. Jefferson County and other school districts in Kentucky are making changes in the way they teach mathematics to foster a greater conceptual knowledge base among students in the Kentucky school system.

Pilot programs in Kentucky are combining software-based, individualized computer lessons with collaborative, real-world problem-solving activities. The new programs' goals are to see that at least 40% of class time is spent using mathematics software while the remainder of the classroom time the students are engaged in classroom problem-solving activities. This type of environment promotes mathematics conversation, collaborative work, and depth of understanding (Jefferson County Public Schools, 2006).

Jefferson County Public Schools and General Electric (GE) have devised a plan that includes six components of a program developed to produce high school graduates who can compete successfully in the global marketplace; they include curriculum, professional development, constituency engagement, GE volunteer support, management capacity, and evaluation. The idea of world-class standards (curriculum and standards based on high performing countries) was developed by mathematics departments. Countries such as Singapore and Japan allow teachers to delve into each individual topic more deeply by concentrating on fewer concepts per grade level. Although the same number of topics is learned throughout the course of the students' school career, students master a concept before moving on to the next concept.

Both the standards for assessment and conceptual understanding will be a part of the world-class standards in mathematics. The first year of professional development implementation will focus on supporting teachers in their efforts to effectively implement the program. Further professional development will help teachers understand how to encourage students to take responsibility for their own learning by asking the important questions and thereby developing a deeper understanding of the subject matter. Support of the school district curriculum changes and a broader understanding will be gained through the community partnerships that are developed. General Electric's Community Volunteerism program is refocusing its efforts to include this initiative, partnering with Jefferson County Public Schools and Jefferson County Teachers Association.

District management staff will be trained to use the business-management strategy employed by the GE Corporation Six Sigma. This strategy aims to improve the quality of outputs by identifying and removing the causes of defects. People within the organization who are experts in the Six Sigma methods are used to help the organization follow a defined sequence of steps to accomplish its goal. American Institutes for Research (AIR), the premier educational research company in the country, has been contracted by the GE Foundation to evaluate the process and results of the initiative.  AIR will measure the following key outcomes:

- Greater conceptual understanding and application
- Growth in student achievement
- Attitudes towards school
- Engagement
- Attitudes towards academic work
- College/Postsecondary readiness
- Career aspirations

In addition, collaborative efforts with outside agencies such as the General Electric partnership with Jefferson County Public Schools and the American Institutes for Research show that many other vital changes are being made to bolster mathematics achievements.

In January of 2007, 30 pilot schools began using SuccessMaker adaptive mathematics software. Individual Computer-Based Tutorial sessions were used to assess students performing below grade level in mathematics. This software program was used as an intervention tool to increase mathematics concepts and skills knowledge. Various districts such as Fayette and Daviess counties in Kentucky have used the software and both districts have reported that schools have posted significant gains in Kentucky Core Content Test (KCCT) scores in mathematics, which helped to close their achievement gaps. In addition to the data collected in Kentucky school districts, the Miami-Dade County Schools in Florida reported a significant drop in the number of schools in assistance under No Child Left Behind as a result of implementing SuccessMaker, along with strong longitudinal results on Florida's State Accountability Test (FCAT) for their students. All of the districts contacted reported positive experiences with SuccessMaker in technology support, teacher management, student engagement, and the impact on mathematics achievement. JCPS will begin using this new resource to help struggling students reach proficiency in mathematics.

The original grant was to include four years of program implementation to run through 2009-10, but may extend an additional year to allow for a full implementation period. In March 2007, a GE/JCPS/JCTA team researched best practices for mathematics professional development in premier districts across the country; with this information they drafted "Vision for Mathematics Teaching." The team then met with national mathematics education experts to determine the best course of action and researched possible uses for existing materials within the initiative. As Phase 2 of SuccessMaker interventions software implementation approached, additional schools were invited to participate in the program.

Implementing the new mathematics system began with the planning phase incorporating various experts, teachers, administrators, and GE Foundation leaders. In April of 2007 all middle schools were invited to participate in the new Mathematics System for the 2007-08 school year. *Connected Mathematics 2* was chosen for inclusion in the sixth and seventh grade Mathematics System for the 2007-08 school years. Professional developments and training to support the new Mathematics System, including SuccessMaker software, were offered to mathematics middle school teachers and new building leaders during the summer of 2007.

The mathematics system being implemented is intended to incorporate conceptual and procedural development of mathematical ideas into the professional development, materials, assessment, and interventions systems. This system will provide support to teachers for maintaining this type of teaching in their classrooms through ongoing professional development and encourage the development of Professional Learning Communities for continued improvement of mathematics teaching and learning. Plans exist to create a sequence of courses and standards that flow from elementary through high school as the district moves forward toward algebra in Grade Eight. Focus groups made up of participating schools, will inform the math team of the support needed to help as the students transition to algebra in Grade Eight. Based upon students' needs, JCPS will spend more than $600,000 of grant funds to purchase licenses for schools.

As the Jefferson County Public School district transitions from the current use of *Connected Mathematics* to the World Class curriculum alignment the district will work to finalize a plan that will meet the needs of students in Grades Five through Seven. The JCPS/JCTA math team also will determine and produce specific materials that will provide additional lessons and units as appropriate to the Advance Program teachers in order to supplement students' learning during the transition.

In order to bring about deeper understanding of learning and improve student achievement, educational technologies must be implemented appropriately and on a regular basis in conjunction with school reform that stresses the importance of integration of technology throughout the curriculum. Chapter 3 explains methods used to analyze the data collected.

## Gap in the Literature

Research has been conducted on educational technology and its importance in bringing about change in many areas. Yet, limited research is available on what specific characteristics of educational technology can effectively bring about that change. Most of the documented research relates to post-secondary education. Limited research has been conducted on technology integration and its relationship to student academic achievement at the primary school levels.

## Summary

This chapter examined the existing literature on the historical perspective of technology use in schools, teacher technology training, outside influences on education, mathematics achievement, and technology integration in mathematics classrooms. Limitless amounts of time in research, implementation of programs, and financial resources have been devoted to technology integration over the past several decades. Teacher-education standards have been created and revised to better meet the needs of the student teachers, schools, and students. While the United States continues to struggle to show vast improvement in its worldwide educational standing, countries such as Japan are leading the G8 nations in advances in education. In order to improve students' academic achievement, all of the parties involved must change their ideas of what the role of a teacher is and how technology must be an integral part of that change. Thus, most important element necessary to create an environment of increased student achievement with technology integration is school restructuring, where technology is a main focus of the school-improvement plan.

# CHAPTER III

## Methodology

The purpose of this study is to (1) aggregate statewide data on mathematics achievement in Enhancing Education Through Technology (EETT) competitive grant and non-grant school districts in Kentucky elementary, middle, and high schools; (2) show the impact of Enhancing Education Through Technology (EETT) competitive grants on mathematics achievement scores in elementary, middle, and high schools; and (3) provide research-based instructional methods that can be widely implemented to increase mathematics achievement in elementary, middle, and high schools.

As the United States education system continues to rank far below other countries in academic achievement and technology competencies, an urgent need exists for sound research in these areas and on how technology integration can improve the United States' standing in the next decade. This study provides evidence that continued support from government policymakers is needed in order to invest additional funding toward technology integration projects that improve the capacity of teachers to integrate technology effectively into the curriculum and instruction, thereby improving students' academic achievement and preparing students to better compete in the world economy.

This study utilizes the comparative-analysis approach to examine data within the context of Enhancing Education Through Technology Grant applications; Data Summary Reports conducted by the Center for Research in Education Policy (CREP); Kentucky Performance Reports; and Commonwealth Accountability Testing System (CATS) School Report Cards results.

## Research Context

The rationale for focusing on Kentucky schools is based upon the fact that no other state or foreign nation had mandated such a comprehensive educational reform effort as the KERA legislation of 1990 and the Master Plan for Education Technology, placing Kentucky in a position of worldwide leadership in education reform (Kentucky Department of Education, 1992). Researchers have found that success at the lower grade levels is a determining factor of success later on (Wittrock, 1986; Hunter, 1982), proving that research needs to be conducted to find effective technology correlates which bring about academic achievement at the elementary, middle, and high school levels.

Due to the continued economic constraints and budget cuts to education and educational technology programs, public schools participating in the EETT grant projects from 2002 to 2008 will be the focus of this study, in an effort to aid school districts and government agencies in planning for future educational technology endeavors.

## Population and Sample

Kentucky elementary, middle, and high schools were used in this research. Post-secondary schools were not used because the bulk of computer technology research has been on these areas in the past and, as stated previously, success at the primary and secondary levels increases the opportunity for success in later grades. Both EETT competitive grant school districts and non-grant school districts were selected based on stratified sampling. In stratified sampling, researchers divide (stratify) the population on some specific characteristic (e.g., gender) and then, using simple random sampling, sample from each subgroup (stratum) of the population (e.g., females and males) (Creswell, 2005). Participants of this study included 162 of the 174 school districts in Kentucky. The 174 Kentucky school districts were divided into two primary stratum 58 EETT competitive grant school districts and 118 non-grant school districts. Only 44 of the 58 EETT competitive grant school districts were used due to statistical formula requirements; school districts that participated in Round 1 only, Round 2 only, Round 3 only and school districts that participated in Rounds 1, 2, and 3. School districts that participated in Rounds 1 and 2 but did not participate in Round 3 or participated in Rounds1 and 3 but did not participate in Round 2 or participated in Rounds 2 and 3 but did not participate in Round 1 were not used in the calculations to keep the requirement of the t-test rule true. The EETT competitive grant school districts were then divided into four secondary stratums. The secondary stratums were as follows:

- Group A: 10 EETT school districts that participated in Round 1 of the program only (academic years 2002-2003 and 2003-2004).
- Group B: 18 EETT school districts that participated in Round 2 of the program only (academic years 2004-2005 and 2005-2006).
- Group C: 8 EETT school districts that participated in Round 3 of the program only (academic years 2006-2007 and 2007-2008).
- Group D: 8 EETT school districts that participated in Round 1, Round 2, and Round 3 of the program (academic years 2002-2003, 2003-2004, 2004-2005, 2005-2006, 2006-2007, and 2007-2008).

Confidentiality and Human Rights

The estimated start date of this research was November 1, 2009. The duration of the research was estimated at five months. Research was conducted using documentation from public records. The researcher compared EETT competitive grant and non-grant school districts from Kentucky by analyzing, Kentucky Performance Reports and Commonwealth

Accountability Testing System (CATS) School Report Cards results. The researcher also analyzed data gained from the NCLB State Strategies and Practices for Educational Technology: Volumes I and II and the FEPSI Data Summary Reports conducted by the Center for Research in Education Policy (CREP) to connect findings from state and national reports to this research.

As the researcher used only archival data (state and national school testing results, surveys, and reports) data within the public domain, no subject participation and/or subject-recruitment requirement existed. In addition, only minimal risk existed for the parties/institutions presented in this research due to the nature of the research. This study has the potential to generate worthwhile knowledge by furthering the research of educational technology strategies for improving mathematics academic achievement in Grades K-12.

The researcher maintained records and assured that the data reported was accurate. No consent forms were needed in obtaining the archival records used in this study. No personality test, inventories, surveys, or questionnaires were conducted during this research process, as only archival data were used.

## Data-Collection Method

The researcher accessed the Internet to retrieve the Kentucky Department of Education Title II-D Competitive Grant Awards list for Round 1, Round 2, and Round 3 CATS testing results, including Academic Index from the Kentucky Performance Reports and CATS Mathematics Student Questionnaire data, in an effort to evaluate the effects of computer technology on students' academic achievement in mathematics for Kentucky EETT competitive grant school districts. The researcher used CATS Mathematics Test Scores from school districts in Kentucky that did not receive the EETT competitive grant funding in Round 1, Round 2, or

Round 3 of the program in order to obtain a comparison of students' academic achievement in mathematics.

The researcher contacted the Kentucky Department of Education to request electronic copies of the FEPSI Data Summary Reports. Lastly, the researcher accessed the Internet to retrieve NCLB State Strategies and Practices for Educational Technology: Volumes I and II. The researcher evaluated these data in an effort to build general themes based on the qualitative data. Approximately three weeks were needed to obtain these data.

In order to give credibility to the research, the researcher examined various state and national reports on technology education, including the FEPSI Data Summary Report for Kentucky and the NCLB State Strategies and Practices for Educational Technology: Volumes I and II. By triangulating these data, the researcher hoped to show evidence to support various interconnected themes that emerged and to correlate them with information presented in the literature review.

Instruments/Tools

The FEPSI Data Summary Reports used in this study consisted of the School Observation Measure (SOM) instrument and the Survey of Computer Use (SCU) instrument, both developed by the CREP. To determine the extent to which 24 factors associated with school improvement were present in each school, the SOM was used during multiple observations by the CREP team. Each SOM consisted of 8 to 12, 15-minute observations of different classes seen in a single day, with varying times of the day and days of the week (e.g., 10 observation visits represented approximately 80 to 100 individual classroom visits). CREP teams looked for factors associated with school improvement. These factors were organized in six categories: instructional orientation, classroom organization, instructional strategies, student activities, technology use, and assessment. Schools could then evaluate actual, observed classroom practices within the context of their instructional goals. The instrument also solicited summary information regarding the amount of class time devoted to academics and to what level the students were engaged in the activities observed. Schools could then use the data gained from the SOM Data Summary to evaluate actual, observed classroom practices and create an achievement action plan to support their instructional goals.

A five-category rubric indicating the percentage of visits in which each of the 24 strategy and two overall items were observed in the school was tested in a reliability study of the SOM. The five categories included (0) Not at all; (1) Rarely; (2) Occasionally; (3) Frequently; and (4) Extensively (Lewis, Ross, & Alberg, 1999). Relative to the issue of reliability, the study found that on the five-category rubric, 67% of the trained observers selected the identical category responses; they were within one category on 95% of the items.

The Survey of Computer Use (SCU) was designed to capture exclusively student access to, ability, and use of computers. Four primary types of data were recorded by the SCU. They included (1) computer capacity and currency; (2) configuration; (3) student computer ability; and (4) student activities while using computers. Computer capacity and currency takes into account the age and type of computers available for student use, including Internet accessibility. Configuration data refer to whether students were working at each computer alone, in pairs, or in small groups. Student computer ability refers to the number of students who were computer-literate or who easily used software features/menus, saved or printed documents and the number who easily used the keyboard to enter information. Student computer activities were divided into three categories: Production such as (a) word processing and/or databases, (b) Internet/Research, and/or (c) Educational Software, based on the type of software tools being used. The aforementioned types of data were recorded as the percentage of visits in which each type was (0) Not Observed, (1) Rarely, (2) Occasionally, (3) Frequently, and (4) Extensively.

The subject areas in which each activity occurred also was recorded, indicating the percentage of visits in which computers were observed in language arts, mathematics, science, social studies, other subject areas, or none, referring to when computer activity did not have an academic focus or the tool was not used.

In order to assess the degree to which computers were being used as a tool to enhance learning, an “Overall Rubric” was designed. This rubric was to reflect if the activities had “meaningful use.” Ratings for this rubric indicated the frequency with which low-level, somewhat meaningful, meaningful, and very meaningful use of computers was observed.

The Mathematics Questionnaire found in the Kentucky Performance Report asks students to answer the following question: In your class, how often do you use a computer? There are five possible answer choices are listed: Never; Sometimes, but not every week; Once a week; Two or three times a week; or Four or five times a week. A five-point Likert scale was used to determine whether there was a significant difference among Kentucky EETT competitive grant school districts and non-grant school districts in average gain on the CATS mathematics achievement scores. The scale in this study utilized the following:

- Never = 0
- Sometimes but not every week = 1
- Once a week = 2
- Two or three times a week = 3
- Four or five times a week = 4

The data was taken from an existing survey, "Kentucky Performance Report Mathematics Questionnaire," developed by Kentucky teachers with expertise in their subject area and edited by contractors, currently WestEd, which is a California company with expertise in question writing and building tests. Data was maintained about both the teachers who wrote the questions and about the match between the Core Content and the Kentucky Core Content Test (KCCT). The contractors evaluated and gave feedback as to the question and its match to the Core Content. With regard to the reliability of the KCCT, an audit of 100 schools (50 selected randomly and 50 selected because they exhibit a large change in scores) is conducted each year to verify the accuracy of scoring. In reading, mathematics, science and social studies at most levels, the reliabilities are between 0.80 and 0.89 ( Kentucky Department of Education, 2003).

Cronbach's (1951) alpha Coefficient, Subgroup alpha, and a stratified version of coefficient alpha were used to assess the reliability of the 2007-2008 KCCT assessments. Cronbach's alpha coefficient compares the aggregation of individual item variances to test total variance, whereas the Subgroup alphas were used to test for various subgroups of interest by grade and content areas. The stratified version of coefficient alpha was used to correct the assumption present in Cronbach's coefficient alpha that there are no local or clustered dependencies. Students were then classified into one of four performance levels – Novice, Apprentice, Proficient, or Distinguished – and empirical analyses were conducted to determine the statistical accuracy and consistency of the classifications. Methods developed by Livingston and Lewis (1995) were used to estimate both accuracy and consistency of classification decisions based on a single administration of a test for the 2007-2008 KCCT. The use of a 4 X 4 contingency table was created for each content area and grade to represent the estimated proportion of students whose true score and observed score fell into the appropriate performance levels to calculate for both accuracy and consistency.

Both the NCLB State Strategies and Practices for Educational Technology: Volumes I and II were a collaborative effort of the Stanford Research Institute (SRI) International, the Urban Institute, and the American Institute for Research that was prepared for the U.S. Department of Education. Data collection for both reports was part of the National Educational Technology Trends Study (NETTS). Data collection was done by staff from 50 states' education authorities (and the District of Columbia and Puerto Rico) along with 916 school districts that completed surveys and six case-study states--Kansas, Massachusetts, Ohio, Texas, Washington, and West Virginia. These data were part of a multiyear evaluation of the implementation of the EETT program. The information presented in these reports was gathered from surveys collected from state educational technology directors in 2004; district technology coordinators in 2005; teachers taking part in the National Assessment of Educational Progress (NEAP) in 2005; and analyses of extant documents and interviews with case-study state staff members.

Volume I of the NCLB State Strategies and Practices for Educational Technology describes state-level educational technology policies, focusing on the implementation of the state-level EETT program in the first years of operation. Volume II examines the degree to which technology is used for mathematics instruction in Grades Four and Eight classes across the country and compares the differences across the states. Data on the Grade Twelve assessment was not available.

## Data Analysis

Using the Statistical Analysis System (SAS v9.1.3) from the SAS Institute Inc. (Cary, NC, USA), the researcher conducted both inferential and descriptive data analyses. The researcher used various data obtained from the CATS testing results found in the Kentucky Performance Reports. Inferential statistical analyses were run at the 0.05 level of significance. The researcher also used various descriptive statistics in analyzing data obtained from the NCLB State Strategies and Practices for Educational Technology: Volumes I and II and the FEPSI Data Summary Reports. The following formal research questions and related quantitative hypothesis were considered.

## Descriptive Research

Will a relationship exist between computer usage, as defined by the CATS Mathematics Student Questionnaire, and CATS mathematics achievements scores? The researcher used the aforementioned as a tool to organize data into patterns that emerged during analysis. A correlational research design was used in analyzing the research to describe the association between the variables. The researcher hypothesized that a relationship would exist between computer usage, as defined by CATS Mathematics Student Questionnaire and CATS Mathematics Achievement Scores. When describing the basic features of the data in a study, the researcher used descriptive analysis methods. This type of analysis provides a summary of the sample and the measures. Descriptive analyses are oftentimes used to present quantitative descriptions in a manageable form (Trochim, 2006).

## Inferential Research Questions

1. Will there be significantly higher average gains for EETT competitive grant school districts over non-grant school districts in Kentucky on the CATS mathematics achievement scores?

The researcher analyzed the data from the CATS testing results, using quantitative analytic methods for Research Question Number One. The research hypothesis for Research Question Number One was as follows:

- H1: There were significantly higher average gains for EETT competitive grant school districts over non-grant school districts in Kentucky on the CATS Mathematics Achievement Scores.
- $H1_a$: The average gain on the 2004 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1 only will be higher than the average gain for non-grant school districts.
- $H1_b$: The average gain on the 2006 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 2 only will be higher than the average gain for non-grant school districts.
- $H1_c$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 3 only will be higher than the average gain for non-grant school districts.
- $H1_d$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1, Round 2, and Round 3 will be higher than the average gain for non-grant school districts.

2. Will there be significant differences in average gain score among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky?

The researcher analyzed the data from the CATS testing results, using quantitative analytic methods for Research Question Number Two. The research hypothesis for Research Question Number Two was as follows:

- H2: There will be significant differences in average gain score among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky.

## Qualitative Research

The researcher used qualitative analytic methods for the following research. How will results found in this study compare to state and national reports on technology education? The researcher analyzed the qualitative data from state and national reports to identify interconnected and/or emerging themes that correspond to the findings presented in this research. A thematic analysis of the state and national reports was conducted to determine where ideas converge. The researcher organized the recurring patterns and/or themes that emerged according to existing definitions and concepts found in the literature regarding educational technology. These themes were used to describe organizational units that correspond to the finding presented in this study, in an effort to aggregate statewide educational technology data.

## Quantitative Analyses

"Analysis of data uses concepts from the theoretical framework and generally results in identification of recurring patterns, categories, or factors that cut through the data and help to further delineate the theoretical frame" (Caelli, Ray, & Mill, 2003). The researcher analyzed the data from the CATS testing results, using quantitative analytic methods for Research Questions One and Two.

- H1: There will be significantly higher average gains for EETT competitive grant school districts over non-grant school districts in Kentucky on the CATS Mathematics Achievement Scores.

- $H1_a$: The average gain on the 2004 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1 only will be higher than the average gain for non-grant school districts.
- $H1_b$: The average gain on the 2006 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 2 only will be higher than the average gain for non-grant school districts.
- $H1_c$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 3 only will be higher than the average gain for non-grant school districts.
- $H1_d$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1, Round 2, and Round 3 will be higher than the average gain for non-grant school districts.
- H2: There will be significant differences in average gain score among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky.

The data was collected and analyzed using SAS v9.1.3. A 1-tail, 2-sample t-test for means was conducted at the 0.05 level of significance for Research Question Number One. The researcher hoped to reject the null hypothesis in favor of the research hypothesis of a significantly higher average gain for EETT competitive grant school districts over non-grant school districts. The researcher hoped the p-value would be less than .05 at the elementary, middle, and high school levels.

Each category of variables (Novice, Apprentice, Proficient, and Distinguished) was listed and compared among groups. Differences in Novice, Apprentice, Proficient, and Distinguished, using a one-way ANOVA for differences among means, was explored at the 0.05 level of significance for Research Question Two. The researcher hoped to reject the null hypothesis in favor of the research hypothesis of significant differences in average gain score among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky. The researcher hoped the p-value would be less than 0.05 at the elementary, middle, and high school levels.

## Descriptive Analysis

Using descriptive analytic methods, the researcher used the CATS Mathematics Students Questionnaire and CATS Mathematics Achievement Scores, along with data from the FEPSI Data Summary Report, to organize data into patterns that emerged during analysis. Descriptive analysis describes conditions, populations, and phenomena as they are; it is used to describe or characterize the population or sample being studied. Descriptive analysis is used to present quantitative description in manageable form. It can help to simplify large amounts of data in a sensible way. Different types of Descriptive analysis include mean and median; measures of dispersion, such as the variance and standard deviation; visual tools such as bar graphs, pie charts, and line charts. Some descriptive analyses involve the use of qualitative rather than statistical data and methods. When using qualitative data, the researcher must sift through various field observations, interviews, documents, etc., to identify distinct patterns, relationships, and themes that can describe the subjects being studied (Trochim, 2006). The researcher used both qualitative and statistical data and methods in this portion of the research.

The researcher analyzed the statistical data from CATS Mathematics Students Questionnaire and CATS mathematics achievement scores, as well as both statistical and qualitative data from the FEPSI Data Summary Report to organize data into patterns that emerged during analysis. A correlational research design was used to describe the association between the variables. These associations help to provide an overview of the data presented.

## Qualitative Analysis

Qualitative analysis is essentially the researcher interpreting the data, including developing descriptions of individuals or settings, and analyzing data from themes or categories, and finally making interpretations or drawing conclusions about its meaning. Qualitative research also involves the researcher stating lessons learned and offering further questions (Wolcott, 1994). Using qualitative analytic methods, the researcher used tables to show dependence between classifications (Never, Sometimes, but not every week; Once a week; Two or three times a week; or Four or five times a week).

The researcher analyzed the qualitative data from state and national reports to identify interconnected and/or emerging themes that corresponded to the findings presented in this research. A thematic analysis of the state and national reports was conducted to determine where ideas converged. The researcher organized the recurring patterns and/or themes that emerged according to existing definitions and concepts found in the literature regarding educational technology. These themes were used to describe organizational units that corresponded to the finding presented in this study in an effort to aggregate statewide educational technology data.

## Summary

A 1-tail, 2-sample t-test is appropriate to use to answer Research Question Number One to see whether the gain scores for each group are different. A 1-way ANOVA for differences among means is appropriate to use to answer Research Question Number Two to see whether the gain scores for each group are different. Descriptive research is appropriate to analyze the descriptive research to see if the data show a correlation between specific items. A qualitative narrative is appropriate to analyze the qualitative research because qualitative data lend themselves to interpretation in view of past literature/research that supports the findings of this study.

A possible weakness of the methodology is that there was no evidence of validity for the SCU or the SOM documented in the FEPSI Data Summary Report. The researcher obtained only reliability test percentages for the SOM as noted above, yet no evidence was found of reliability for the SCU. This weakness is minimized by triangulating the data found in state and national reports of educational technology. This helps to validate the information documented in the FEPSI Data Summary Report.

# CHAPTER IV

## Results

The purpose of this study was to (1) aggregate statewide data on mathematics achievement in Enhancing Education Through Technology (EETT) competitive grant and non-grant school districts in Kentucky elementary, middle, and high schools; (2) show the impact of Enhancing Education Through Technology (EETT) competitive grants on mathematics achievement scores in elementary, middle, and high schools; and (3) provide research-based instructional methods that can be widely implemented to increase mathematics achievement in elementary, middle, and high schools. In accordance with these research purposes, this chapter includes (a) research questions and hypotheses; (b) statistical methods and results; (c) descriptive analysis of demographic variables; (d) research questions analysis; and (e) the results summary. To achieve these purposes, questions below were asked.

### Descriptive Research

The following descriptive research was used as a tool to organize data into patterns that emerged during analysis. These patterns aid in the comprehension of the qualitative analysis and its implications. Here the researcher used a correlational research design in analyzing the following to describe the association between the variables. In an effort to show the connection between effective use of technology and students' achievement in mathematics, the researcher posed the following question: Will a relationship exist between computer usages, as defined by the CATS Mathematics Student Questionnaire and CATS Mathematics Achievement Scores? The researcher hypothesized that a relationship would exist between computer usage, as defined by CATS Mathematics Students Questionnaire and CATS Mathematics Achievement Scores.

## Inferential Research Questions and Hypotheses

Because the main purpose of this study was to show the impact of Enhancing Education through Technology (EETT) competitive grants on mathematics achievement scores in elementary and secondary schools, the researcher also used inferential research questions and hypotheses that specifically focused on the relationship between the variables. To achieve this objective the following primary research questions were asked for elementary, middle, and high schools:

Research Question Number One: Will there be higher average CATS Mathematics Achievement Scores for EETT competitive grant school districts over non-grant school districts in Kentucky?

The research hypothesis for Research Question Number One was as follows:

- $H_1$. There will be significantly higher average gains for EETT competitive grant school districts over non-grant school districts in Kentucky on the CATS Mathematics Achievement Scores.

As previously stated, 2002 was the first year the No Child Left Behind (NCLB) Title II-D Competitive Awards were granted in the state of Kentucky, which allocated funding for the Enhancing Education Through Technology (EETT) competitive grant program. The Kentucky Department of Education awards competitive grants that focus on a particular initiative to improve students' academic achievement through the use of technology. The awards are based on an initial first-year award and a continuation of the second year, contingent upon funding from the U.S. Department of Education (Kentucky Department of Education, 2010).

Kentucky's school districts were awarded multi-year EETT competitive grant funding in the academic years of 2002-2003 and 2003-2004 to hire technology resource teachers. This was

Round 1 of the EETT competitive grant for Kentucky school districts. In the academic years of 2004-2005 and 2005-2006, Kentucky school districts shifted their focus from acquiring technology resource teachers to satisfying the requirements of one of the top 10 priorities listed in the KETS Master Plan for Education Technology FY2001, FY2006 (see page 45). This was Round 2 of the multi-year EETT competitive grant funding. Kentucky entered its third Round of multi-year funding from the Enhancing Education through Technology (EETT) competitive grant program. EETT grant specifications were changed in 2007, refocusing its efforts and allocating money for hiring Technology Integration Specialists, limiting analysis of the focus areas previously required for grant approval. This was Round 3, academic years of 2006-2007 and 2007-2008.

Research hypotheses were divided according to the EETT competitive grant funding distribution (H1a – Round 1, H1b – Round 2, H1c – Round 3, and H1d – Rounds1, 2, and 3 combined).

- $H1_a$: The average gain on the 2004 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1 only will be higher than the average gain for non-grant school districts.
- $H1_b$: The average gain on the 2006 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 2 only will be higher than the average gain for non-grant school districts.
- $H1_c$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 3 only will be higher than the average gain for non-grant school districts.

- H1$_d$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1, Round 2, and Round 3 will be higher than the average gain for non-grant school districts.

A second research question was used to determine if there were differences among the Rounds.

Research Question Number Two: Will there be differences in average CATS Mathematics Achievement Scores among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky?

The research hypothesis for Research Question Number Two was as follows:

- H2: There will be significant differences in average CATS Mathematics Achievement Scores among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky.

## Qualitative Research

The data that were used for the following research was compiled from various reports to give an overview of the state of technology education, both locally and nationally. The researcher wanted to find out how results found in this study compared to state and national reports on technology education. Qualitative research helps one formulate one's own ideas about what causes what else to happen and helps one achieve a deep understanding of how people think about their topics. Qualitative research excels at "telling the story" from the participant's viewpoint, providing the rich descriptive detail that sets qualitative results into their human context (Trochin, 2006).

## Descriptive Analysis of Demographic Variables

Participants for this study consisted of 162 of the 174 Kentucky school districts, K-12, for the academic school years of 2002 to 2008. Participants were 1,221 public schools consisting of the following demographic percentages: White - 82.50%; African American - 10.60%; Hispanic - 3.10%; Asian – 1.00%; Native American - less than 1.00%; and Other - 2.20%. As of October 2009, the percent of individuals eligible for free or reduced-price meals in public schools (includes K-12 students; preschool/Head Start students; some adults who qualify through the National School Lunch Program) was 55.00%. The number of exceptional children ages 3 to 5, as of December 2009, was 18,865 and ages 6 to 21 was 87,181. The number of students qualifying for Gifted and Talented services was 111, 275; Primary Talent Pool Grades K-3, 24,045 and Grades 4-12, 87,230 (Kentucky Department of Education, 2011).

The population for the Enhancing Education Through Technology (EETT) grant school districts consisted of Kentucky school districts that received EETT competitive grant funding for the academic school years of 2002 to 2008. EETT grant school districts were divided into four sub-groups. The first group consisted of EETT school districts that participated in Round 1 only of the program (academic years 2002 to 2004). The second group consisted of EETT school districts that participated in Round 2 only of the program (academic years 2004 to 2006). The third group consisted of EETT school districts that participated in Round 3 only of the program (academic years 2006 to 2008). The fourth and final EETT group consisted of EETT school districts that participated in all three Rounds of the program (academic years 2002 to 2008).

Enhancing Education Through Technology (EETT) school districts that participated in Rounds 1 and 2 but did not participate in Round 3, or participated in Rounds 1 and 3 but did not participate in Round 2, or participated in Rounds 2 and 3 but did not participate in Round 1 were not used in this study. These 12 EETT competitive school districts were not used in the study in order to keep the requirements of the t-test rule true.

The population for the non-grant school districts consisted of 118 Kentucky school districts that did not receive EETT competitive grant funding for any of the three Rounds.

The detailed information about the sample distribution is shown in Table 1. There are 174 school districts in Kentucky; 118 (67.80%) non- grant school districts and 56 (32.10%) grant school districts. Of the 56 EETT grant school districts, only 44 were used in this study to keep the t-test requirements true.

Table 1

Sample Distribution Grant and Non-Grant School Districts

| Group<br>Year | No. of School Districts |
|---|---|
| EETT Round 1<br>2002-2004 Only | 10 |
| EETT Round 2<br>2004-2006 Only | 18 |
| EETT Round 3<br>2006-2008 Only | 8 |
| EETT Rounds 1-3<br>2002-2008 | 8 |
| Non-EETT Grant<br>2002-2008 | 118 |
| Not Used in Study<br>2002-2008 | 12 |

N=174

Of the 56 (32.20%) competitive grant school districts, only 44(25.20%) were used in this study; 10 school districts participated in Round 1 only(5.70%); 18 school districts participated in Round 2 only(10.30%); 8 school districts participated in Round 3 only(4.50%); and 8 school districts participated in all three Rounds (4.50%).

## Presentation of the Results

Tables 2, 3, and 4 present the summary statistics CATS Mathematics Scores by type of school, group, and Round respectively. Non-grant school districts are school districts in Kentucky that did not receive EETT competitive grant awards in Round 1, Round 2, or in Round 3 of their distribution; therefore, the same 118 school districts were compared against the varying number of grant school districts for the various Rounds.

Table 2

Summary Statistics of CATS Mathematics Scores by Round and EETT Group from Elementary School Districts in Kentucky

| Rounds | Groups | N | Mean | SD | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| 1 | Grant | 10 | 78.06 | 8.34 | 82.15 | 60.74 | 87.64 |
| 2002-2004 | Non-Grant | 118 | 75.39 | 12.16 | 74.93 | 44.50 | 111.82 |
| 2 | Grant | 18 | 75.48 | 12.42 | 75.47 | 43.03 | 96.81 |
| 2004-2006 | Non-Grant | 118 | 82.20 | 11.41 | 81.31 | 51.65 | 114.64 |
| 3 | Grant | 8 | 98.92 | 8.52 | 101.48 | 84.13 | 111.18 |
| 2006-2008 | Non-Grant | 118 | 95.92 | 10.38 | 95.92 | 51.24 | 125.35 |
| 1-3 | Grant | 8 | 97.20 | 10.60 | 97.51 | 78.65 | 108.31 |
| 2002-2008 | Non-Grant | 118 | 84.50 | 9.40 | 83.61 | 60.32 | 117.27 |

At the elementary school level in Round 1, 10 grant school districts were compared to 118 non-grant school districts with almost a 3-point increase for the mean scores for the grant group. In Round 3, 8 grant school districts showed an increase by 3 points over the 118 non-grant school districts. The largest increase of over 12 points was found when the 8 grant school districts that participated in all three Rounds were compared to the 118 non-grant school districts. However, Round 2 of the EETT grant program did not show a positive increase for the 18 grant school districts over the 118 non-grant school district. The grant school districts in Round 2 were down by 6 points as compared to the non-grant school districts.

Table 3

Summary Statistics of CATS Mathematics Scores by Round and EETT Group from Middle School Districts in Kentucky

| Round | EETT | N | Mean | SD | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| 1 | Grant | 10 | 67.26 | 7.89 | 69.89 | 52.27 | 76.04 |
| 2002-2004 | Non-Grant | 118 | 68.38 | 11.91 | 67.80 | 42.45 | 109.60 |
| 2 | Grant | 18 | 66.89 | 9.32 | 66.75 | 43.23 | 83.66 |
| 2004-2006 | Non-Grant | 118 | 70.87 | 11.89 | 68.87 | 47.22 | 114.43 |
| 3 | Grant | 8 | 86.30 | 6.58 | 86.01 | 74.88 | 93.78 |
| 2006-2008 | Non-Grant | 118 | 85.42 | 11.12 | 85.64 | 58.58 | 125.43 |
| 1-3 | Grant | 8 | 82.91 | 12.37 | 89.20 | 60.07 | 95.28 |
| 2002-2008 | Non-Grant | 118 | 74.89 | 10.45 | 73.66 | 54.13 | 116.49 |

At the middle school level in Round 3, 8 grant school districts showed a slight increase by less than 1 point over the 118 non-grant school districts. The largest increase of over 8 points was found when the 8 grant school districts that participated in all three Rounds were compared to the 118 non-grant school districts. However, neither Round 1 nor Round 2 of the EETT grant program showed a positive increase for the EETT grant school districts. In Round 1, 10 grant school districts were compared to 118 non-grant school districts with a 1-point decrease for the mean scores for the grant group. In Round 2, 18 grant school districts were compared to 118 non-grant school districts. The grant school districts in Round 2 were down by 3 points as compared to the non-grant school districts.

Table 4

Summary Statistics of CATS Mathematics Scores by Round and EETT Group from High School Districts in Kentucky

| Round | EETT | N | Mean | SD | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| 1 | Grant | 10 | 61.99 | 7.08 | 62.24 | 47.27 | 69.70 |
| 2002-2004 | Non-Grant | 113 | 67.96 | 11.10 | 67.55 | 33.54 | 106.22 |
| 2 | Grant | 18 | 67.19 | 9.70 | 68.50 | 46.05 | 84.48 |
| 2004-2006 | Non-Grant | 113 | 68.79 | 11.08 | 68.05 | 46.92 | 98.94 |
| 3 | Grant | 8 | 62.08 | 9.29 | 61.97 | 45.61 | 74.43 |
| 2006-2008 | Non-Grant | 113 | 68.29 | 10.77 | 68.25 | 44.47 | 107.76 |
| 1-3 | Grant | 8 | 66.03 | 10.40 | 67.89 | 46.79 | 78.18 |
| 2002-2008 | Non-Grant | 113 | 68.35 | 9.73 | 67.71 | 43.49 | 100.74 |

At the high school level, although Rounds showed a positive increase in mean scores for the grant school districts, the non-grant school districts had higher mean scores. In Round 1, 10 grant school districts were compared to 113 non-grant school districts with over a 5-point decrease for the mean scores for the grant group. Round 2 of the program showed much of the same. Of the 18 grant school districts compared to the 113 non-grant school districts, the grant school districts in Round 2 were down by a little less than 2 points. In Round 3, 8 grant school districts showed a decrease by more than 6 points as compared to the 113 non-grant school districts. In the group where the grant school districts participated in all three Rounds, 8 grant school districts and 113 non-grant school districts had a decrease in the mean score of over 2 points.

Table 5

Summary Statistics of CATS Mathematics Baseline Scores for School Districts in Kentucky

| Baseline | Group | N | Mean | Std. Deviation | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Elementary Baseline 2002 | Grant | 8 | 60.56 | 9.23 | 61.38 | 45.09 | 72.28 |
| | Non-Grant | 27 | 65.36 | 11.53 | 69.53 | 38.97 | 97.83 |
| Middle Baseline 2002 | Grant | 8 | 55.50 | 8.48 | 52.79 | 46.70 | 72.30 |
| | Non-Grant | 27 | 61.35 | 9.92 | 58.96 | 46.76 | 88.06 |
| High Baseline 2002 | Grant | 8 | 55.34 | 10.05 | 53.11 | 44.17 | 73.67 |
| | Non-Grant | 25 | 59.58 | 11.43 | 60.45 | 33.95 | 82.71 |

Table 5 presents the summary statistics of CATS Mathematics Baseline Scores by grade level, type of school, and group. Baseline scores are the year-end scores prior to implementation of Round 1 of the EETT grant. Non-grant school districts are school districts in Kentucky that did not receive EETT competitive grant awards in Round 1, Round 2, or Round 3 of their distribution. For the baseline school districts only 27 elementary and middle school districts reported scores and only 25 for high school level. Only 8 grant school districts were selected, using systematic sampling for the baseline school districts in 2002. Systematic sampling arranges the target population according to some ordered scheme and then selects elements at regular intervals throughout the ordered list. These same 8 grant school districts were used throughout for the baseline grant school districts. The baseline grant and non-grant school districts were compared against the varying number of grant and non-grant school districts for the various Rounds.

Student Questionnaire and CATS Scores--Descriptive

Tables 2, 3, and 4 display the summary statistics of CATS Mathematics Scores by Rounds for elementary, middle, and high school districts in Kentucky. Table 5 presents the summary statistics of CATS Mathematics Baseline Scores by grade level, type of school, and group. Tables 2, 3, 4, and 5 were used to analyze the research questions in this study.

The results of data analysis corresponding to the following question and hypothesis was given below. Will a relationship exist between computer usage as defined by the CATS Mathematics Student Questionnaire and CATS Mathematics Achievement Score? A relationship will exist between computer usage, as defined by CATS Mathematics Students Questionnaire and CATS Mathematics Achievement Scores.

The CATS Mathematics Student Questionnaire defines computer usage as "the number of times, or how often, the students use a computer in the classroom." On the Kentucky Performance Report, Question No. 42 of the Mathematics Student Questionnaire asks, "In your class, how often do you use a computer?" For this analysis, descriptive statistics were used. Table 6 shows the perceptions of elementary school students from the Round 1 Kentucky school districts, in percentages, for how often they use computers in the mathematics classroom, along with the statewide percentages.

Table 6

2004 Elementary School Totals for Question No. 42

| Never | | Sometimes but not every week | | Once a week | | Two or three times a week | | Four or five times a week | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| N | % | N | % | N | % | N | % | N | % | |
| 771 | 32.19 | 761 | 31.77 | 290 | 12.11 | 276 | 11.52 | 248 | 10.35 | 2395 |

N = Number of students answered
% = Percentage of students answered
49 Invalid Responses, 02.05%

As shown in Table 6, 32.19% of the respondents stated that they Never used the computer in mathematics class; Sometimes, but not every week (31.77%); Once a week (12.11%); Two or three times a week (11.52%); and Four or five times a week (10.35%).

Using Table 2, which displays the summary statistics of CATS Mathematics Scores by Rounds for elementary school districts in Kentucky, and Table 5, which displays the summary statistics of CATS Mathematics Baseline Scores by grade level, type of school, and group, the following data were analyzed. The baseline mean for grant elementary school Round 1 participants' CATS Mathematics Score was 60.56 with the standard deviation of 9.23. The mean for grant elementary school Round 1 participants' CATS Mathematics Score was 78.06 with a standard deviation of 8.34. The baseline non-grant elementary mean was 65.36 with a standard deviation of 11.53. The mean for non-grant elementary school Round 1 participants' CATS Mathematics Score was 75.39 with a standard deviation of 12.16.

Table 7 shows the perceptions of middle school students from the Round 1 Kentucky school districts, in percentages, for how often they use computers in the mathematics classroom.

Table 7

2004 Middle School Totals for Question No. 42

| Never | | Sometimes but not every week | | Once a week | | Two or three times a week | | Four or five times a week | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| N | % | N | % | N | % | N | % | N | % | |
| 1,193 | 49.50 | 835 | 34.65 | 148 | 06.14 | 95 | 03.94 | 96 | 03.98 | 2,410 |

N = Number of students answered
% = Percentage of students answered
43 Invalid Responses, 01.78%

As shown in Table 7, 49.50% of the respondents stated that they never used the computer in mathematics class, Sometimes, but not every week (34.65%); Once a week (6.14%); Two or three times a week (3.94%); and Four or five times a week (3.98%).

Using Table 3, which displays the summary statistics of CATS Mathematics Scores by Rounds for middle school districts in Kentucky, and Table 5 which displays the summary statistics of CATS Mathematics Baseline Scores by grade level, type of school, and group, the following data were analyzed. The baseline mean for grant middle school Round 1 participants' CATS Mathematics Score was 55.50 with the standard deviation of 8.48. The mean for grant middle school Round 1 participants' CATS Mathematics Score was 67.26 with a standard deviation of 7.89. The baseline non-grant middle school mean was 61.35 with a standard deviation of 9.92. The mean for non-grant middle school Round 1 participants' CATS Mathematics Score was 68.38 with a standard deviation of 11.91.

Table 8 shows the perceptions of high school students from the Round 1 Kentucky school districts, in percentages, for how often they use computers in the mathematics classroom.

Table 8

2004 High School Totals for Question No. 42

| Never | | Sometimes but not every week | | Once a week | | Two or three times a week | | Four or five times a week | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| N | % | N | % | N | % | N | % | N | % | |
| 1,213 | 58.32 | 534 | 25.67 | 109 | 05.24 | 71 | 03.41 | 90 | 04.33 | 2,080 |

N = Number of students answered
% = Percentage of students answered
63 Invalid Responses, 03.03%

As shown in Table 8, more than 58.32% of the respondents stated that they Never used the computer in mathematics class; Sometimes, but not every week (25.67%); Once a week (5.24%); Two or three times a week (3.41%); and Four or five times a week (4.33%).

Using Table 4, which displays the summary statistics of CATS Mathematics Scores by Rounds for high school districts in Kentucky, and Table 5 which displays the summary statistics of CATS Mathematics Baseline Scores by grade level, type of school, and group, the following data were analyzed. The baseline mean for grant high school Round 1 participants' CATS Mathematics Score was 55.34 with the standard deviation of 10.05. The mean for grant high school Round 1 participants' CATS Mathematics Score was 61.99 with a standard deviation of 7.08. The baseline non-grant high school mean was 59.58 with a standard deviation of 11.43. The mean for non-grant high school Round 1 participants' CATS Mathematics Score was 67.96 with a standard deviation of 11.10.

Table 9 shows data from the Formative Evaluation Process for School Improvement (FEPSI) Data Summary Reports conducted by the Kentucky State Technology Project, 2005-

2006, published by the Center for Research in Educational Policy (CREP). It summarizes the results from school observation visits. Multiple observations using the School Observation Measure (SOM) aided in researchers being able to determine the extent to which factors associated with school improvement are present in each school. Table 9 shows data generated at the elementary, middle and high school levels for the five-category rubric that tracks the extent to which various items are present in the school. The five-categories are Not observed, Rarely observed, Occasionally observed, Frequently observed, and Extensively observed.

Table 9

School Observation Measure of Technology Use

| The extent to which each of the following is present in the school: | % Not observed | | | % Rarely Observed | | | % Occasionally Observed | | | % Frequently Observed | | | % Extensively Observed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Period | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High |
| Technology Use | | | | | | | | | | | | | | | |
| Computer for instructional delivery (e.g., CAI, drill and practice) | 32.60 | 26.30 | 30.90 | 27.30 | 28.90 | 40.90 | 20.90 | 24.30 | 21.80 | 14.50 | 17.10 | 5.50 | 4.70 | 3.30 | 0.90 |
| Technology as a learning tool or resource (e.g., Internet research, spreadsheet or database creation, multi-media, CD Rom, Laser disk) | 37.20 | 30.90 | 30.00 | 22.70 | 28.90 | 30.00 | 23.30 | 32.90 | 29.10 | 13.40 | 5.30 | 8.20 | 3.50 | 2.00 | 2.70 |

(Center for Research in Educational Policy, 2006)

Table 10 shows data from the Formative Evaluation Process for School Improvement (FEPSI) Data Summary Reports conducted by the Kentucky State Technology Project, 2005-2006, published by the Center for Research in Educational Policy (CREP). It summarizes the results from school observation visits. The Survey of Computer Use was designed to capture exclusively student access to, ability with, and use of computers rather than teacher use of technology. Table 10 shows data generated at the elementary, middle, and high school levels for the five-category rubric that tracks the extent to which various items are present in the school. The five-categories are Not observed, Rarely observed, Occasionally observed, Frequently observed, and Extensively observed.

Table 10

Survey of Computer Use of Educational Software Used by Students

| The extent to which each of the following is present in the school: | % Not observed | | | % Rarely observed | | | % Occasionally observed | | | % Frequently observed | | | % Extensively observed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Period | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High |
| Eduactional software used by students | | | | | | | | | | | | | | | |
| Problem-solving | 74.00 | 84.80 | 78.90 | 14.80 | 4.80 | 7.90 | 4.70 | 5.50 | 2.60 | 3.60 | 3.40 | 5.30 | 0.00 | 0.70 | 0.00 |

(Center for Research in Educational Policy, 2006)

Table 11 shows data from the Formative Evaluation Process for School Improvement Data Summary Reports conducted by the Kentucky State Technology Project, 2005-2006, published by the Center for Research in Educational Policy (CREP). It summarizes the results from school observation visits. The Survey of Computer Use was designed to capture exclusively student access to, ability with, and use of computers rather than teacher use of technology. Table 11 shows data generated at the elementary, middle, and high school levels for the five-category rubric that tracks the extent to which various items are present in the school. The five-categories are Not observed, Rarely observed, Occasionally observed, Frequently observed, and Extensively observed.

Table 11

Survey of Computer Use of Overall Meaningful Use of Computers

| The extent to which each of the following is present in the school: | % Not observed | | | % Rarely observed | | | % Occasionally observed | | | % Frequently observed | | | % Extensively observed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey Period | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High | Elem | Midd | High |
| Overall Meaningful Use of Computers | | | | | | | | | | | | | | | |
| Low-level use of computers | 53.60 | 67.60 | 58.80 | 22.50 | 20.00 | 16.70 | 8.90 | 4.80 | 7.00 | 7.10 | 2.80 | 7.00 | 5.30 | 3.40 | 2.60 |
| Somewhat meaningful use of computers | 47.30 | 68.30 | 50.00 | 18.90 | 10.30 | 23.70 | 21.90 | 15.20 | 14.90 | 6.50 | 3.40 | 5.30 | 1.20 | 2.10 | 0.00 |
| Meaningful use of computers | 50.30 | 62.80 | 43.90 | 10.70 | 13.10 | 14.00 | 18.90 | 13.10 | 20.20 | 14.80 | 9.70 | 12.30 | 3.60 | 1.40 | 5.30 |
| Very meaningful use of computers | 64.50 | 73.80 | 61.40 | 10.70 | 5.50 | 10.50 | 10.70 | 9.00 | 6.10 | 5.30 | 9.00 | 7.90 | 4.70 | 2.80 | 6.10 |

(Center for Research in Educational Policy, 2006)

Table 12 shows the perceptions of elementary school students from the Round 2 Kentucky school districts, in percentages, for how often they use computers in the mathematics classroom.

Table 12

2006 Elementary School Totals for Question No. 42

| Never | | Sometimes but not every week | | Once a week | | Two or three times a week | | Four or five times a week | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| N | % | N | % | N | % | N | % | N | % | |
| 1,523 | 27.96 | 1,647 | 30.23 | 776 | 14.24 | 757 | 13.90 | 638 | 11.71 | 5,448 |

N = Number of students answered
% = Percentage of students answered
107 Invalid Responses, 01.96%

As shown in Table 12, more than 27.96% of the respondents stated that they Never used the computer in mathematics class; Sometimes, but not every week (30.23%); Once a week (14.24%); Two or three times a week (13.90%); and Four or five times a week (11.71%).

Using Table 2, which displays the summary statistics of CATS Mathematics Scores by Rounds for elementary school districts in Kentucky, the following data were analyzed. The mean for grant elementary school Round 2 participants' CATS Mathematics Score was 75.48 with a standard deviation of 12.42. The mean for non-grant elementary school Round 2 participants' CATS Mathematics Score was 82.20 with a standard deviation of 11.41.

Table 13 shows the perceptions of middle school students from the Round 2 Kentucky school districts, in percentages, for how often they use computers in the mathematics classroom.

Table 13

2006 Middle School Totals for Question No. 42

| Never | | Sometimes but not every week | | Once a week | | Two or three times a week | | Four or five times a week | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| N | % | N | % | N | % | N | % | N | % | |
| 2,662 | 45.68 | 1,936 | 33.22 | 401 | 06.88 | 335 | 05.75 | 383 | 06.57 | 5,828 |

N = Number of students answered
% = Percentage of students answered
111 Invalid Responses, 01.90%

As shown in Table 13, more than 45.68% of the respondents stated that they Never used the computer in mathematics class; Sometimes, but not every week (33.22%); Once a week (6.88%); Two or three times a week (5.75%); and Four or five times a week (6.57%).

Using Table 3, which displays the summary statistics of CATS Mathematics Scores by Rounds for middle school districts in Kentucky, the following data were analyzed. The mean for grant middle school Round 2 participants' CATS Mathematics Score was 66.89 with a standard deviation of 9.32. The mean for non-grant middle school Round 2 participants' CATS Mathematics Score was 70.87 with a standard deviation of 11.89.

Table 14 shows the perceptions of high school students from the Round 2 Kentucky school districts, in percentages, for how often they use computers in the mathematics classroom.

Table 14

2006 High School Totals for Question No. 42

| Never | | Sometimes but not every week | | Once a week | | Two or three times a week | | Four or five times a week | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| N | % | N | % | N | % | N | % | N | % | |
| 2,817 | 58.08 | 1,279 | 26.37 | 243 | 05.01 | 186 | 03.84 | 253 | 05.22 | 4,850 |

N = Number of students answered
% = Percentage of students answered
72 Invalid Responses, 01.48%

As shown in Table 14, 58.08% of the respondents stated that they Never used the computer in mathematics class; Sometimes, but not every week (26.37%); Once a week (5.01%); Two or three times a week (3.84%); and Four or five times a week (5.22%).

Using Table 4, which displays the summary statistics of CATS Mathematics Scores by Rounds for high school districts in Kentucky, the following data were analyzed. The mean for grant high school Round 2 participants' CATS Mathematics Score was 67.19 with a standard deviation of 9.70. The mean for non-grant high school Round 2 participants' CATS Mathematics Score was 68.79 with a standard deviation of 11.08.

The Kentucky Performance Report was restructured in 2007; therefore, 2006 was the last year the student questionnaire was on the report and there is no data for 2008 on students' perception of how often computers are used in the classroom for mathematics. Using the cumulative data from the summary statistics of CATS Mathematics Scores for Round 1 and Round 2 and the available data from the 2004 and 2006 CATS Mathematics Student Questionnaire, the data indicate that the perception students have of how often they use computers in mathematics class was not a determinant of their scores on the CATS Mathematics Test.

Although students reported that they Never used the computer in mathematics class most often on the questionnaire for both Rounds 1 and 2 at the high school level, (over 50%), their score on the CATS Mathematics Test remained relatively the same as the baseline scores for 2002. Round 1 mean scores for grant school districts were 61.99% and non-grant school districts were 67.96%; Round 2 mean scores for grant school districts were 67.19% and non-grant school districts were 68.79%; baseline mean scores for grant school districts were 55.34% and non-grant school districts were 59.58%.

The middle school percentages indicated primarily the same results with just below 50% of the students reporting that they never used the computer in mathematics class (49.50% and 45.60%). Middle school scores did not differ much from the 2002 baseline scores (grant 55.50% and non-grant 61.35%) and Round 1 and Round 2 respectively (grant 67.26% and non-grant 68.38%; grant 66.89% and non-grant 70.87%).

At the elementary level although most students in Round 1 felt they Never used computers in mathematics class, Round 2 found different results. The percentages of the students' perceptions for Round 1 were slightly lower than that of the middle school and high school students, with a percentage of close to 30% (32.19%). CATS Mathematics Scores were similar for Round 1 (grant 78.06% and non-grant 75.39%) as they were in 2002 (grant 60.56% and non-grant 65.30%) for the baseline scores. Round 2 elementary level students reported most often that they Sometimes, but not every week used the computers in mathematics class at 30.23% with Never using the computer as the second most selected response at 27.95%. Scores for the grant schools (75.48%) were relatively close to baseline scores (60.56%), yet the non-grant scores were higher at 82.20% and baseline scores at 65.36%.

H1-EETT Grant vs. Non-Grant- Inferential

- H1. There were significantly higher average gains for EETT competitive grant school districts over non-grant school districts in Kentucky on the CATS Mathematics Achievement Scores.
- $H1_a$: The average gain on the 2004 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1 only will be higher than the average gain for non-grant school districts.
- $H1_b$: The average gain on the 2006 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 2 only will be higher than the average gain for non-grant school districts.
- $H1_c$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 3 only will be higher than the average gain for non-grant school districts.
- $H1_d$: The average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1, Round 2, and Round 3 will be higher than the average gain for non-grant school districts.

Table 15 shows data to determine whether or not the evidence found warrants performing a t-test. Table 16 presents the two-sample t-test results for Research Question Number One for elementary school districts.

Table 15

Elementary School - Evidence=Sufficient Evidence

| Test | Is There Evidence? | Is There Sufficient Evidence? |
|---|---|---|
| H1a: Grant vs. Non-Grant | Y | N |
| H1b: Grant vs. Non-Grant | N | N |
| H1c: Grant vs. Non-Grant | Y | N |
| H1d: Grant vs. Non-Grant | Y | Y |

Based on the data from the summary statistics in Table 2, there is evidence that the grant school districts performed better than the non-grant school districts at the elementary school level for the groups that participated in Round 1 and Round 3 and in those that participated in all three Rounds of the EETT grant program. For the group that participated in Round 2, there was no evidence, based on the summary statistics, that the grant school districts performed better than the non-grant school districts; therefore, there would not be any significant evidence found, so there was no need to run a 1-tail, 2-sample t-test for Round 2.

Table 16

Comparison of CATS Mathematics Scores for Grant vs. Non-Grant Elementary School Districts in Kentucky

| Test | Difference(Δ) | $SD_{pooled}$ | p-Value | Significance |
|---|---|---|---|---|
| H1a: *Grant vs. Non-Grant* | 2.67 | 11.93 | 0.25 | ns |
| H1c: *Grant vs. Non-Grant* | 3.00 | 10.28 | 0.21 | ns |
| H1d: *Grant vs. Non-Grant* | 12.70 | 9.47 | <.00 | * |

ns – Not significant
* - Significant at the 5% level

A 2.50 point difference exists for H1a; the average gain on the 2004 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1 only will be higher than the average gain for non-grant school districts. A 3 point difference exists for H1c; the average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 3 only will be higher than the average gain for non-grant school districts. Lastly, a 12.75 point difference exists for H1d; the average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1, Round 2, and Round 3 will be higher than the average gain for non-grant school districts. The t-test results show that there is not significant evidence at the 5% level for H1a and H1c but did show a significant difference at the 5% level for H1d.

Table 17 shows data on whether or not the evidence found warrants performing a t-test. Table 18 presents the two-sample t-test results for Research Question Number One for elementary school districts.

Table 17

Middle School - Evidence=Sufficient Evidence

| Test | Is There Evidence? | Is There Sufficient Evidence? |
|---|---|---|
| H1a: Grant vs. Non-Grant | N | N |
| H1b: Grant vs. Non-Grant | N | N |
| H1c: Grant vs. Non-Grant | Y | N |
| H1d: Grant vs. Non-Grant | Y | Y |

Based on the data from the summary statistics in Table 3, there is evidence that the grant school districts performed better than the non-grant school districts at the middle school level for the groups that participated in Round 3 only, and in those that participated in all three Rounds of the EETT grant program. For the groups that participated in Round 1 only and Round 2 only there was no evidence, based on the summary statistics, that the grant school districts performed better than the non-grant school districts; therefore, there would not be any significant evidence found. There was no need to run a 1-tail, 2-sample t-test for Round 1 or Round 2.

Table 18

Comparison of CATS Mathematics Scores for Grant vs. Non-Grant Middle School Districts in Kentucky

| Test | Difference(Δ) | $SD_{pooled}$ | p-Value | Significance |
|---|---|---|---|---|
| H1c: *Grant vs. Non-Grant* | 0.88 | 10.91 | 0.41 | ns |
| H1d: *Grant vs. Non-Grant* | 8.02 | 10.57 | 0.02 | * |

ns – Not significant
* - Significant at the 5% level

At the middle school level, there is less than a 1 point difference for H1c; the average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 3 only will be higher than the average gain for non-grant school districts. An 8 point difference exists for H1d at the middle school level; the average gain on the 2008 CATS Mathematics Achievement Scores for EETT competitive grant school districts that participated in Round 1, Round 2, and Round 3 will be higher than the average gain for non-grant school districts. The t-test results show that there is not significant evidence at the 5% level for H1c but did show a significant difference at the 5% level for H1d.

Table 11 shows data on whether or not the evidence found warrants performing a t-test.

Table 19

High School - Evidence=Sufficient Evidence

| Test | Is There Evidence? | Is There Sufficient Evidence? |
|---|---|---|
| H1a: Grant vs. Non-Grant | N | N |
| H1b: Grant vs. Non-Grant | N | N |
| H1c: Grant vs. Non-Grant | N | N |
| H1d: Grant vs. Non-Grant | N | N |

Ns - Not significant
* - Significant at the 5% level

For five out of the twelve situations presented in Tables 15, 17, and 19, there was evidence to warrant a t-test. T-tests were performed for H1a, H1c, and H1d at the elementary school level, H1c and H1d at the middle school level. Two of the five t-tests found there was sufficient evidence. As shown in the High School - Evidence = Sufficient Evidence Table there were zero out of the four situations that produced evidence to warrant a t-test being performed. Therefore, there was no t-test run at the high school level.

H2 - EETT Grant Rounds

H2: There will be significant differences in average gain score among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky. Tables 20, 21, and 22 present the one-way ANOVA results for research Hypothesis 2, ANOVA table, and the post-hoc pair-wise comparisons of Rounds for the EETT school districts at the elementary school level respectively. Figure 1 presents the distribution of CATS Mathematics Scores by EETT Rounds along with the overall F-statistic and p-value for elementary schools.

Table 20

Overall Comparison of CATS Mathematics Scores Between Rounds of EETT Grant Elementary School Districts in Kentucky

| EETT | Round | N | Mean | SD | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Grant | 1<br>2002-2004 | 10 | 78.06 | 8.34 | 82.15 | 60.74 | 87.64 |
| | 2<br>2004-2006 | 18 | 75.48 | 12.42 | 75.47 | 43.03 | 96.81 |
| | 3<br>2006-2008 | 8 | 98.92 | 8.52 | 101.48 | 84.13 | 111.18 |
| | 1-3<br>2002-2008 | 8 | 97.20 | 10.60 | 97.51 | 78.65 | 108.31 |

Table 21

Elementary School ANOVA

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 4831.79 | 1610.60 | 14.18 | <.00 |
| Error | 40 | 4542.82 | 113.57 | | |
| Corrected Total | 43 | 9374.61 | | | |

The one-way ANOVA was used to test for differences in average gain score among the three Rounds of EETT competitive grant school districts in Kentucky for elementary school. Since [F(3,40)=14.18, .0001<.05], there is a significant difference among Round 1, Round 2 and Round 3 of the EETT elementary school districts in Kentucky.

Table 22

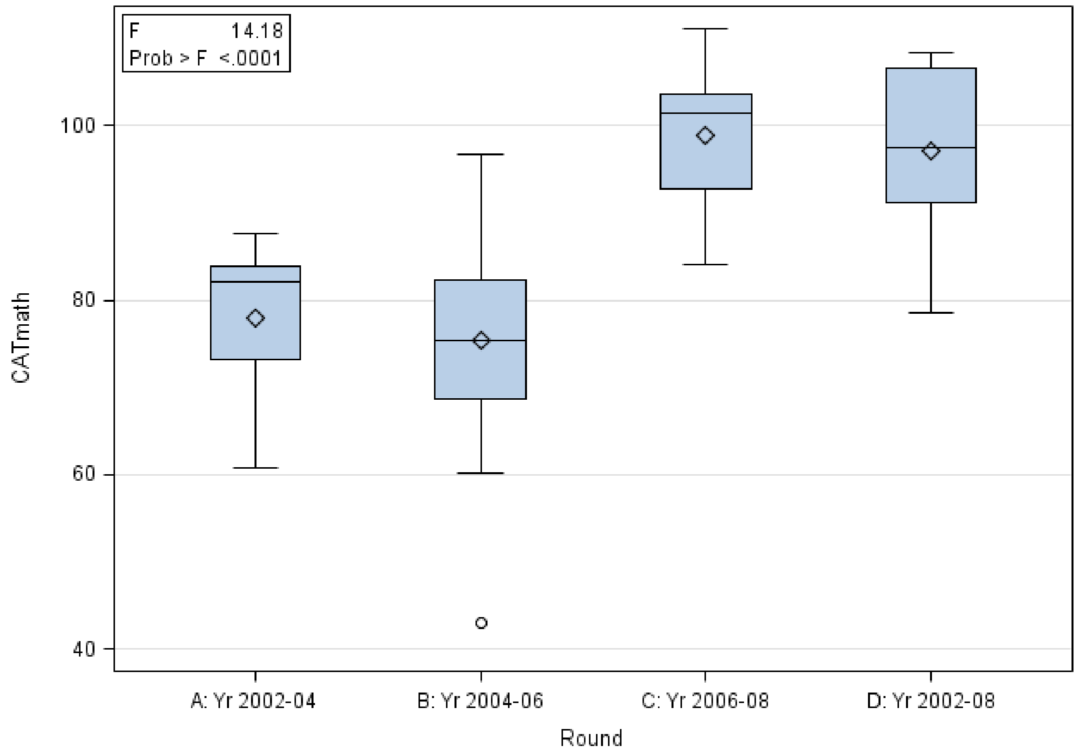
Post-Hoc Pair-Wise Comparisons of CATS Mathematics Scores Between EETT Grant Rounds for Elementary School Districts in Kentucky

| Effect | Round | _Round | Estimate | SE | p-Value | Adjustment | Adj P |
|---|---|---|---|---|---|---|---|
| Round | 1 | 2 | 2.59 | 4.20 | 0.54 | Bonferroni | 1.00 |
| Round | 1 | 3 | -20.86 | 5.06 | 0.00 | Bonferroni | 0.00 |
| Round | 1 | 1-3 | -19.14 | 5.06 | 0.00 | Bonferroni | 0.00 |
| Round | 2 | 3 | -23.44 | 4.53 | <.00 | Bonferroni | <0.00 |
| Round | 2 | 1-3 | -21.72 | 4.53 | <.00 | Bonferroni | 0.00 |
| Round | 3 | 1-3 | 1.72 | 5.33 | 0.75 | Bonferroni | 1.00 |

Since the overall test for group difference exists, or is significant, post-hoc pair-wise tests were performed to see where the differences existed between the Rounds. The adjustment for multiple comparisons was done to control for type I error, or errors in calculation based on the difference found for multiple tests being run. The significant p-values were found between the groups that participated in Rounds 2 only and the groups that participated in Round 3 only and between the groups that participated in Rounds 2 only and the groups that participated in all three Rounds at the elementary school level.

Figure 1.

Distribution of CATS Mathematics Scores by EETT Grant Rounds for Elementary School Districts in Kentucky.



Tables 23, 24, and 25 present the one-way ANOVA results for research Hypothesis 2, ANOVA table, and the post-hoc pair-wise comparisons of Rounds for the EETT school districts at the middle school level respectively. Figure 2 presents the distribution of CATS Mathematics Scores by EETT Rounds along with the overall F-statistic and p-value for middle schools.

Table 23

Overall Comparison of CATS Mathematics Scores Between Rounds of EETT Grant Middle School Districts in Kentucky

| EETT | Round | N | Mean | SD | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Grant | 1 2002-2004 | 10 | 67.26 | 7.89 | 69.89 | 52.27 | 76.04 |
| | 2 2004-2006 | 18 | 66.89 | 9.32 | 66.75 | 43.23 | 83.66 |
| | 3 2006-2008 | 8 | 86.30 | 6.58 | 86.01 | 74.88 | 93.78 |
| | 1-3 2002-2008 | 8 | 82.91 | 12.37 | 89.20 | 60.07 | 95.28 |

Table 24

Middle School ANOVA

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 3194.89 | 1064.96 | 12.49 | <0.00 |
| Error | 40 | 3410.09 | 85.25 | | |
| Corrected Total | 43 | 6604.98 | | | |

The one-way ANOVA was used to test for differences in average gain score among the three Rounds of EETT competitive grant school districts in Kentucky for middle school. Since [$F(3,40)=12.49$, $.0001<.05$], there is a significant difference among Round 1, Round 2, and Round 3 of the EETT middle school districts in Kentucky.

Table 25

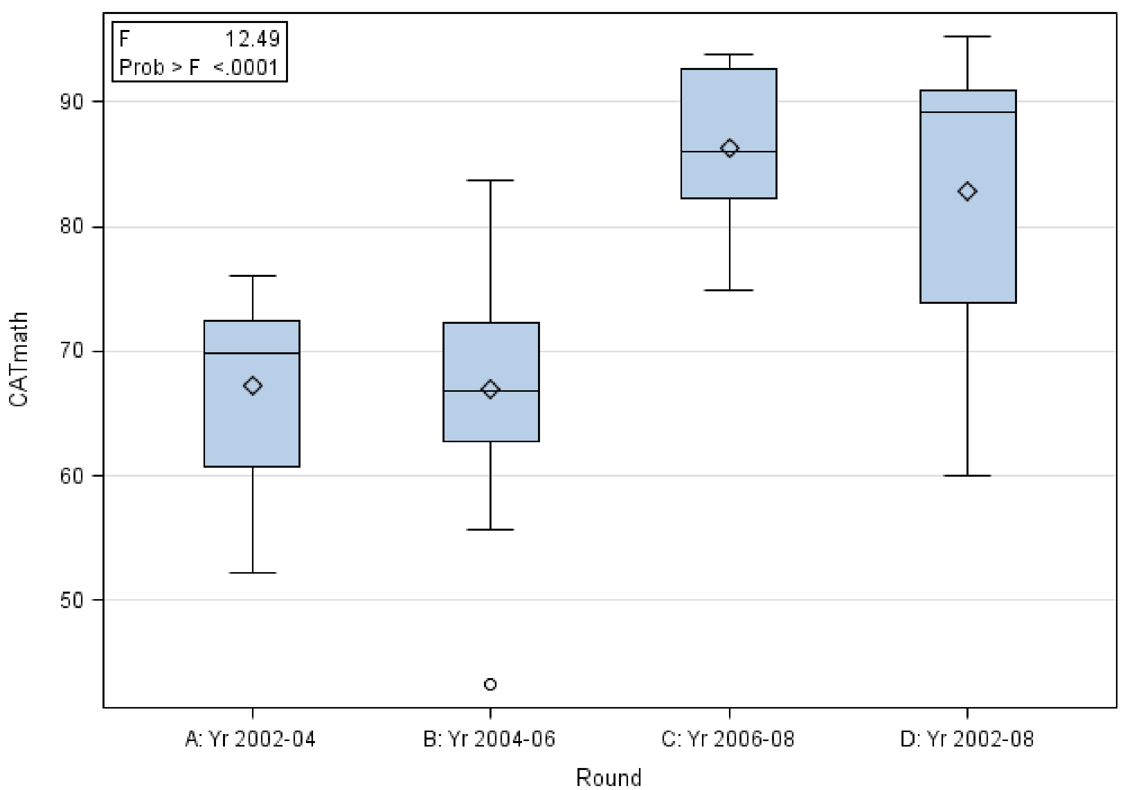
Post-hoc Pair-wise Comparisons of CATS Mathematics Scores Between EETT Grant Rounds for Middle School Districts in Kentucky

| Effect | Round | _Round | Estimate | SE | p-Value | Adjustment | Adj P |
|---|---|---|---|---|---|---|---|
| Round | 1 | 2 | 0.37 | 3.64 | 0.92 | Bonferroni | 1.00 |
| Round | 1 | 3 | -19.04 | 4.38 | <0.00 | Bonferroni | 0.00 |
| Round | 1 | 1-3 | -15.65 | 4.38 | 0.00 | Bonferroni | 0.01 |
| Round | 2 | 3 | -19.41 | 3.92 | <0.00 | Bonferroni | <0.00 |
| Round | 2 | 1-3 | -16.02 | 3.92 | 0.00 | Bonferroni | 0.00 |
| Round | 3 | 1-3 | 3.39 | 4.62 | 0.45 | Bonferroni | 1.00 |

Since the overall test for group difference exists, or is significant, post-hoc pair-wise tests were performed to see where the differences existed between the Rounds. The adjustment for multiple comparisons was done to control for type I error, or errors in calculation based on the difference found for multiple tests being run. The significant p-values were found between the groups that participated in Round 1 only and the groups that participated in Round 3 only and between the groups that participated in Rounds 2 only and the groups that participated in Round 3 only at the middle school level.

Figure 2

Distribution of CATS Mathematics Scores by EETT Grant Rounds for Middle School Districts in Kentucky.



Tables 26 and 27 present the one-way ANOVA results for research Hypothesis 2 and ANOVA table at the high school level respectively. Figure 3 presents the distribution of CATS Mathematics Scores by EETT Rounds along with the overall F-statistic and p-value for high schools.

Table 26

Overall Comparison of CATS Mathematics Scores Between Rounds of EETT Grant High School Districts in Kentucky

| EETT | Round | N | Mean | SD | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Grant | 1<br>2002-2004 | 10 | 61.99 | 7.08 | 62.24 | 47.27 | 69.70 |
| | 2<br>2004-2006 | 18 | 67.19 | 9.70 | 68.50 | 46.05 | 84.48 |
| | 3<br>2006-2008 | 8 | 62.08 | 9.29 | 61.97 | 45.61 | 74.43 |
| | 1-3<br>2002-2008 | 8 | 66.03 | 10.40 | 67.89 | 46.79 | 78.18 |

Table 27

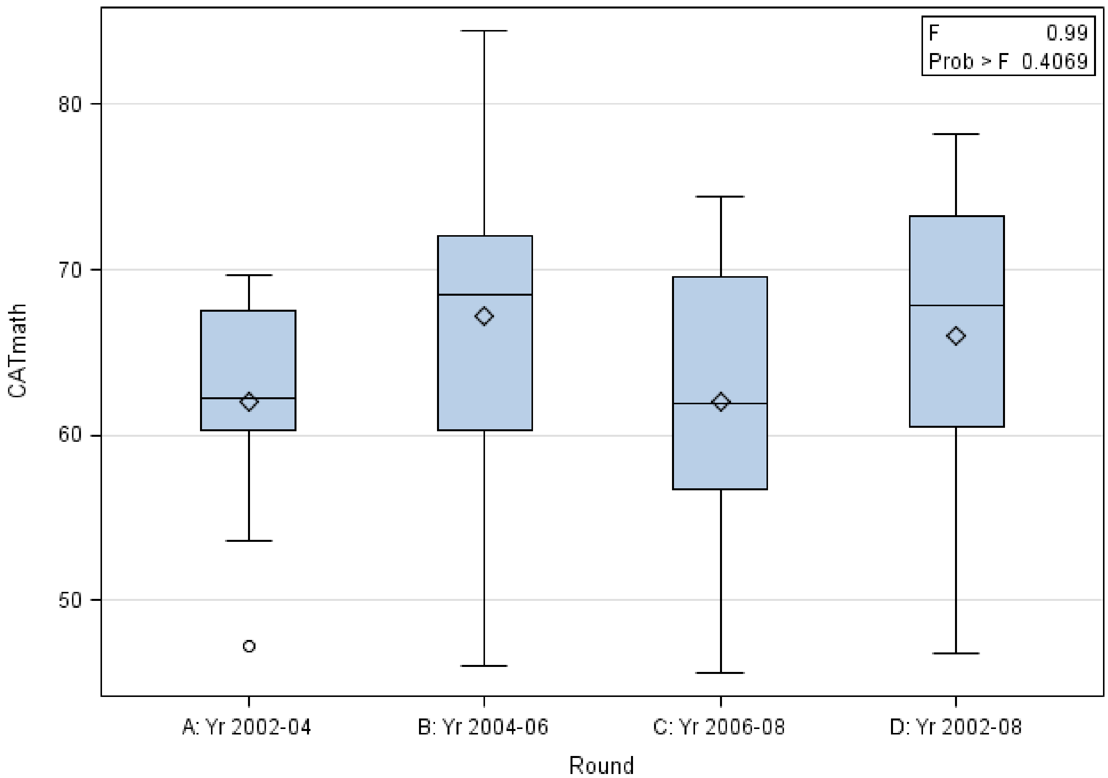
High School ANOVA

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 3 | 253.53 | 84.51 | 0.99 | 0.41 |
| Error | 40 | 3411.63 | 85.29 | | |
| Corrected Total | 43 | 3665.17 | | | |

The one-way ANOVA was used to test for differences in average gain score among the three Rounds of EETT competitive grant school districts in Kentucky for high school. Since [F(3,40)=.99, .407>.05], there is not significant evidence of a difference among averages for Round 1, Round 2, and Round 3 of the EETT high school districts in Kentucky. The overall test for group difference did not exist, or was not significant; therefore, no post-hoc pair-wise test was performed for the high school level. As shown in Table 27, the F-value was less than 1 and no further test was needed.

Figure 3

Distribution of CATS Mathematics Scores by EETT Grant Rounds for High School Districts in Kentucky.




EETT Non-Grant Rounds

Finally, Tables 28, 29, and 30 present the results from the repeated measures ANOVA looking at trends in the scores over time in the non-grant schools districts for elementary, middle, and high school districts respectively. Tables 29, 31, and 33 present the estimates for non-grant elementary, middle, and high schools respectively.

Table 28

Overall Comparison of CATS Mathematics Scores Between Rounds of Non-Grant Elementary School Districts in Kentucky

| Group | Rounds | N | Mean | SD | Median | Minimum | Maximum | p-Value | Linear Trend p |
|---|---|---|---|---|---|---|---|---|---|
| Non-Grant | 1 2002-2004 | 118 | 75.39 | 12.16 | 74.93 | 44.50 | 111.82 | <0.00 | <0.00 |
| | 2 2004-2006 | 118 | 82.20 | 11.41 | 81.31 | 51.65 | 114.64 | | |
| | 3 2006-2008 | 118 | 95.92 | 10.38 | 95.92 | 51.24 | 125.35 | | |

Table 28 shows an increase in average scores for non-grant elementary school districts in Kentucky. For the non-grant school districts during the Round 1 period, the mean score was 75.39 and 82.20 for the non-grant school districts in the Round 2 period. This is an increase in average score of slightly less than 7 points. From Round 2 to Round 3 the scores of 82.20 and 95.92 show an increase of over 13 ½ points.

Table 29

Estimates for Non-Grant Elementary School Districts in Kentucky

| Label | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Round 2 vs. 1 | 6.80 | 1.48 | 234 | 4.61 | <0.00 |
| Round 3 vs. 2 | 13.72 | 1.48 | 234 | 9.29 | <0.00 |
| Linear Trend | 20.52 | 1.48 | 234 | 13.9 | <0.00 |

The t-value for non-grant elementary school districts in Kentucky (N=118) shows that Round 2, compared to the previous Round, Round 1, shows a significant increase. When looking at Round 3, compared to the previous Round, Round 2, a significant increase in scores exists for the non-grant elementary school districts in Kentucky. Lastly, the greatest increase was shown when comparing the consecutive years, or Rounds, for the non-grant elementary school districts in Kentucky. This comparison shows the most significant increase in score over the three-Round grouping.

Table 30

Overall Comparison of CATS Mathematics Scores Between Rounds of Non-Grant Middle School Districts in Kentucky

| Group | Rounds | N | Mean | SD | Median | Minimum | Maximum | p-Value | Linear Trend p |
|---|---|---|---|---|---|---|---|---|---|
| Non-Grant | 1 2002-2004 | 118 | 68.38 | 11.91 | 67.80 | 42.45 | 109.60 | <0.00 | <0.00 |
| | 2 2004-2006 | 118 | 70.87 | 11.89 | 68.87 | 47.22 | 114.43 | | |
| | 3 2006-2008 | 118 | 85.42 | 11.12 | 85.64 | 58.58 | 125.43 | | |

A one-way repeated measure ANOVA of scores for the non-grant school districts was performed to examine trends in Rounds. Table 30 also shows an increase in CATS Mathematics Scores for non-grant school districts, at the middle school level. For Round 1, the mean score is 68.38, and in Round 2 the mean score is 70.87, a little less than a 2.50-point increase. In Round 3, the mean score of 85.42 is a 14.50-point increase over the 70.87 mean score of Round 2.

Table 31

Estimates for Non-Grant Middle School Districts in Kentucky

| Label | Estimate | Standard Error | DF | Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Round 2 vs. 1 | 2.50 | 1.52 | 234 | 1.65 | 0.10 |
| Round 3 vs. 2 | 14.55 | 1.52 | 234 | 9.59 | <0.00 |
| Linear Trend | 17.04 | 1.52 | 234 | 11.24 | <0.00 |

For the non-grant middle school group there was only a slight increase found from Round 2 when compared to the previous round, Round 1. Greater increases were found in the later Round comparisons. In comparing Round 3 to the previous Round, Round 2, there shows a significant increase in score and a greater significant increase in scores over the course of all three Rounds.

Table 32

Overall Comparison of CATS Mathematics Scores Between Rounds of Non-Grant High School Districts in Kentucky

| Group | Rounds | N | Mean | SD | Median | Minimum | Maximum | p-Value | Linear Trend p |
|---|---|---|---|---|---|---|---|---|---|
| Non-Grant | 1 2002-2004 | 113 | 67.96 | 11.10 | 67.55 | 33.54 | 106.22 | 0.85 | 0.82 |
| | 2 2004-2006 | 113 | 68.79 | 11.08 | 68.05 | 46.92 | 98.94 | | |
| | 3 2006-2008 | 113 | 68.29 | 10.77 | 68.25 | 44.47 | 107.76 | | |

Table 32 does not show the same positive increase or linear trend for non-grant high school districts in Kentucky as Tables 28 and 30. In Round 1 the mean score is 67.96 and in Round 2 the mean score is 68.79, which is not significant increase. In Round 3 the score drops from the 68.79 in Round 2 to 68.29, a decrease in score.

Table 33

Estimates for Non-Grant High Schools in Kentucky

| Label | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Round 2 vs. 1 | 0.83 | 1.46 | 224 | 0.57 | 0.57 |
| Round 3 vs. 2 | -0.50 | 1.46 | 224 | -0.34 | 0.73 |
| Linear Trend | 0.32 | 1.46 | 224 | 0.22 | 0.82 |

As shown by the t-value in Table 33, the comparison scores for the non-grant schools all remained below 1 point, showing no increase in scores among the Rounds.

Trends in CATS Mathematics Scores of Rounds from the non-grant schools were highly apparent at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels, indicative of improvement over time in scores. However, this same trend was not statistically significant at the high school level ($p = 0.82$); i.e, the scores remained consistent over time.

Results of This Study vs. State and National Technology Education Reports--Qualitative

For the final portion of this research, descriptive statistics were used. How will results found in this study compare to state and national reports on technology education?

In an effort to establish links between the EETT program and students' academic achievement, the Department of Education gave additional funding to nine states (Arkansas, Iowa, Maine, North Carolina, Pennsylvania, Tennessee, Texas, West Virginia, and Wisconsin). The additional funding was provided to the states in an effort to conduct rigorous, high-quality state evaluations of educational technology (U.S. Department of Education; Office of Planning, Evaluation and Policy Development; Policy and Program Studies Service, 2007). After completing their four-year research models, the Evaluating State Educational Technology Programs (ESETP), found trends that existed within the EETT programs.

School districts in Maine used the eMints program to implement technology throughout the curriculum. Results of a study between eMint users and a control group, conducted with funds from the ESETP, showed that student achievement of the eMints users was 10 percent higher than the control group. ESETP funded a study comparing the achievement levels of students within the School District of Philadelphia, enrolled in schools using an Instructional Management System in comparison to a matched set of students in schools not yet using the IMS. Over a three-year period, results showed significantly steeper learning trajectories in the treatment group in comparison to the control group in mathematics and reading/language arts (State Educational Technology Directors Association, 2008).

In North Carolina, students in the high need schools with the IMPACT program have demonstrated that they are 33% more likely to improve one full grade level each year than the comparison schools. Student achievement is consistently higher in the IMPACT schools. In one middle school in Texas that implemented the Technology Immersion Pilot(TIP), TIP program standardized mathematics scores increased at every grade level. While using the TIP program, Grade Six mathematics scores increased by 5%, Grade Seven by 42%, and Grade Eight by 24%.

Similar findings were seen in Iowa. Students showed a 14 point increase in Grade Eight mathematics and a 16 point increase in Grade Four mathematics (State Educational Technology Directors Association, 2008).

In Pennsylvania, a three-year analysis showed increased proficiency in math at 13%. The Grade Seven students increased PSSA math scores from 46.90% proficient to 52.20%, an increase of 5.30% (State Educational Technology Directors Association, 2007). The Technology Infused Education (TIE) Project, a statewide project implemented in Arkansas helped to improve state test data from TIE Cadre members' classrooms. Results showed combined math scores up 5 to 10% and the African-American mathematics scores up 10 to 15%. The achievement gap between Caucasians and African Americans in Arkansas showed significant closing, up to 11 points in mathematics (State Educational Technology Directors Association (SETDA), 2007). In both Wisconsin and Tennessee overall, project research findings showed that participants increased knowledge and proficiency in using educational technology, which helped to engage and enhance students' content learning and students' academic achievement (State Educational Technology Directors Association, 2011).

Of the nine states that received ESETP awards, only one state was unable to complete the research project. Although West Virginia focused its state-level set-aside on personnel and technical assistance, state officials in West Virginia reported that budget concerns in the state threatened the stability of the West Virginia educational technology office and, therefore, they were unable to continue to deliver relatively high levels of technical assistance and conduct impact evaluations (U.S. Department of Education; Office of Planning, Evaluation and Policy Development; Policy and Program Studies Service, 2007).

## Summary of Results

### Statistical Methods

CATS Mathematics Scores were summarized by type of school (elementary, middle, and high school); group (grant vs. non-grant); and Round (1, 2, 3, and all three Rounds). The 1- tail, 2-sample t-tests were done to compare performance between Enhancing Education Through Technology (EETT) grant and non-grant school districts in Kentucky. The 1-tail p-values were used to assess whether or not the EETT grant school districts performed better than non-grant school districts overall (across all years/Rounds) and within each Round.

Next, a one-way ANOVA model was run to check for differences in Rounds of the EETT grant group. Post-hoc (i.e., unplanned) pair-wise comparisons of Rounds were done to see how the scores differed between them. The post-hoc pair-wise comparisons between Rounds were performed, and

p-values were adjusted for multiple comparisons using the Bonferroni method. Box plots of EETT Rounds were produced to visualize these differences. Figures 1-3 present the distribution of CATS Mathematics Scores by EETT Rounds along with the overall F-statistic and p-value for elementary, middle, and high school districts respectively.

In addition, a one-way repeated measures ANOVA of scores in the non-grant school districts was done to examine trends in Rounds (time). Trends in CATS Mathematics Scores of Rounds from the non-grant school districts were highly apparent at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels indicative of improvement over time in scores. However, this same trend was not statistically significant at the high school level ($p = 0.82$); i.e., the scores remained consistent over time.

### EETT Grant vs. Non-Grant

Overall, there was not enough evidence to state that EETT grant school districts had higher average CATS Mathematics Scores than the non-grant school districts. Differences between grant vs. non-grant schools within each Round resulted in similar conclusions.

Differences between grant vs. non-grant school districts for each Round (1, 2, and 3) resulted in non-significance at the alpha=0.05. That is, there is not enough statistical evidence to state that the average difference in CATS Mathematics Scores between the two groups was higher in the EETT grant school districts over the non-grant school districts. However, the comparison of average CATS Mathematics Scores across all three Rounds for the non-grant school districts and the grant school districts that participated in all three Rounds suggested that EETT grant school districts had higher average CATS Mathematics Scores than the non-grant school districts. This was particularly evident at the elementary and middle school levels. Based on the one-sided two-sample t-test, similar increase in average CATS Mathematics Scores cannot be noted at the high school level for the EETT groups.

EETT Grant Rounds

Differences between the Rounds of the EETT grant schools were highly evident at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels. However, the same differences were not statistically significant at the high school level ($p = 0.41$). A significant p-value here suggested that there was at least one Round that performed differently from another Round.

Ad-hoc Pair-wise comparisons between Rounds were adjusted for multiple comparisons using the Bonferroni adjustment. Figures 1-3 present the distribution of CATS Mathematics Scores by EETT Rounds for elementary, middle, and high, school along with the overall F-statistic and p-value.

EETT Non-Grant Rounds

Trends in Rounds of the non-grant schools were highly apparent at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels, indicative of improvement over the examined Rounds. However, no trend was statistically significant at the high school level ($p = 0.82$).

Student Questionnaire and CATS Scores

At the elementary school level for the 2004 school year more than 30% (32.00) of the students perceived that they never used the computer in mathematics class. More than 30% (30.20) of students perceived that they only sometimes used the computer in mathematics class in the 2006 school year. At the middle school level for both the 2004 and 2006 school years, nearly 50% (49.50 and 45.60 respectively) of the students perceived that they never used the computer in mathematics class. At the high school level, for both the 2004 and 2006 school years, more than 50% (58.30 and 58.00 respectively) of the students perceived that they never used the computer in mathematics class.

Results Compared to State and National Technology Reports

Results of this study and national reports completed over a four-year period by Evaluating State Educational Technology Programs (ESETP) found positive trends that existed within the EETT programs implemented. Several states reported increased scores in mathematics. The comparison of average CATS Mathematics Scores across all Rounds for the non-grant schools and the grant schools, which performed in all three Rounds of the EETT grant, indicated that EETT grant schools had higher average CATS Mathematics Scores than the non-grant schools particularly at the elementary and middle school levels. The same difference in EETT groups was not noted at the high school level.

This research did not yield enough evidence to state that EETT competitive grant school districts had higher average CATS Mathematics Scores than non-grant school districts.

# CHAPTER V

## Discussion

The purpose of this study is to (1) aggregate statewide data on mathematics achievement in Enhancing Education Through Technology (EETT) competitive grant and non-grant school districts in Kentucky elementary, middle, and high schools; (2) show the impact of Enhancing Education Through Technology (EETT) competitive grants on mathematics achievement scores in elementary, middle, and high schools; and (3) provide research-based instructional methods that can be widely implemented to increase mathematics achievement in elementary, middle, and high schools.

### Student Questionnaire and CATS Scores

At the elementary school level for the 2004 school year, more than 30% (32.00) of the students perceived that they never used the computer in mathematics class. More than 30% (30.20) of students perceived that they only sometimes used the computer in mathematics class in the 2006 school year. At the middle school level, for both the 2004 and 2006 school years, nearly 50% (49.50 and 45.60 respectively) of the students perceived that they never used the computer in mathematics class. At the high school level for both the 2004 and 2006 school years, more than 50% (58.30 and 58.00 respectively) of the students perceived that they never used the computer in mathematics class.

The researcher believes that unlike observations which rely on fact or evidence to support its findings, the student questionnaires were subjective or bias-based on one's opinion or feelings. They could not alone, be used to show the full picture of the frequency of computer use in mathematics classrooms. Because younger students' concept of time may not have been fully developed, they oftentimes forget what activities they were involved in from month to month.

Depending on whether or not the most recent lessons in mathematics class used computers, could sometimes determine what answers were given on the questionnaire and could play a big part in how students perceived the frequency of use. The student questionnaires were given at the end of the school year, usually at the end of the testing session; students' perception of computer use may not have been accurate. For older students, testing as a whole may not have been viewed as interesting or exciting. Therefore, they may not have taken the time to answer questions; especially questions that they felt would not affect their grades, with the care necessary to fully incorporate an accurate account of their computer use that had taken place throughout the year.

The following formal research questions were used to show the impact of Enhancing Education Through Technology (EETT) competitive grants on mathematics achievement scores in elementary, middle, and high schools. Question 1: Will there be significantly higher average gains for EETT competitive grant school districts over non-grant school districts in Kentucky on the CATS Mathematics Achievement Scores? 1-tail, 2-sample t-tests were done to compare performance between EETT grant and non-grant school districts in Kentucky. The 1-tail p-values were used to assess whether or not the EETT grant school districts performed better than non-grant school districts overall (across all years/Rounds) and within each Round.

EETT Grant vs. Non-Grant

Overall, there was not enough evidence to state that EETT grant school districts had higher average CATS Mathematics Scores than the non-grant school districts. Differences between grant vs. non-grant schools within each Round resulted in similar conclusions.

Differences between grant versus non-grant school districts for each Round (1, 2, and 3) resulted in non-significance at the alpha=0.05. That is, there was not enough statistical evidence to state that the average difference in CATS Mathematics Scores between the two groups was higher in the EETT grant school districts over the non-grant school districts. However, the comparison of average CATS Mathematics Scores across all three Rounds for the non-grant school districts and the grant school districts that participated in all three Rounds suggested that EETT grant school districts had higher average CATS Mathematics Scores than the non-grant school districts. This was particularly evident at the elementary and middle school levels. The same difference in EETT groups was not noted at the high school level based on the 1-tailed, 2-sample t-test.

The researcher concluded that having the EETT competitive grant funding for all three Rounds enabled the recipients to have access to some of the necessary aspects of effective technology use, thereby having a positive effect on CATS Mathematics Achievement Scores. Round 1 allowed for Kentucky school district to hire Technology Resource Teachers; Round 2 funding was allocated to purchase hardware and educational software applications; and Round 3 funding was used to hire Technology Integration Specialists. By having the appropriate hardware and software, having someone to aid in instructing students in the appropriate use of the technology, and someone to assist teachers in being able to integrate technology throughout their lessons, as well as being able to use the technology for an expanded amount of time, elementary and middle school level grant groups that participated in all three Rounds were able to increase scores over the non-grant school districts that did not participate during the same timeframe.

However, the lack of an increase in scores at the high school level may have been due to the fact that students today have grown up in a world where computers have dominated their existence. Most phones and media devices are small computers with access to the Internet. Therefore, giving older students the use of a laptop and having them merely watch a teacher generated PowerPoint presentation--only to have them click on the appropriate answers that follow--has little to no interest for the students. What was a boring and mundane lecture by the teacher is the same boring information only on a computer screen. Many students then become even more apathetic in regard to their classes and begin to simply scroll or click through the information, not paying any attention to it at all and clicking on an answer to simply get through the work so they can find ways to search the Web and explore without getting caught.

Question 2: Will there be significant differences in average gain score among Round 1, Round 2, and Round 3 EETT competitive grant school districts in Kentucky? Next, a one-way ANOVA model was run to check for differences in Rounds of the EETT grant groups. Post-hoc (i.e., unplanned) pair-wise comparisons of Rounds were done to see how the scores differed between them. The post-hoc pair-wise comparisons between Rounds were performed and p-values were adjusted for multiple comparisons using the Bonferroni method. Box plots of EETT Rounds were produced to visualize these differences. Figures also were provided to present the distribution of CATS Mathematics Scores by EETT Rounds along with the overall F-statistic and p-value for elementary, middle, and high school districts.

EETT Grant Rounds

Overall differences between the Rounds of the EETT grant schools districts were highly evident at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels. However, the same differences were not statistically significant at the high school level ($p = 0.41$). A significant p-value here suggests that there is at least one Round that performed differently from another Round. Ad-hoc pairwise comparisons between Rounds were adjusted for multiple comparisons using the Bonferroni adjustment.

In addition, a one-way repeated measures ANOVA of scores in the non-grant school districts was done to examine trends in Rounds (time). Trends in CATS Mathematics Scores of

Rounds from the non-grant school districts were highly apparent at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels, indicative of improvement over time in scores. However, this same trend was not statistically significant at the high school level ($p = 0.82$); i.e., the scores remained consistent over time.

The researcher concluded that the significant differences found in the scores between the Rounds were due to the differences in how the grant funding was used. Because Round 3 funding was allocated for hiring Technology Integration Specialists, persons trained in effectively integrating technology throughout the curriculum/lessons, everyday instructional practices, as well as student interest/motivation may have been positively impacted. By having the regular classroom teacher collaborate with the Technology Integration Specialist, all of the teachers were then able to integrate technology throughout their lessons. This, in turn, helped to create a technology-rich environment.

EETT Non-Grant Rounds

Trends in Rounds of the non-grant schools were highly apparent at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels, indicative of improvement over the examined Rounds. However, no trend was statistically significant at the high school level ($p = 0.82$).

The No Child Left Behind Law includes the provision that all students must be proficient in math and reading by 2014. Even school districts that did not receive EETT competitive grant funding are looking at how to raise test scores. Some schools have implemented programs such as after-school enrichment programs for struggling students; in-school remediation or pull-out classes to aid in moving students from novice to proficient; and even hired testing coaches to come in prior to the assessment test to help students learn strategies for test-taking. These, as well as other programs, may be in place at the non-grant school districts, helping to facilitate raising test scores over an extended time.

The researcher concluded that predominantly at the high school level, today's students fail to see the relevance in learning calculations that can be performed on a computer in a matter of seconds or in studying classic literature that they feel will not serve them in their everyday existence. Although this is not new insight into the mind of high school-aged students, it does bring up the point that using the same teaching strategies that were used decades ago does not allow students to expand their knowledge and fails to spark their interest. This may account for the disconnection that exists between teachers and students.

The researcher used qualitative research methods to assess the following: How will results found in this study compare to state and national reports on technology education? The researcher analyzed the qualitative data from state and national reports to identify interconnected and/or emerging themes that correspond to the findings presented in this research. The researcher also conducted a thematic analysis of the state and national reports to determine where ideas converged. The researcher organized the recurring patterns and/or themes that emerged according to existing definitions and concepts found in the literature regarding educational technology. The researcher used these themes to describe organizational units that correspond to the finding presented in this study in an effort to aggregate statewide educational technology data.

## Results Compared to State and National Technology Reports

Results of this study and results from national reports completed over a four-year period by Evaluating State Educational Technology Programs (ESETP) both found positive trends that existed within the EETT programs implemented. Several states reported increased scores in mathematics by the ESETP findings. Although the comparison of average CATS Mathematics Scores across all Rounds for the non-grant schools and the grant schools, which performed in all three Rounds of the EETT grant indicated that EETT grant schools had higher average CATS Mathematics Scores than the non-grant schools, particularly at the elementary and middle school levels, the same difference in EETT groups was not noted at the high school level. The finding of this report did not yield enough evidence to state that EETT competitive grant school districts had higher average CATS Mathematics Scores than non-grant school districts.

The researcher feels that the positive trends within the EETT programs found in both this and the ESEPT's national study could be attributed to the fact that there are many positive outcomes that occur from the implementation of computer use in the classroom. At the elementary and middle school levels, much of the increase can be attributed to students' motivational changes in response to the novelty of computer use in the classroom. Students are just learning many of the uses for the technology and, therefore, they are more motivated to complete multiple exercises and/or numerous problems practicing skills that will improve their academic achievement using computers.

Although this may be true at the elementary and middle school levels, high school students are not that easily motivated and are quick to find ways around actually calculating and/or working through the problems to achieve mastery of a particular skill. At this level students must be able to find in an activity a purpose that directly affects them or they feel it not worth their time and effort to complete.

## Limitations

The researcher focused on schools that received Enhancing Education Through Technology (EETT) competitive grants and their counterparts beginning in 2002 and ending in 2008, because 2002 was the first year the NCLB Title II-D Competitive Awards were granted in the state of Kentucky, and 2008 was the last year that state documentation is available for the EETT competitive grant program.

The researcher limited the information contained in the 2005-2006 Formative Evaluation Process for School Improvement (FEPSI) Data Summary Report for Kentucky State Technology Project because this was the only year the state conducted this type of formative evaluation report. EETT grant specifications were changed in 2007, refocusing its efforts and allocating money for hiring Technology Integration Specialists, limiting analysis of the focus areas previously required for grant approval.

Because of other factors that may influence student achievement on the Commonwealth Accountability Testing System (CATS), there are limitations to the correlations that are identified. Other factors may include, but are not limited to other programs implemented throughout the school district in an effort to raise test scores; after-school tutoring programs that may be offered; as well as teaching experience and the major or area of concentration teachers had during their college experience. The researcher also acknowledged that data collected from respondents on the Student Mathematics Questionnaire found in the Kentucky Performance Report (KPR) did not come from observations and, for this reason, may not be accurate in the frequency of technology use.

## Implications

Technology can be used as a tool to aid in raising test scores (Niess, Preparing Teachers to Teach Science and Mathematics with Technology: Developing a Technology Pedagogical Content Knowledge, 2005). However, it is not the fix-all or magic bullet that some would have it to be. Technology is a tool, and when implemented correctly, using research-based programs that have shown promise in increasing student achievement, it can result in the transformation of the educational process.

The results of this study indicate that simply acquiring technology and/or a technology resource teacher will not increase achievement scores. The implications gained from Chapter Two: Technology Use, The President's Committee of Advisors on Science and Technology Panel on Educational Technology (1997); Ysseldyke and Bolt, 2007; Kulik 1994 and Green (2001) in the Effects on Learning Section, mirror the idea that if implementation of the technology is meaningful and at high levels, incorporating higher-order and lower-order thinking as it occurs in real-life situations, students will show significantly higher scores on tests of achievement as compared to students with low levels of implementation of technology. Therefore, school districts should advocate implementing common state standards that integrate throughout the curriculum purposeful technology which has been researched and are based on students' achieving mastery of the content before new material is introduced.

Because a countless number of students move in and out of districts during their primary and secondary educational careers, state standards bring about consistency throughout school systems. What may have been taught in one school district at a particular level may not have been addressed in another school district at the same level, and transient students are forever playing catch-up. By having common state standards that integrate throughout the curriculum technology that has been researched and found to improve student achievement, this will also increase the number of college-ready students in our nation.

Technology in the classroom was supposed to allow students the ability to increase their knowledge by being able to access the Internet for research, never before possible in the classroom. But by placing technology in the hands of teachers who are bound by state and national test-score pressures and not allowing students to use the computers for exploration and real-world learning, computers have simply become yet another obstacle for teachers to maneuver around in the digital age of today.

Both Sheigold (1991) and Hardly (1998) champion the idea of teachers and administrators being allowed the time and resources to continue working with a program over an extended amount of time before discarding the program as ineffective; that program could be useful in creating change through the school. Change includes ongoing teacher training with instructional strategies and representations of the subject matter within a technology framework; appropriate hardware and software to teach the content; as well as knowledgeable technology support available to answer questions and fix problems when they arise.

Teachers are often resistant to implementing technology into their lessons because teachers' technology use varies from survival to mastery to impact and innovation according to Barnett (2001). A teacher who modifies his or her classroom environment to take full advantage of technology to enhance curriculum and learning activities is said to be in the innovation stage (Mandinach & Cline, 1992). However, it can take a teacher from three to five years to reach the mastery and impact stages, even with extensive professional development and coaching. For technology to become an integral component or tool for learning, teachers also must develop knowledge of their subject matter with respect to technology. Technology Pedagogical Content

Knowledge (TPCK) is the integration of the development of knowledge of subject matter with the development of technology and of knowledge of teacher and learning (Niess, Preparing Teachers to Teach Science and Mathematics with Technology: Developing a Technology Pedagogical Content Knowledge, 2005). Teachers with TPCK tend to have increased efficiency in the planning and implementation of the technology in their classrooms.

Technology can be used not only for bringing about increased efficiency for teachers, students, and administrators in their everyday activities, but it can also break down the boundaries/walls of their classroom to connect with other students in their district, other cities, or even other parts of the world. The proper use of technology can give students the opportunity to do original research through up-to-date articles published on the Internet (Merrow, 2011). Students are not limited to the use of outdated textbooks and videos purchased for the entire school district. With the Internet, students are not limited to the use of a classroom set of books that they do not have access to at home because virtual textbooks can be updated automatically and accessed from almost anywhere.

## Suggestions for Future Research

Suggestions for further research include looking at and determining which specific characteristics of educational technology can most effectively bring increased student achievement. As noted in Chapter II, programs such as the Enhancing Missouri's Instructional Networked Teaching Strategies (eMINTS) program implemented at Peabody Elementary School in St. Louis, Missouri, were able to raise scores in reading, science, social studies, and mathematics (U.S. Department of Education, Office of Eduational Technology, 2004). By using a technology-rich environment, this urban school that services almost entirely Title I students from the lowest income families, was able to raise test scores more than 70% in a two-year span.

Students work on desktop computers and are able to proceed at their own pace using teachers' assign-online instruction and online tutoring programs based on individual students' levels of mastery of the curriculum. The students also take regular online assessments of their progress, which allows teachers to customize instruction to the specific needs of individual students. The program provides 200 hours of professional development, coaching and technical support for teachers to enhance their use of technology so they can better use multimedia tools in their classrooms to promote critical-thinking and problem-solving techniques of the students.

Another suggestion for further research is to look at creating international standards by researching countries that produce students with advanced skills in critical areas such as mathematics, like Japan, whereby 26% of Japan's eighth-graders in mathematics, compared with only 6% of the United States eighth-graders who reached the advanced benchmark. (the highest TIMSS benchmark) in 2007, or Singapore's World-Class Mathematics System was ranked first in the world on the Trends in International Mathematics and Science Study (TIMSS) in 2003 with the United States ranking 16th out of 46 participants.

## Summary

Baseline scores showed that grant school districts had lower CATS Mathematics Mean Scores than non-grant school districts in Kentucky. At both the elementary and middle school levels, the grant groups that participated in all three Rounds had higher mean scores than non-grant school districts. In school observations, technology use as a learning tool or resource was either rarely or not observed at all. Educational software for problem-solving meaningful, uses of computers was mostly not observed at all or either at low levels of use. The descriptive data show that for both 2004 and 2006, more than 50% of students perceived that they never or only sometimes used the computer in mathematics class.

Overall, there was not enough evidence to state that EETT grant school districts had higher average CATS Mathematics Scores than the non-grant school districts. However, the comparison of average CATS Mathematics Scores across all three Rounds for the non-grant school districts and the grant school districts that participated in all three Rounds suggested that EETT grant school districts had higher average CATS Mathematics Scores. This was particularly evident at the elementary and middle school levels. The same difference in EETT groups was not noted at the high school level based on the 1-tail, 2-sample t-test.

The overall differences between the Rounds of the EETT grant school districts were highly evident at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels. However, the same differences were not statistically significant at the high school level ($p = 0.41$). A significant p-value here suggested that there was at least one Round that performed differently from another Round. Ad-hoc pairwise comparisons between Rounds were adjusted for multiple comparisons, using the Bonferroni adjustment. EETT non-grant trends in Rounds for schools were highly apparent at the elementary ($p < 0.00$) and middle ($p < 0.00$) school levels, indicative of improvement over the examined Rounds.

Results of this study compared to results from national reports completed over a four-year period by Evaluating State Educational Technology Programs (ESETP) found positive trends that existed within the EETT programs implemented. Several states reported increased scores in mathematics by the ESETP findings. Similar findings were reported in this study. Although the comparison of average CATS Mathematics Scores across all Rounds for the non-grant schools and the grant schools, which performed in all three Rounds of the EETT grant, indicated that EETT grant schools had higher average CATS Mathematics Scores than the non-grant schools, particularly at the elementary and middle school levels. The same difference in

EETT groups was not noted at the high school level. The finding of this report did not yield enough evidence to state that EETT competitive grant school districts had higher average CATS Mathematics Scores than non-grant school districts.

This research serves as a guide to schools in the implementation of long-term changes in the way schools educate students in an effort to prepare young people to thrive in a technologically advanced and economically driven nation. With continued funding/investments in educational technology and the resources stated above, technology can be used as the catalyst to expand and develop education in the next decade. The Enhancing Education Through Technology (EETT) Act made available funding for elementary, middle, and high school districts, with the primary goal of improving students' academic achievement through the use of technology. The researcher believes that somewhere along the way this goal of improving students' academic achievement has been overshadowed by the assessment or calculation of increasing test scores. Schools must get back to the basic premise of educating children for the future. This can be accomplished by creating common state standards that integrate meaningful technology throughout the curriculum; making sure that the tools and techniques used in the classroom reinforce the skills necessary for success in college and/or career, and stimulating innovative thought and creativity from students to help them move forward into the future. Numerous studies have been done over the past decade related to technology and test scores. This researcher believes that as long as increasing test scores is the focus of education, then actually educating students ultimately will be lost.

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APPENDICES

APPENDIX A

Historical Timeline of the Reauthorization of the Federal Elementary and Secondary Education Act

| | Historical Timeline of the Reauthorization of the Federal Elementary and Secondary Education Act |
|---|---|
| 1965 | Elementary and Secondary Education Act (ESEA) first implemented |
| 1981 | The reauthorization of the Elementary and Secondary Education Act (ESEA) named the Education Consolidation and Improvement Act (ECIA) |
| 1988 | The Elementary and Secondary Education Act (ESEA) reauthorization named the Augustus F. Hawkins-Robert T. Stafford Elementary and Secondary School Improvement amendments |
| 1994 | The Elementary and Secondary Education Act (ESEA) reauthorization named Improving American Schools Act (IASA) |
| 2001 | The Elementary and Secondary Education Act (ESEA) reauthorization named No Child Left Behind Act of 2001 **(Oklahoma State Department of Education, 2007)** |
| 2002 | The Elementary and Secondary Education Act (ESEA) reauthorization appropriated its first fiscal year funds for the Enhancing Education Through Technology (EETT) Act, Title II, Part D of the No Child Left Behind Act of 2001 |
| 2010 | Obama Reauthorization of the ESEA, March 13, 2001, Blueprint for Reform **(U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2010)** |

APPENDIX B

NCATE Unit Standards

| NCATE Unit Standards |
| --- |

Candidate Knowledge, Skills, and Professional Disposition

- Candidates preparing to work in schools as teachers or other school professionals know and demonstrate the content knowledge, pedagogical content knowledge and skills, pedagogical and professional knowledge and skills, and professional dispositions necessary to help all students learn.
- Assessments indicate that candidates meet professional, state, and institutional standards.

Assessment System and Unit Evaluation

- The Unit has an assessment system that collects and analyses data on applicant qualifications, candidate and graduate performance, and unit operations to evaluate and improve the performance of candidates, the unit, and its programs.

Field Experiences and Clinical Practice

- The unit and its school partners design, implement, and evaluate field experiences and clinical practice so that teacher candidates and other school professionals develop and demonstrate the knowledge, skills, and professional dispositions necessary to help all students learn.

Diversity

- The Unit designs, implements, and evaluates curriculum and provides experiences for candidates to acquire and demonstrate the knowledge, skills and professional dispositions necessary to help all students learn.
- Assessments indicate that candidates can demonstrate and apply proficiencies related to diversity.
- Experiences provided for candidates include working with diverse populations, including higher education and P-12 school faculty, candidates, and students in P-12 schools.

Faculty Qualifications, Performance, and Development

- Faculty are qualified and model best professional practices in scholarship, service, and teaching, including the assessment of their own effectiveness as related to candidate performance.
- They also collaborate with colleagues in the disciplines and school.
- The unit systematically evaluates faculty performance and facilitates professional development.

Unit Governance and Resources

- The unit has the leadership, authority, budget, personnel, facilities, and resources, including information technology resources, for the preparation of candidate to meet professional, state, and institutional standards.

(National Council for Accreditation of Teacher Education, 2007)

APPENDIX C

NETS for Teachers 2008

| NETS for Teachers 2008 |
| --- |
| Facilitate and Inspire Student Learning and Creativity<br>• Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments.<br>Design and Develop Digital-Age Learning Experiences and Assessments<br>• Teachers design, develop, and evaluate authentic learning experiences and assessment incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills and attitudes identified in the NETS-S.<br>Model Digital-Age Work and Learning<br>• Teachers exhibit knowledge, skill, and work processes representative of an innovative professional in a global and digital society.<br>Promote and Model Digital Citizenship and Responsibility<br>• Teachers understand local and global society issues and responsibilities in an evolving digital culture and exhibit legal and ethical behavior in their professional practices.<br>Engage in Profession Growth and Leadership<br>• Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources. |

(International Society for Technology in Education, 2008)

APPENDIX D

NETS for Students 2007

| NETS for Students 2007 |
| --- |
| Creativity and Innovation<br>• Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.<br>Communication and Collaboration<br>• Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.<br>Research and Information Fluency<br>• Students apply digital tools to gather, evaluate, and use information.<br>Critical Thinking, Problem Solving, and Decision Making<br>• Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.<br>Digital Citizenship<br>• Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.<br>Technology Operations and Concepts<br>• Students demonstrate a sound understanding of technology concepts, systems, and operations. |

(International Society for Technology in Education, 2007)

APPENDIX E

2004 Kentucky Performance Report Mathematics Student Questionnaire Elementary School

2004 Kentucky Performance Report Mathematics Student Questionnaire Elementary School
Question No. 42: In your class, how often do you use a computer?

| School Districts | Never | | | Sometimes but not every week | | | Once a week | | | Two or three times a week | | | Four or five times a week | | | Invalid response | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP |
| Ashland Ind | 57 | 25 | 35 | 63 | 27 | 28 | 28 | 12 | 14 | 34 | 15 | 12 | 43 | 19 | 9 | 5 | 2 | 2 |
| Barren Co | 56 | 19 | 35 | 155 | 53 | 28 | 32 | 11 | 14 | 20 | 7 | 12 | 25 | 9 | 9 | 4 | 1 | 2 |
| Breckinridge | 12 | 7 | 35 | 26 | 14 | 28 | 9 | 5 | 14 | 64 | 36 | 12 | 68 | 38 | 9 | 1 | 1 | 2 |
| Cloverport | 7 | 39 | 35 | 3 | 17 | 28 | 7 | 39 | 14 | 1 | 6 | 12 | 0 | 0 | 9 | 0 | 0 | 2 |
| Fleming Co | 39 | 20 | 35 | 32 | 17 | 28 | 28 | 15 | 14 | 51 | 27 | 12 | 38 | 20 | 9 | 4 | 2 | 2 |
| Knott Co | 108 | 45 | 35 | 63 | 26 | 28 | 28 | 12 | 14 | 17 | 7 | 12 | 14 | 6 | 9 | 10 | 4 | 2 |
| Owen Co | 14 | 10 | 35 | 101 | 69 | 28 | 12 | 8 | 14 | 5 | 3 | 12 | 6 | 4 | 9 | 8 | 5 | 2 |
| Powell Co | 43 | 24 | 35 | 50 | 28 | 28 | 47 | 26 | 14 | 23 | 13 | 12 | 15 | 8 | 9 | 3 | 2 | 2 |
| Scott Co | 251 | 49 | 35 | 162 | 32 | 28 | 36 | 7 | 14 | 39 | 8 | 12 | 19 | 4 | 9 | 6 | 1 | 2 |
| Shelby Co | 184 | 46 | 35 | 106 | 26 | 28 | 63 | 16 | 14 | 22 | 5 | 12 | 20 | 5 | 9 | 8 | 2 | 2 |

N = 2,395

N = Number of students answered
% = Percentage of students answered
SP = State percentage of students answered

APPENDIX F

2004 Kentucky Performance Report Mathematics Student Questionnaire Middle School

2004 Kentucky Performance Report Mathematics Student Questionnaire Middle School
Question No. 42: In your class, how often do you use a computer?

| School Districts | Never | | | Sometimes but not every week | | | Once a week | | | Two or three times a week | | | Four or five times a week | | | Invalid response | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP |
| Ashland Ind | 135 | 54 | 48 | 86 | 34 | 33 | 11 | 4 | 7 | 7 | 3 | 5 | 10 | 4 | 5 | 2 | 1 | 2 |
| Barren Co | 159 | 47 | 48 | 125 | 37 | 33 | 22 | 7 | 7 | 10 | 3 | 5 | 19 | 6 | 5 | 3 | 1 | 2 |
| Breckinridge | 14 | 7 | 48 | 105 | 52 | 33 | 25 | 12 | 7 | 32 | 16 | 5 | 22 | 11 | 5 | 4 | 2 | 2 |
| Cloverport | 0 | 0 | 48 | 9 | 60 | 33 | 1 | 7 | 7 | 1 | 7 | 5 | 1 | 7 | 5 | 3 | 20 | 2 |
| Fleming Co | 98 | 53 | 48 | 62 | 34 | 33 | 13 | 7 | 7 | 3 | 2 | 5 | 4 | 2 | 5 | 4 | 2 | 2 |
| Knott Co | 105 | 52 | 48 | 58 | 29 | 33 | 16 | 8 | 7 | 10 | 5 | 5 | 8 | 4 | 5 | 6 | 3 | 2 |
| Owen Co | 28 | 17 | 48 | 113 | 68 | 33 | 10 | 6 | 7 | 4 | 2 | 5 | 5 | 3 | 5 | 5 | 3 | 2 |
| Powell Co | 127 | 66 | 48 | 42 | 22 | 33 | 13 | 7 | 7 | 5 | 3 | 5 | 5 | 3 | 5 | 1 | 1 | 2 |
| Scott Co | 296 | 62 | 48 | 127 | 26 | 33 | 22 | 5 | 7 | 12 | 3 | 5 | 11 | 2 | 5 | 12 | 3 | 2 |
| Shelby Co | 231 | 61 | 48 | 108 | 28 | 33 | 15 | 4 | 7 | 11 | 3 | 5 | 11 | 3 | 5 | 3 | 1 | 2 |

N = 2410

N = Number of students answered
% = Percentage of students answered
SP = State percentage of students answered

APPENDIX G

2004 Kentucky Performance Report Mathematics Student Questionnaire High School

2004 Kentucky Performance Report Mathematics Student Questionnaire High School
Question No. 42: In your class, how often do you use a computer?

| School Districts | Never | | | Sometimes but not every week | | | Once a week | | | Two or three times a week | | | Four or five times a week | | | Invalid response | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP |
| Ashland Ind | 164 | 75 | 58 | 24 | 11 | 25 | 10 | 5 | 5 | 8 | 4 | 4 | 9 | 4 | 5 | 4 | 2 | 2 |
| Barren Co | 180 | 68 | 58 | 52 | 20 | 25 | 13 | 5 | 5 | 6 | 2 | 4 | 7 | 3 | 5 | 7 | 3 | 2 |
| Breckinridge | 78 | 42 | 58 | 79 | 43 | 25 | 5 | 3 | 5 | 4 | 2 | 4 | 16 | 9 | 5 | 2 | 1 | 2 |
| Cloverport | 4 | 18 | 58 | 9 | 41 | 25 | 5 | 23 | 5 | 2 | 9 | 4 | 2 | 9 | 5 | 0 | 0 | 2 |
| Fleming Co | 63 | 41 | 58 | 47 | 30 | 25 | 21 | 14 | 5 | 12 | 8 | 4 | 10 | 6 | 5 | 2 | 1 | 2 |
| Knott Co | 89 | 49 | 58 | 55 | 30 | 25 | 16 | 9 | 5 | 8 | 4 | 4 | 11 | 6 | 5 | 2 | 1 | 2 |
| Owen Co | 50 | 45 | 58 | 43 | 38 | 25 | 7 | 6 | 5 | 3 | 3 | 4 | 6 | 5 | 5 | 3 | 3 | 2 |
| Powell Co | 71 | 42 | 58 | 82 | 48 | 25 | 2 | 1 | 5 | 5 | 3 | 4 | 6 | 4 | 5 | 5 | 3 | 2 |
| Scott Co | 303 | 74 | 58 | 45 | 11 | 25 | 16 | 4 | 5 | 11 | 3 | 4 | 11 | 3 | 5 | 22 | 5 | 2 |
| Shelby Co | 211 | 58 | 58 | 98 | 27 | 25 | 14 | 4 | 5 | 12 | 3 | 4 | 12 | 3 | 5 | 16 | 4 | 2 |

N = 2080

N = Number of students answered
% = Percentage of students answered
SP = State percentage of students answered

APPENDIX H

2006 Kentucky Performance Report Mathematics Student Questionnaire Elementary School

2006 Kentucky Performance Report Mathematics Student Questionnaire Elementary School
Question No. 42: In your class, how often do you use a computer?

| School Districts | Never | | | Sometimes but not every week | | | Once a week | | | Two or three times a week | | | Four or five times a week | | | Invalid response | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP |
| Adair Co | 50 | 26 | 32 | 41 | 21 | 30 | 13 | 7 | 14 | 25 | 13 | 12 | 64 | 33 | 10 | 2 | 1 | 2 |
| Barbourville Ind | 43 | 84 | 32 | 2 | 4 | 30 | 1 | 2 | 14 | 2 | 4 | 12 | 3 | 6 | 10 | 0 | 0 | 2 |
| Clark Co | 101 | 26 | 32 | 168 | 43 | 30 | 50 | 13 | 14 | 59 | 15 | 12 | 14 | 4 | 10 | 3 | 1 | 2 |
| Elliott Co | 17 | 21 | 32 | 22 | 28 | 30 | 13 | 16 | 14 | 16 | 20 | 12 | 11 | 14 | 10 | 1 | 1 | 2 |
| Franklin Co | 241 | 53 | 32 | 135 | 30 | 30 | 34 | 7 | 14 | 19 | 4 | 12 | 13 | 3 | 10 | 15 | 3 | 2 |
| Fulton Ind | 3 | 10 | 32 | 4 | 14 | 30 | 8 | 28 | 14 | 9 | 31 | 12 | 5 | 17 | 10 | 0 | 0 | 2 |
| Grayson Co | 87 | 28 | 32 | 105 | 34 | 30 | 54 | 17 | 14 | 28 | 9 | 12 | 29 | 9 | 10 | 9 | 3 | 2 |
| Hardin Co | 226 | 26 | 32 | 276 | 32 | 30 | 136 | 16 | 14 | 137 | 16 | 12 | 74 | 8 | 10 | 22 | 3 | 2 |
| Laurel Co | 133 | 19 | 32 | 232 | 32 | 30 | 121 | 17 | 14 | 134 | 19 | 12 | 84 | 12 | 10 | 12 | 2 | 2 |
| Lawrence Co | 47 | 32 | 32 | 54 | 36 | 30 | 18 | 12 | 14 | 18 | 12 | 12 | 8 | 5 | 10 | 4 | 3 | 2 |
| Lewis Co | 77 | 39 | 32 | 50 | 25 | 30 | 37 | 19 | 14 | 14 | 7 | 12 | 19 | 10 | 10 | 3 | 2 | 2 |
| Lincoln Co | 106 | 33 | 32 | 104 | 33 | 30 | 49 | 15 | 14 | 40 | 13 | 12 | 12 | 4 | 10 | 6 | 2 | 2 |
| McCracken Co | 82 | 17 | 32 | 50 | 10 | 30 | 49 | 10 | 14 | 114 | 23 | 12 | 193 | 39 | 10 | 5 | 1 | 2 |
| Metcalfe Co | 6 | 6 | 32 | 49 | 46 | 30 | 17 | 16 | 14 | 12 | 11 | 12 | 22 | 21 | 10 | 1 | 1 | 2 |
| Perry Co | 96 | 29 | 32 | 94 | 28 | 30 | 57 | 17 | 14 | 41 | 12 | 12 | 42 | 13 | 10 | 6 | 2 | 2 |
| Providence Ind | 5 | 18 | 32 | 10 | 36 | 30 | 2 | 7 | 14 | 9 | 32 | 12 | 2 | 7 | 10 | 0 | 0 | 2 |
| Pulaski Co | 125 | 24 | 32 | 162 | 32 | 30 | 107 | 21 | 14 | 69 | 13 | 12 | 34 | 7 | 10 | 15 | 3 | 2 |
| Russell Co | 78 | 39 | 32 | 89 | 45 | 30 | 10 | 5 | 14 | 11 | 6 | 12 | 9 | 5 | 10 | 3 | 2 | 2 |

N = 5448

N = Number of students answered
% = Percentage of students answered
SP = State percentage of students answered

APPENDIX I

2006 Kentucky Performance Report Mathematics Student Questionnaire Middle School

2006 Kentucky Performance Report Mathematics Student Questionnaire Middle School
Question No. 42: In your class, how often do you use a computer?

| School Districts | Never | | | Sometimes but not every week | | | Once a week | | | Two or three times a week | | | Four or five times a week | | | Invalid response | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP |
| Adair Co | 81 | 40 | 44 | 83 | 41 | 37 | 6 | 3 | 7 | 12 | 6 | 5 | 18 | 9 | 5 | 3 | 1 | 2 |
| Barbourville Ind | 39 | 87 | 44 | 3 | 7 | 37 | 2 | 4 | 7 | 1 | 2 | 5 | 0 | 0 | 5 | 0 | 0 | 2 |
| Clark Co | 265 | 62 | 44 | 101 | 24 | 37 | 28 | 7 | 7 | 15 | 3 | 5 | 7 | 2 | 5 | 13 | 3 | 2 |
| Elliott Co | 23 | 30 | 44 | 42 | 55 | 37 | 8 | 10 | 7 | 3 | 4 | 5 | 1 | 1 | 5 | 0 | 0 | 2 |
| Franklin Co | 239 | 50 | 44 | 186 | 39 | 37 | 17 | 4 | 7 | 9 | 2 | 5 | 13 | 3 | 5 | 12 | 3 | 2 |
| Fulton Ind | 1 | 4 | 44 | 6 | 24 | 37 | 13 | 52 | 7 | 3 | 12 | 5 | 2 | 8 | 5 | 0 | 0 | 2 |
| Grayson Co | 116 | 34 | 44 | 136 | 40 | 37 | 29 | 9 | 7 | 32 | 9 | 5 | 22 | 7 | 5 | 3 | 1 | 2 |
| Hardin Co | 545 | 53 | 44 | 306 | 30 | 37 | 47 | 5 | 7 | 53 | 5 | 5 | 49 | 5 | 5 | 25 | 2 | 2 |
| Laurel Co | 394 | 58 | 44 | 140 | 20 | 37 | 70 | 10 | 7 | 29 | 4 | 5 | 30 | 4 | 5 | 22 | 3 | 2 |
| Lawrence Co | 99 | 44 | 44 | 51 | 23 | 37 | 20 | 9 | 7 | 28 | 12 | 5 | 22 | 10 | 5 | 5 | 2 | 2 |
| Lewis Co | 85 | 43 | 44 | 83 | 42 | 37 | 9 | 5 | 7 | 9 | 5 | 5 | 6 | 3 | 5 | 7 | 4 | 2 |
| Lincoln Co | 58 | 18 | 44 | 232 | 73 | 37 | 15 | 5 | 7 | 7 | 2 | 5 | 2 | 1 | 5 | 2 | 1 | 2 |
| McCracken Co | 253 | 50 | 44 | 171 | 34 | 37 | 43 | 8 | 7 | 22 | 4 | 5 | 17 | 3 | 5 | 3 | 1 | 2 |
| Metcalfe Co | 60 | 46 | 44 | 27 | 21 | 37 | 30 | 23 | 7 | 9 | 7 | 5 | 5 | 4 | 5 | 0 | 0 | 2 |
| Perry Co | 137 | 38 | 44 | 111 | 31 | 37 | 39 | 11 | 7 | 35 | 10 | 5 | 32 | 9 | 5 | 3 | 1 | 2 |
| Providence Ind | 18 | 78 | 44 | 2 | 9 | 37 | 1 | 4 | 7 | 1 | 4 | 5 | 0 | 0 | 5 | 1 | 4 | 2 |
| Pulaski Co | 202 | 38 | 44 | 110 | 21 | 37 | 13 | 2 | 7 | 52 | 10 | 5 | 143 | 27 | 5 | 10 | 2 | 2 |
| Russell Co | 47 | 20 | 44 | 146 | 62 | 37 | 11 | 5 | 7 | 15 | 6 | 5 | 14 | 6 | 5 | 2 | 1 | 2 |

N = 5828

N = Number of students answered
% = Percentage of students answered
SP = State percentage of students answered

APPENDIX J

2006 Kentucky Performance Report Mathematics Student Questionnaire High School

2006 Kentucky Performance Report Mathematics Student Questionnaire High School
Question No. 42: In your class, how often do you use a computer?

| School Districts | Never | | | Sometimes but not every week | | | Once a week | | | Two or three times a week | | | Four or five times a week | | | Invalid response | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP | N | % | SP |
| Adair Co | 67 | 38 | 57 | 55 | 31 | 26 | 16 | 9 | 5 | 10 | 6 | 4 | 22 | 13 | 6 | 6 | 3 | 2 |
| Barbourville Ind | 30 | 77 | 57 | 6 | 15 | 26 | 1 | 3 | 5 | 1 | 3 | 4 | 1 | 3 | 6 | 0 | 0 | 2 |
| Clark Co | 252 | 70 | 57 | 66 | 18 | 26 | 17 | 5 | 5 | 6 | 2 | 4 | 11 | 3 | 6 | 8 | 2 | 2 |
| Elliott Co | 31 | 42 | 57 | 27 | 37 | 26 | 7 | 10 | 5 | 4 | 5 | 4 | 3 | 4 | 6 | 1 | 1 | 2 |
| Franklin Co | 211 | 59 | 57 | 93 | 26 | 26 | 19 | 5 | 5 | 11 | 3 | 4 | 20 | 6 | 6 | 4 | 1 | 2 |
| Fulton Ind | 9 | 27 | 57 | 13 | 39 | 26 | 4 | 12 | 5 | 2 | 6 | 14 | 5 | 15 | 6 | 0 | 0 | 2 |
| Grayson Co | 134 | 52 | 57 | 88 | 34 | 26 | 13 | 5 | 5 | 8 | 3 | 4 | 12 | 5 | 6 | 2 | 1 | 2 |
| Hardin Co | 569 | 59 | 57 | 273 | 29 | 26 | 34 | 4 | 5 | 36 | 4 | 4 | 30 | 3 | 6 | 15 | 2 | 2 |
| Laurel Co | 361 | 67 | 57 | 90 | 17 | 26 | 27 | 5 | 5 | 16 | 3 | 4 | 31 | 6 | 6 | 10 | 2 | 2 |
| Lawrence Co | 108 | 63 | 57 | 36 | 21 | 26 | 7 | 4 | 5 | 6 | 4 | 4 | 10 | 6 | 6 | 4 | 2 | 2 |
| Lewis Co | 100 | 77 | 57 | 17 | 13 | 26 | 3 | 2 | 5 | 4 | 3 | 4 | 4 | 3 | 6 | 2 | 2 | 2 |
| Lincoln Co | 91 | 35 | 57 | 110 | 42 | 26 | 23 | 9 | 5 | 19 | 7 | 4 | 17 | 6 | 6 | 3 | 1 | 2 |
| McCracken Co | 268 | 59 | 57 | 120 | 26 | 26 | 26 | 6 | 5 | 11 | 2 | 4 | 27 | 6 | 6 | 3 | 1 | 2 |
| Metcalfe Co | 37 | 38 | 57 | 38 | 39 | 26 | 4 | 4 | 5 | 5 | 5 | 4 | 11 | 11 | 6 | 2 | 2 | 2 |
| Perry Co | 138 | 53 | 57 | 80 | 31 | 26 | 9 | 3 | 5 | 14 | 5 | 4 | 13 | 5 | 6 | 4 | 2 | 2 |
| Providence Ind | 11 | 55 | 57 | 6 | 30 | 26 | 0 | 0 | 5 | 0 | 0 | 4 | 3 | 15 | 6 | 0 | 0 | 2 |
| Pulaski Co | 306 | 64 | 57 | 95 | 20 | 26 | 20 | 4 | 5 | 25 | 5 | 4 | 22 | 5 | 6 | 7 | 1 | 2 |
| Russell Co | 94 | 49 | 57 | 66 | 34 | 26 | 13 | 7 | 5 | 8 | 4 | 4 | 11 | 6 | 6 | 1 | 1 | 2 |

N = 4850

N = Number of students answered
% = Percentage of students answered
SP = State percentage of students answered

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