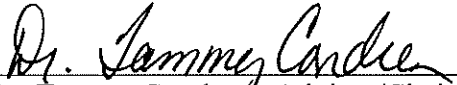


1:1 TECHNOLOGY AND COMPUTERIZED STATE ASSESSMENTS

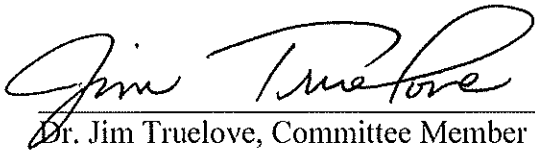
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1:1 TECHNOLOGY AND COMPUTERIZED STATE ASSESSMENT

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1:1 TECHNOLOGY AND COMPUTERIZED STATE ASSESSMENT

A Dissertation
Presented to
The Faculty of the Graduate Education Department
Southwest Baptist University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

By

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Abstract

American students in the 21st century are growing up with Internet accessible technology available at their fingertips. Considering this and the continued pressure to compete in a global society, The United States' Department of Education's National Education Technology Plan (NETP) (2010) calls for educators to leverage technology in order to provide more meaningful and authentic learning opportunities for students. Not only is technology being harnessed for instruction, but the push for online assessments as a part of The Race to the Top federal initiative has compelled school districts to continue to pour funding into technology. While student motivation, collaboration skills and critical thinking skills are often reported as benefits to students' access to technology, the impact of these computing initiatives on student achievement has been inconclusive.

The purpose of this quantitative study was to better understand the impact of 1:1 technology on 4th grade student achievement on the computerized Missouri Assessment Program. For the purpose of this study, 1:1 technology is an Internet connected device provided by the school district that students have direct access to throughout the school day. The researcher examined state standardized testing data to determine the impact of 1:1 technology usage on student achievement at the 4th grade level in communication arts and mathematics. Analysis of the data associated a statistically significant difference in overall student achievement in the areas of communication arts and mathematics with students in schools with access to 1:1 technology performing below their peers in schools without access to 1:1 technology. As technology advances, so must our instructional best practices to ensure teaching and technology work together to support student learning.

Chapter I

Introduction

American students in the 21st century are growing up with Internet accessible technology available at their fingertips. Considering this and the continued pressure to compete in a global society, The United States' Department of Education's National Education Technology Plan (NETP) (2010) calls for educators to leverage technology in order to provide more meaningful and authentic learning opportunities for students. The International Society for Technology in Education (ISTE) (2012) echoes this call for increased student use of technology to analyze, learn, and explore claiming these digital skills are paramount for equipping students to successfully contribute to the workforce and civic makeup of their communities. When considering the ISTE standards and the National Education Technology Plan, Rosen and Beck-Hill (2012) state the primary goal for leveraging educational technology in learning is to prepare learners to be active, creative, knowledgeable, and ethical participants in a global networked society" (p. 226).

With this increased focus on technology and 21st century learning, technology initiatives have expanded across districts and states resulting in lower student-to-computer ratios (Bebell & O'Dwyer, 2010; Lawless & Pellegrino, 2007; NETP, 2010; Weston & Bain, 2010). Penuel (2006) attributes increased 1:1 computing programs in schools to innovative developments in technology available at decreased costs with ever-expanding wireless accessibility. Lewis (2012) notes this rapid expansion of innovative technologies ranging from stationary desktops to handheld devices has presented unique learning opportunities in today's schools. Lewis (2012) goes on to identify the various

descriptions of 1:1 technology integration in schools as “mobile computing, handheld computing, one-to-one computing, ubiquitous computing, and pervasive computing represent[ing] the concept that every student has access to a computer or technological resource for learning” (p. 16). Norris et al. (2011) boldly predict, “within five years *every* child in *every* grade in *every* K-12 classroom in America will be using a mobile learning device” (p. 25).

According to Kposowa and Valdez (2013) over one thousand schools were implementing some form of laptop program by 2003 in the United States. Over the past decade, 1:1 laptop initiatives allowing students and teachers full access to a technology-rich learning environments have continued to grow in popularity in the United States (Bebell and O’Dwyer, 2010; O’Dwyer et al., 2008). In her research, Rizzo (2013) references that more than 37 percent of public schools and at least 33 states have schools implementing 1:1 technology programs. However, Rosen and Beck-Hill (2012) note the majority of these initiatives lack true innovation towards a shift in pedagogy and instructional practices, but simply use these technologies for technology-related activities. Bebell and O’Dwyer (2010) support this claim adding that 1:1 computing simply refers to the level of accessibility to technology by students and educators, not the instructional practices connected to these devices. Additionally, they note the vast and unique differences found in every 1:1 technology initiative including instructional expectations, teacher professional development, funding and implementation practices, hardware, software, network infrastructure and technical support.

While educational leaders and researchers have mainly focused on the use of technology in the secondary setting, Penuel (2006) notes the interest in technology at the

elementary level is rapidly increasing. Bird (2008) believes this increased accessibility to technology at the elementary level will influence classrooms and ultimately student achievement.

With this increased accessibility to technology, students have the opportunity to take greater ownership over their own learning. Rosen and Beck-Hill (2012) recognize the wider instructional network and increased flexibility in learning as parents and mentors join teachers as facilitators of learning. Lewis (2012) challenges all stakeholders to rethink teaching and learning in the aspect of 1:1 computing devices considering many students are exposed to technology early in life and have grown comfortable utilizing mobile devices for learning, entertainment and communication.

While individual access to computing devices is becoming more commonplace at the state and local level, relatively little is known about the impact on student achievement according to Kposowa and Valdez (2013). Penuel (2006) observed that the educational technology community has not kept up-to-date on the effectiveness of these quickly changing initiatives. The lack of research and examination of longitudinal data to determine the impact of technology integration on student achievement is also observed by Holfeld (2007). Rosen and Beck-Hill (2012) support these statements noting the common criticism of educational technology research is examining the impact of educational technology on student learning too quickly after implementation. This quick evaluation fails to identify the cumulative effect and outcomes of technology in a more stable and established learning environment.

While instruction and technology have made dramatic changes over the past decades, Dietel (2012) of the National Center for Research on Evaluation, Standards, and

Student Testing argues that educational testing, though slow to evolve, does not sufficiently measure the more complex skills required by today's students in conjunction with this expansion of technology. To improve the quality of standardized state assessments, the United States Department of Education (2010) awarded two consortia competitive grant funds to create innovative tests under President Obama's Race to the Top assessment program initiative. According to Dietel (2012), these new assessment platforms will utilize high-quality assessment principles that incorporate technology in all aspects of the assessment process including design and development, test administration, scoring and reporting.

Problem Statement

The emphasis for the need of 1:1 technology initiatives continues to spread across public schools making its way in to elementary classrooms. Dunleavy and Heinecke (2007) highlight this continual expansion of technology noting the growth of ubiquitous 1:1 technology programs over the last two decades. Advocates of 1:1 programs claim these initiatives have the prospect to transform education ushering in the rapid influx of 1:1 technology plans in schools across the country from the mere 1,000 American schools utilizing 1:1 computing initiatives 15 years ago (Dunleavy & Heinecke, 2007).

Conversely, Cuban (2001) believes this push towards 1:1 technology programs is an oversold fad creating pressure on already stressed educational funds and in reality may be detrimental to student learning. Larkin and Finger (2011) surmise the crux of this issue is the unresolved debate questioning whether or not the substantial expense of 1:1 initiatives truly results in improved student learning outcomes. To this end, limited and conflicting data has been collected to determine the impact of 1:1 technology initiatives on student

achievement in the elementary setting. Penuel (2006) observed the collective understanding of the educational technology community in regards to the impact of 1:1 computer initiatives has not kept up with the rapid expansion of these programs. Furthermore, Larkin and Finger (2011) note that although 1:1 technology programs are becoming increasingly popular in many schools, nominal analysis as been performed regarding their effectiveness in the elementary setting. Dunleavy and Heinecke (2007) support Penuel's claims finding mixed results of significant effects to marginal and no significant effects on student achievement in laptop initiatives warranting further extensive and scientifically based research studies to assess the impact and efficacy of 1:1 technology programs on student learning.

As is the case for most 1:1 initiatives, Dunleavy and Heinecke (2007) believe most schools pursue ubiquitous computer initiatives to increase efficiency in their current instructional practices as a way of improving student achievement measured by state standardized test scores. This mode of thinking is becoming more prevalent as many states, including Missouri, transition from a traditional paper and pencil state assessment format to an online, computerized assessment format in the spring of 2015. This new online test was developed by the Smarter Balanced Assessment Consortium (SBAC) to align to the Missouri Learning Standards derived from the Common Core State Standards (CCSS). In order to comply with funding mandates set forth for states participating in President Obama's Race to the Top education initiative, states must adopt a computerized assessment platform to measure student achievement. The intent of this study is to determine the impact of 1:1 technology on 4th grade student achievement utilizing Missouri's new computerized state assessment. Determining the significance of this

impact is important considering the National Education Technology Plan's (NETP) (2010) emphasis on technology-based assessment data to drive decisions about learning for individual students as well as the continuous improvement of the entire educational system.

Rationale for the Study

The use of technology, 1:1 initiatives, and mobile learning programs is a prolific topic in education. Accordingly, the National Education Technology Plan (NETP) (2010) has set the goal that every student and educator have access to at least one internet capable device, both in and out of the school setting, for learning activities, communication and collaboration by 2020. While there is considerable distance to cover for the realization of this goal, individual school districts and states have increased their focus on technology-rich learning environments. Despite this increased interest and move towards implementing 1:1 computing initiatives, Bebell and O'Dwyer (2010) note there is limited empirical evidence for educational leaders to consider when looking to invest in these technology initiatives. Additionally, educational research in this area has primarily focused on junior high and secondary level programs with little data on student achievement and 1:1 computing initiatives at the elementary level.

Current analysis and reviews of existing research on student laptop use by Kposowa and Valdez (2013) show mixed results on the impact of student achievement. With our nation's increased focus on standardized test scores and student achievement, O'Dwyer, Russell, Bebell and Seeley (2008) note the important relationship between student performance and technology initiatives as school leaders consider educational technology expenditures. This review of the achievement of 4th grade students in

Missouri with access to 1:1 technology and their performance on the computerized state assessment will offer insight to school leaders as they study future technology purchases or expand their use of technology to other grade levels. Additionally, as Dietel (2012) recommends, school districts must prepare to expand their capacity for technology for these computer-based assessments in order to have the capability and resources to assess all students through this computerized testing format.

Research Question/Hypothesis

The purpose of this study explores the impact of 1:1 technology on 4th grade student achievement in Missouri on the state's computerized assessment. The researcher examined state standardized testing data to determine the impact 1:1 technology has on student achievement at the 4th grade level in the following areas:

1. What impact does 1:1 technology have on overall student achievement in communication arts?
2. What impact does 1:1 technology have on overall student achievement in mathematics?

The researcher identified schools with 1:1 technology initiatives and examined student achievement to test the following null hypothesis: There is no statistically significant impact on the achievement of 4th grade students with 1:1 technology access in communication arts and mathematics on Missouri's computerized state assessment.

Theoretical Framework

Educational theory and instructional practices utilizing technology intersect with the implementation of technology in the classroom. To address how technology interacts with prominent learning theories, Athabasca University in Athabasca, Canada published

the Theory and Practice of Online Learning. Through this work, Ally (2004) offers a foundation of educational theory for online learning encompassing the behaviorist, cognitivist and constructivist schools of learning as well as suggestions for creating computer-assisted instruction grounded in appropriate educational theory.

The behaviorist school of learning influenced by Pavlov and Skinner focused on the observable changes in behavior to identify if learning had occurred. According to Ally (2004), the implications for learning through the use of technology for this school of thought would focus on explicit learning outcomes when developing electronic learning activities as well as online or other forms of assessment to ensure timely and appropriate feedback on student learning and achievement. This feedback allowing for ongoing self-monitoring and corrective learning, if necessary, combined with the sequential development of learning materials from simple to complex would further promote learning under the behaviorist theory of education.

Ally (2004) explains cognitive psychology as the internal process and principles of learning impacted by memory, motivation and mental processing. When considering the cognitive school of learning, Ally emphasizes the role of memory and individual learning styles as areas of focus in order for technology to support learning. The author posits that online learning tools and technology can be utilized to chunk or organize information for students to process quickly and efficiently in meaningful ways to support working memory capacity. Additionally, Ally notes the importance of individual learning styles, or cognitive styles, with technology offering the ability to cater learning activities to a learner's preferred way of processing information. In this way, electronic learning

experiences can be connected and applied to real-life situations while providing both intrinsic and extrinsic motivation for learning.

Under the constructivist theory of learning credited to the work of Jean Piaget, Ally (2004) describes the learner as being actively involved in the learning experience through the construction of new learning and discovery of knowledge. Constructivist learning emphasizes the contextualization of new information to offer immediate application and the development of personal meaning while learning. When applied to technology and online learning, constructivism prescribes that the learner is actively involved in the learning process, directing their learning experience with choice and control. Additionally, technology offers extended opportunities for collaboration and cooperation that are encouraged in the guided discovery process of constructivist learning.

Ally (2004) believes the behaviorist, cognitivist and constructivist theories have and will continue to play a role in the development and design of learning through the use of technology. Ally also notes that while technology and online instruction can serve as a tool to influence learning, technology is simply the medium to deliver information. Combining this powerful learning tool with these educational theories offers instructional strategies that can be used to teach not only facts, but also the principles and processes for understanding while shifting learning forward towards real-life applications and contextual learning.

Assessment Theory

In January of 2011, the Educational Testing Services (ETS) established the Gordon Commission to examine the future of assessment in education (Gordon, 2013).

This 30 member team, consisting of scholars, policymakers and educators, identified and made recommendations regarding the critical issues concerning educational assessment. Through their work, Gordon surmised the history of assessment in education as society's efforts to document the standing, explain the characteristics and measure the achievements for people's learning. The prominence placed on an individual's characteristics and the extent to which they have developed their abilities often resulted in the measurement on the effect of education or the perceived need for education. These efforts to quantify learning have resulted in an extensive science in regards to the measurement of education and educational assessment systems.

According to the Gordon Commission (2013), the classical, or modern, test theory can be traced to the first third of the 20th century. During this time, mental model measurement tools were designed according to evidential values that evaluated student learning as numbers on a continuum. Under modernism, this continuum is based on the use of models and methods that characterize people through common observations or instruments in regards to common variables or common learning domains. These values then represent a collection of data to support various inferences about human competencies, the processes by which these skills were developed, and the potential for their development. This process of assessment serves multiple purposes in education: identifying individual intellect, validating that proper evidence of learning has been achieved, providing accountability for educational practices, practitioners, and institutions, and creating the basis for inferences to inform and improve the teaching and learning process. Evidence from the practices of this standardized test theory is used to support inferences regarding students' overall proficiency in various domains, in

comparison with others or with a standard, or in evaluating changes over periods of time. Due to their cost effectiveness and efficiency to administer, the primary instrument for assessment throughout modern test theory practices has been the standardized, multiple choice test. The Gordon Commission (2013) believe these present testing practices have defined educational accomplishment for most through their emphasis on factual knowledge as a primary purpose of schooling.

However, with the impending changes facing America in regards to standards and assessments, the Gordon Commission (2013) concluded it is a critical time for reflection and reevaluation of methodology and theory in regards to assessment. While educators assess to better understand student learning, teaching processes, the situations in which students learn or fail to do so, and to enhance intellectual competencies, the use of standalone tests for reporting and accountability purposes should be replaced with assessment systems that offer multiple and varied assessment opportunities. Additionally, the Gordon Commission (2013) believes these assessment practices should be administered over time and throughout the teaching and learning process to allow for the diagnostic and prescriptive use of data.

Looking to the future, the Gordon Commission (2013) warns that educational assessment must keep pace with the changes in educational practices and technology in order to remain relevant. Gordon notes that assessment in the 20th century was dominated by the testing and measurement of developed skills and abilities. Gordon believes that the 21st century of assessment will focus on the development of human capacities requiring assessments to be diagnostic, prescriptive and instructive while simultaneously being able to document current understanding as well as capture the

process by which abilities are developing throughout the teaching and learning process. Additionally, Gordon believes the context for education and assessment are transitioning beyond the traditional skills for reading, writing and arithmetic into ways to assess creativity and innovation, conceptualization and problem solving, communication and collaboration, and computer literacy. This shift will challenge existing frameworks requiring authentic and performance-based assessments demanding more complex and higher-level assessments. In his contributions to the Gordon Commission (2013), Misleavy identifies these more subjective assessments of learning as the postmodern test theory that challenge the adequacy of one-size-fits-all, multiple choice standardized assessments focused on specified tasks and domains in the same way for all students.

Misleavy further expands on the postmodern theory of assessment in the Gordon Commission (2013) findings arguing the need for assessment practices to account for the context and social considerations in which learning and assessment occurs. Misleavy identifies these considerations given to the contextual and educational background factors as neopragmatic postmodernists. Neopragmatic postmodern test theory investigates the potential of using methodological and inferential instruments developed in the modern perspective to promote learning in ways envisioned in a postmodern perspective.

To accomplish assessment tasks of this magnitude that move beyond the modern test theory, the Gordon Commission (2013) focused on the paramount role of informational technologies. Assessment through these technologies will require the capacity to document and establish the status of the learner's competence while accessing needed resources and supporting the use of these resources. Progress in assessment technology can present students with tasks that are interactive, constructive, and dynamic

with automatic scoring for timely feedback. While these technology advances will not eliminate the barriers of modern test theory, they can ease the constraints of how data would be collected, warehoused, transmitted and analyzed to offer new possibilities within the conventional mental measurement paradigm (Gordon, 2013).

Limitations/Delimitations

While it is the researcher's intent to provide the most accurate information and data available to add to the body of knowledge on educational best practices, educational research is a difficult field of study due to the many variables that play a part in the teaching and learning process. Many factors influence student achievement making educational research complex. This complexity creates limitations and delimitations within educational studies.

Limitations-

1. Teacher quality, pedagogy, professional development and level of proficiency in the use of educational technology are factors not controlled for in this study.
2. The quality and degree of successful implementation of the district's curriculum, school and instructional leadership, funding, and technology plans were not reviewed for this study.
3. While students from the schools identified in this study had individual access to computers throughout the school day, the exact amount of time and instructional purposes for which these devices were utilized was not measured.
4. Student use of technology outside of the school day was also not evaluated.

Delimitations-

1. This study focused on 4th grade classrooms in the state of Missouri.
2. Only testing data from the spring 2015 Missouri Assessment Program (MAP) in communication arts and mathematics was analyzed for this study.
3. This study encompassed all Internet accessible devices and did not establish limitations based on type or device specifications.
4. An attempt was made to identify all schools with 1:1 technology initiatives in Missouri at the 4th grade level.

Design Controls

This quantitative study utilized a demographic questionnaire to identify all public schools in the state of Missouri who have implemented a 1:1 technology initiative in 4th grade. Once identified, Annual Yearly Progress (AYP) data from the Missouri Department of Elementary and Secondary Education was reviewed for the 2014-2015 school year to examine overall student achievement in the areas of communication arts and mathematics for those students in schools with 1:1 access to technology and for those without.

Definition of Key Terms

1:1 technology. 1:1 technology is defined as an Internet connected device that students have direct access to throughout the school day. For the purpose of this study, 1:1 devices were provided to the students by the school district and were not limited by manufacturer, software or type of device.

Adequate Yearly Progress. The Adequate Yearly Progress (AYP) report provides student achievement data for the areas of communication arts and mathematics

for schools, districts and the state compared to state performance targets. Student achievement data is disaggregated into demographic subgroup areas. Student achievement is divided into four achievement levels: Below Basic, Basic, Proficient and Advanced.

Missouri Assessment Program. The Missouri Assessment Program (MAP) is the state's standardized assessment measuring student achievement in communication arts and mathematics at the 4th grade level. This test changed to an online, computerized format in the spring of 2015 through the Smarter Balanced Assessment Consortium.

Summary

This chapter contained an overview and history of the increased implementation of educational technology and the need to examine the impact 1:1 technology initiatives have on student achievement in the elementary setting. This chapter also contained an overview of recognized theories of learning and their connection to online or electronic learning technology. An overview of educational assessment was also provided. This study intends to determine the relationship between the achievement of 4th grade students with 1:1 technology and Missouri's computerized state assessment.

Chapter II of this paper will provide a literature review of existing research on the educational use of technology, 1:1 initiatives, and the relationship between technology use and student achievement. A review of educational assessment will also be provided. Chapter III will describe the method for identifying and selecting school districts utilizing 1:1 technology initiatives. This chapter will also outline the collection of state data for the selected districts and demographic areas for study. Chapter IV will offer a presentation of these findings. Chapter V will provide a summary of this project and the educational

implications and significance of these findings for educational decisions and future studies.

Chapter II

Review of Literature

Introduction

The following framework will provide a review of the literature regarding the assessment of learning and the use of technology in education. This review looks from the historical progression of educational assessment to current practices for mandated standardized assessment of student learning. This chapter will also look at the evolution of computer usage in the classroom setting building to the current trend of 1:1 computing devices for each student. The research surrounding the impact of technology on learning and student achievement will also be addressed in this chapter.

Assessment

Historical Perspective of Assessment

Assessments and measurements have been a part of education since ancient times. While it is logical to assume that teachers have assessed the work and understanding of their students, evidence suggests this predominantly occurred through oral questioning and observation (Ali & Ali, 2010). While oral examinations were customary practice throughout and beyond medieval times, Ali and Ali (2010) identify the first extensive written examinations occurring in China around 2357 B.C. However, the debate between oral versus written examinations reached a turning point in 1845 when Horace Mann persuaded the Massachusetts Board of Education to replace oral examinations with written examinations. According to Kaestle's contribution to the work of the Gordon

Commission (2013), Mann and his reformist allies favored periodic written exams to be administered at least annually as a method of determining promotion to higher grade levels. These reformers called for further accountability for schoolmasters and to move beyond the traditional recitations and performance exhibitions by students as methods to gauge the teacher's accomplishments.

According to the Gordon Commission (2013), the use of exhibitions, recitations and spelling bees persisted in most rural areas and some larger cities. However, after the Civil War, factors such as immigration, urbanization, railroads and national markets for agriculture influenced a push towards more centralized educational systems and the use of common tests to determine grade level promotion. By 1865, uniform high school admission tests were introduced through Massachusetts' state testing program, and according to Ali and Ali (2010), were well received. However, as Kaestle reported to the Gordon Commission (2013), this sentiment was not universal citing claims from teachers, administrators, and other critics asserting these tests encouraged heartless instruction, ruined students' health and caused suicides while solely focusing on rote learning and memorization. High school graduation and college admission exams soon followed in 1878, and by 1900, the College Entrance Examination Board was announced to develop uniform entrance examinations for colleges in the United States.

While standardized testing became more prevalent in the education setting, psychologists began to pursue the task of measuring an individual's intelligence. Kaestle tracks the development of various methods and theories in his historical perspective of assessment for the Gordon Commission (2013). However, it is Alfred Binet's study with mentally subnormal children in conjunction with his interest in developmental stages and

the ability to perform tasks of varying complexity at different ages that led to the creation of intelligence scales. Through efforts from Lewis Terman, a Stanford professor, the scale was recalibrated to the American population to create the Stanford-Binet Intelligence Quotient test in 1916. According to the Gordon Commission (2013), these intelligence tests were used to classify army recruits during World War I, increasing the popularity of these new assessments. While these tests quickly fell out of favor in their use of assigning recruits to jobs in relation to their intelligence quotient, public schools seemed to welcome these new cognitive assessment tools as a means to evaluate teacher performance and assist in student placement decisions. To this end, the National Research Council enlisted five prominent psychologists to develop the National Intelligence Test. In 1920, the test's first year of production, 200,000 copies were sold (Gordon Commission, 2013).

Achievement testing continued to expand throughout the early 1900s. In 1908, Cliff Stone is credited with publishing the first standardized achievement test, an arithmetic reasoning test (Gordon Commission, 2013) and by the 1920s multiple-choice formatting dominated achievement tests. Proponents for this format touted the speed and ease of scoring, test rater objectivity, and the elimination of ambiguity in regards to correct answers as benefits to multiple-choice assessments. Higher education followed in the use of standardized testing with the multiple-choice formatted Scholastic Assessment Test (SAT) designed in 1926 to assess college readiness (Ali & Ali, 2010).

Following World War II, the Gordon Commission (2013) noted a dramatic increase in high school attendance and graduation rates as the United States became a world superpower. However, by the 1950s, educational reform was a topic of focus

following the Soviet Union's successful launch of the Sputnik satellite. As a result of this perceived deficit, President Eisenhower supported federal aid for elementary and secondary education under the National Defense Education Act (NDEA) of 1958 (Gordon Commission, 2013). The NDEA solidified the vital role of testing in United States schools by offering states financial resources to support local school efforts towards increased testing to identify the most gifted students and encourage them to become scientists.

While the 1950s connected federal funding to school testing, the 1960s ushered in the concern for equity in the field of testing (Gordon Commission, 2013). Efforts through the movement for Civil Rights spilled over into educational testing and concerns for test bias. Under Public Law number 94-192, requirements for scientific validation were outlined. While legislation and the civil right movement led to restrictions in the uses of tests, the Gordon Commission (2013) notes the use and emphasis on tests continued to increase in the following decades shifting the testing focus on the need to close the achievement gap between students of varying racial and socioeconomic demographics.

Following the allocation of federal funds to schools to support testing through the National Defense Education Act (NDEA) of 1958, educational accountability gained momentum (Gordon Commission, 2013). To assess the nation's educational standing, the National Assessment of Educational Progress (NAEP) was implemented in the 1969-1970 school year. This tool has since been used as a device for monitoring learning by individual states and as a nation at large. Additionally, the NAEP has served as a measuring stick for state developed assessments in relation to standards and national levels of proficiency (Bandeira de Mello, 2011). These state-level NAEP results are

important resources for policymakers in understanding and taking action on state assessment results. The mapping and analysis of levels of proficiency on the NAEP in comparison to state assessment standards and levels of proficiency allows states to examine the stringency of criteria for proficiency in regards to other states (Bandeira de Mello, 2011). This mapping of state scores against the NAEP scale also informs states about the equivalency of the rigor of standards on state assessments against the NAEP grade level assessments. According to the 2009 NAEP proficiency equivalency scale, Missouri ranked second among the states in both reading and mathematics for proficient performance.

The creation of Title I funds for compensatory education to address the needs of at-risk populations through the Elementary and Secondary Education Act (ESEA) of 1965 further linked the use of school assessments to federal funding (Gordon Commission, 2013). Through the ESEA, districts were required to produce evidence for the effective use of Title I program funding. However, as Kaetle reported in his findings to the Gordon Commission (2013), this assessment plan was weakly developed and allowed school districts to devise their own tests. In reality, Title I evaluations including test scores were primarily conducted by research organizations or district samplings by the government. However, a greater emphasis was placed on reporting achievement test data after the passage of the Education of All Handicapped Children Act of 1974. Following the release of the famous *A Nation at Risk* report in 1983, a movement for greater district accountability and increased state achievement testing was issued (Gordon Commission, 2013). In the reauthorization of ESEA in 1988, the federal government

required states receiving Title I funding to define student achievement levels and identify schools failing to meet these goals.

The Improving America's Schools Act of (IASA) of 1994 created significant changes in the Title I by establishing a federal approach to improve education for all students with a framework of standards-based reforms in conjunction with state and local reform initiatives (Goertz et al., 2001). According to Goertz et al. (2001), these new provisions gave states a prominent role in creating state assessment and accountability systems tied to Title I funding. Through their research, Goertz et al. noted student outcomes on state assessments as the primary focus of these state accountability systems with 48 states utilizing their state assessment as the principal indicator of school performance. Additionally, 33 of these states established performance goals on the state assessments for schools or districts tying rewards and sanctions directly to the goals through these state-defined accountability systems. While the state assessment guidelines from IASA required states to test students at least one time during each of the elementary, middle and high school grade spans, Goertz et al. discovered many states assessed students more often than this with some states assessing students in every grade.

State assessment and accountability systems expanded after the Improving America's School Act of 1994, with a focus on a standards-based and performance goals to ensure schools made continuous and significant progress within a reasonable frame of time with the goal of proficiency for all students (Goertz et al., 2001). Often these goals for accountability systems feel like high-stakes state assessments; however, Gong (2002) identified the purposes of state accountability systems in order to identify and support improved instructional practices and results, to inform stakeholders on areas of success

and areas for needed improvement, and to better inform policy decisions at all levels since criteria and standards are established by the state.

While the use of standardized assessments in schools were utilized for state accountability for funding, more extensive federal proficiency targets and significant sanctions were established with the No Child Left Behind Act (NCLB) of 2001 (Gong, 2002). Under NCLB, schools districts in each state are required to administer annual assessments in mathematics, communication arts, and science to measure student progress toward state achievement standards. A school's Adequate Yearly Progress (AYP) reports student achievement for all students between grades three through eight while establishing progress objectives to ensure student proficiency by graduation. Failure to achieve the goals set for AYP results in varying levels of sanctions in Title I funding (NCLB, 2001). With this increased focus on accountability through standardized assessments under the authorization of NCLB, the importance of student proficiency and the emphasis on statewide assessments to educators and school district administrators has increased in recent years (Burns, Klingbeil & Ysseldyke 2010; Lawton 2014; Lederman & Burnstein 2006).

Under this legislation, states have produced a variety of norm-referenced and criterion-referenced examinations to evaluate student performance and assess the understanding of state identified standards (Goertz et al., 2001). According to Goertz et al., six states, including Missouri, have created state assessments to produce both nationally-normed results through the use of the Terra-Nova multiple choice assessment as well as measures of student performance on Missouri standards. Goertz et al. pointed out that often these states partnered with a test publisher to utilize national norm-

referenced assessment components in conjunction with customized items to address state standards. The 2009 Profile of State Assessment Programs released by the National Center for Education Statistics (NCES) places state assessments on a common scale defined by the National Assessment of Education Progress (NAEP) to compare state assessment scores to the nationally benchmarked NAEP test. For the 2008-2009 Missouri Assessment Program (MAP) test, the state's reading/language arts assessment at the 4th grade was comprised of multiple choice items (84%), short constructed response items (10%), extended constructed response items (6%), and performance tasks (0%). Missouri's math assessment at the 4th grade was similarly comprised of multiple choice items (84%), short constructed response items (11%), extended constructed response items (5%), and performance tasks (0%). This data would indicate that Missouri's assessment platform is similar to Deitel's (2012) description of the Smarter Balanced Assessment Consortium standardized measurement instrument consisting of a combination of selected-response, constructed response, technology-enhanced and performance event tasks.

Reed, Scull, Slicker and Winkler (2012) view the adoption of the Common Core State Standards (CCSS), the call for developing new assessments and the granting of federal waivers for the Elementary and Secondary Education Act (ESEA) as a critical crossroads for redefining strong state accountability systems. Reed et al. believe this current educational era provides latitude for states to reboot their accountability systems that include the adoption of clear, demanding standards in all content areas with rigorous assessments in conjunction with reporting platforms to make assessment data more easily accessible to all stakeholders. Reed et al. note the frustration by states towards federal

laws attempting to dictate uniform accountability and seek to offer guidance for accountability agencies to pursue improved student outcomes through stronger state accountability systems.

With the increased emphasis on standardized assessments at the local, state, and federal levels, Lawton (2014) notes that the 21st century of educational testing has become a highly lucrative enterprise for commercial testing corporations with Popham (2011) claiming that nearly all nationally standardized assessments are created by for-profit, commercial businesses. The assessment industry economic boom is clearly illustrated by Kohn's (2000) claims that the manufacturing and scoring of standardized assessments had earned nearly 250 million dollars when compared to Chingos' (2012) findings that nationwide expenditures on assessments were estimated at 1.7 billion dollars per year just at grades three through nine.

The Race to the Top (2010) educational reform plan in conjunction with the adoption of the Common Core State Standards (CCSS) will reshape standardized assessments. Schaffhauser (2011) notes the requirement for the technological skills needed by students in the 21st century with this educational initiative must match the method of assessment. As a result of this, states that have adopted the CCSS are required to administer their standardized tests through the use of computers by the 2014-2015 school year by utilizing the online student assessments from either the Smarter Balanced Assessment Consortium (SBAC) or the Partnership for Assessment of Readiness for College and Careers (PARCC).

Technology and Assessment

As Dietel (2012) considers the transition from the traditional paper-pencil assessments to more robust assessment models in the 1990s that required performance events, extended essays and other demonstration based tasks beyond multiple choice or single answer questions, he notes the difficulties, expenses and constraints of NCLB requirements as factors for maintaining more traditional assessments to measure student learning. However, with the utilization of technology through these new assessment consortia, Dietel believes the important attributes of high-quality assessments can be achieved. Dietel asserts that technology assessments will move beyond the paper-pencil test due to inexpensive test development, ease of test administration, timely item scoring and efficient data reporting. Additionally, computerized assessments will be able to test adaptability to students' skill levels while being able to measure complex skills such as collaboration and communication through performance events. The Smarter Balanced Assessment Consortium (SBAC) plans to establish a composite measurement in learning for students in grades three through eight, as well as the eleventh grade, in the areas of mathematics and English Language Arts. This robust testing platform will utilize an adaptive computerized assessment platform consisting of a combination of selected-response, constructed response, technology-enhanced, and performance event tasks (Deitel, 2012). As technology and standardized testing expanded in the educational setting, guidelines for computer-based tests were created by the American Psychological Association in 1986 with guidelines for adaptive computerized tests being developed in 1995 by the American Council on Education (Ali & Ali, 2010).

The 2014-2015 school year will mark the first year for statewide computerized, standardized assessments for students in Missouri. According to the State Educational Technology Directors Association (SETDA) (2015), approximately 40 states will utilize the new online student assessment platforms from either the PARCC or Smarter Balanced Assessment Consortium. While this will be the first year for online assessment in the state of Missouri, a current study by SETDA on the issues facing the use of technology on large-scale online assessments noted that by June of 2011, 33 states were already administering significant assessments electronically. While states like Washington were just beginning this statewide assessment process, other states such as Idaho, Virginia, and North Carolina have utilized similar assessments for a decade or longer (SETDA, 2015).

The Smarter Balanced Assessment Consortium Field Test Report (2014), in which more than 4.2 million students and more than 16,500 schools participated, provided several recommendations for schools as they transition to the new online state assessment platform. Evidence reported from surveys from 13 participating states encouraged schools and districts to further update their technology infrastructures and bandwidth in all testing locations to best ensure sufficient Internet connectivity during testing. The report also called for opportunities for students to strengthen keyboarding and word processing skills. Additionally, opportunities for students to practice and receive exposure to the online testing platform for familiarity with the assessment format was encouraged to ensure that final testing results reflect students' knowledge and skills rather than their lack of familiarity with the test format.

While the online assessments developed by the Smarter Balanced Assessment Consortium (SBAC) will be implemented in the spring of 2015, a February 2015

Missouri court ruling found that Missouri's partnership with SBAC was an unlawful interstate compact (Strauss, 2015). In the ruling, Judge Daniel Green found the \$4.3 million dues budgeted for Missouri's membership in SBAC, a federally funded assessment consortium, was a violation of the Compact Clause of the United States Constitution. On behalf of the Missouri Department of Elementary and Secondary Education (DESE) and the State's Board of Education, the Missouri Attorney General's office filed an appeal in March of 2015 arguing SBAC is a partnership of states working together to share the expense of creating common state assessments. The Board of Education and DESE released a statement supporting the use of high quality assessments aligned to the Missouri Learning Standards, but fear this ruling has potential implications that could limit the mutual benefits of state departments working together with other state departments to share costs and resources in providing public services.

Technology

History of Technology in Education

Thomas Edison predicted that books would soon become obsolete and that students soon would be taught through the eye (Dunn, 2011). While many would argue these statements are a near reality today, Edison shared them nearly a century ago in 1925. In his review of how technology has evolved in the classroom, Dunn (2011) notes how far classroom instructional tools have progressed as well as the exponential growth in educational technology in recent years. While the printing press was mass producing copies in the 1500s, schools in 1650 started utilizing the Horn-Book, a wooden paddle with the alphabet printed on it for students to copy and learn how to write in the Colonial era. Before students and teachers had individual slates or classroom chalkboards in 1890,

the “magic lantern,” the predecessor to the slide project, projected images from glass plates in 1870. By 1900, pencils became readily available replacing school slates eventually. In 1925, the addition of the slide projector and the radio offered visual and auditory medians for sharing information. Though initially used by the military, the overhead projector became an instructional staple in the classroom for decades to come. The mimeograph of 1940 followed by the invention of the photocopier in 1959 offered the ability to duplicate multiple copies of instructional materials for students. By the 1960s, programs, some educational, were being broadcast to televisions across the United States.

As Dunn (2011) proceeds through the timeline of classroom technologies, the sharing, manipulating, and reporting of information started to change in the classroom with the development of the Scantron multiple-choice exam grader in the 1970s. This was followed by the Plato Computer in 1980. Dunn (2011) notes that the United States schools averaged one computer for every 94 students in 1984 as compared to the current average of one computer for four students. An obscure computer network called the Internet, primarily used by academics and National Aeronautics and Space Administration physicists, gained broader acceptance and popularity in 1996. Interactive whiteboards utilized touch-sensitive screens in conjunction with a projector and computer to create a modern version of the chalkboard in 1999. Individual hand-held devices like iClickers allowed teachers to quickly poll students beginning in 2005 with durable, affordable student laptops like the XO Laptop becoming available in 2006. In 2010, Apple introduced the iPad bringing the individual student slate full circle. With these advances in informational technology, Carey (2014) sees an opportunity to improve the

quality of education to a degree yet to be done since the origination of the written word through unparalleled interactivity and inter-personal connectivity to create communities of learners on a global scale.

1:1 Technology

According to Larkin and Finger (2011), 1:1 initiatives have become popular solutions due to their perceived potential to span the digital age and traditional instructional divide occurring in schools today. This popularity of 1:1 technology initiatives is supported by the meta-synthesis of research by the Ozarks Educational Research Initiative in which Sell et al. (2012) note the billions of dollars spent on educational technology. One federal grant program identified in the study, the Enhancing Education Through Technology program, received \$650 million in government funding (Sell et al. 2012). Utilizing federal, state and local financial resources, larger scale 1:1 initiatives have been implemented in Texas, Michigan, North Carolina and South Dakota (Sell et al. 2012). This trend is further evidenced by Maine's 8th and 9th grade decade old 1:1 initiative as well as the widespread growth of these initiatives in Florida and Pennsylvania (Larkin & Finger, 2011). Larkin and Finger (2011) also note the popularity of this movement world-wide citing Australia's Digital Education Revolution plan to distribute laptop computers to every secondary student in grades 9-12.

Upon review of four empirical studies, Bebell and O'Dwyer (2010) identify the role and professional development of the teacher as the primary factor for the effectiveness of any 1:1 technology implementation. The teacher's level of ownership for the technology initiative and his or her judgments for the most effective use of the existing technology for impacting learning support Bebell and O'Dwyer's call for

focusing on teacher support when pursuing a 1:1 technology initiative. Bebell and O'Dwyer believe these efforts to support teachers are vital to ensuring success in the teaching and learning process in the 1:1 setting.

Lawless and Pellegrino (2007) also note the key role the teacher plays in the effectiveness of technology-rich learning environments on student success. They contend teachers must stay current on instructional strategies for utilizing new technologies within the curriculum. Through interviews of elementary teachers in 1:1 technology classrooms, teachers reported an increase in their ability to adapt instructional practices as individual student access to technology increased (Lewis, 2012). The research by Lawless and Pellegrino (2007) also emphasizes the pedagogical shift towards not just what is taught, but how subject matter is addressed in a 1:1 instructional setting. Dunleavy and Heinecke (2007) concur: specifying the technology itself does not impact the learning, but rather how it is utilized for teaching and learning.

In her extensive research of technology integration and student achievement within public schools in Florida, Hohlfeld (2007) examined standardized test scores for elementary, middle, and high school students over a four-year span. Even when accounting for school level, demographics, and various learning environment variables, the data revealed a significant relationship between technology integration and a school's overall academic achievement. Despite these findings, the author also noted the importance time plays in the implementation of educational initiatives drawing attention to the four-year scope of the study and the need for continued examination of the data.

While there does not seem to be any definitive outcome for the use of educational technology on student achievement, much evidence exists to support the positive student

learning benefits in technology-rich environments. Apple Computer, Inc. (1995) conducted research through their Apple Classroom of Tomorrow (ACOT) program. Their findings showed that students who used computers as classroom learning tools performed well on standardized tests. Additionally, these students demonstrated peer collaboration in developing presentations and communicating about complex processes. In 2008, Apple Computer, Inc. researchers updated their findings through their Apple Classroom of Tomorrow-Today (ACOT2) program. Through their review of research, they noted that no national platform for measuring the use of 1:1 technology has been established yet individual school districts and a statewide program in Maine have shown improved student learning and standardized test scores. Another private organization supporting the immersion of technology in the school setting, Project Revolutionizing Education (RED) (2010), shared findings that implementing 1:1 technology on a daily basis in core areas improves student engagement, creating a reduction in discipline issues and decreasing dropout rates. Larkin and Finger (2011) concur with these findings noting that ubiquitous computing resulted in increased student motivation, improved engagement and attendance, and a decrease in discipline issues. Additionally, Rosen and Beck-Hill (2012) cite previous works by Rosen and others in which learning environments immersed in technology more effectively promoted higher-order thinking skills, motivation for learning, and peer collaboration when compared to traditional classroom settings.

A current review of the Time to Know 1:1 laptop program by Rosen and Beck-Hill (2012) showed a significant increase in student learning and achievement. The study went on to mention improved student discipline and a reduction in unexcused student absences. The researchers linked these positive findings to the constructivist technology-

enriched model of the program that fostered differentiated teaching and learning practices in this technology-rich learning environment.

Technology and Learning

In *Curriculum 21: Essential Education for a Changing World*, Heide Hayes-Jacobs (2010), addresses curriculum, learning, and technology in an ever-changing 21st century world. One of the contributing authors to this work, Stephen Wilmarth, notes, “Today’s student, nearly everywhere in the world, lives in a technological era in which the Internet and Google and text messaging never *didn’t* exist” (p. 81). These new technologies provide ubiquitous connectivity changing the way students use information to make meaning and create new knowledge. Wilmarth (2010) argues that this shift in thinking and processing through the use of technology has moved students beyond the role of consumers of content, into an active role as participants and creators of content. With information accessible at one’s fingertips, Wilmarth believes the traditional rules of the classroom and education are changing and are being replaced with real-time learning as students learn as they work through problems and situations without the prerequisite base knowledge required in the past.

Lowther et al. (2008) identify two driving forces that are prevalent for integrating technology in schools today: equipping students for the workforce and increasing student knowledge and skills. Yet, in spite of years of countless, well-funded technology initiatives, the results have been disappointing according to a 2003 United States Department of Commerce report ranking education as the least technology-concentrated enterprise amid 55 United States industry sectors. Lowther et al. site additional evidence

from U.S. employers claiming high school graduates are lacking in 21st century skillsets for today's workforce.

In her contributions to Hayes-Jacobs' work (2010), Vivien Stewart supports Wilmarth's claims noting that today's students will leave school in a fundamentally different world from recent decades. Due to the prolific use of technology, students will be required to compete and collaborate on a global scale. Stewart also notes, while once competitive, the United States led the world in secondary and post-secondary attendance, but not only are other countries catching up, they are surpassing the United States in graduation rates as well as math and science achievement. This trend shows a widening gap in knowledge and achievement on a global scale. Technology is often viewed as one of the tools to help bridge this gap, yet Baker's input into Hayes-Jacobs' work believes that many teachers are ill prepared to maximize the use of technology with their technology savvy students claiming this gap offers one more digital disconnect between students, teachers, technology and the teaching and learning process.

Hayes-Jacobs, and Wilmarth (2010) believe technology changes and the many facets connected to technology will challenge the teaching and learning process for both teachers and students. The formal process of teaching and learning changes to become less structured and more organic to support student needs as digital social networks and gaming influence learning. Li and Ma (2010) concur, noting that over the past few decades, computer technology has become more popular in the elementary and secondary school setting leaving little uncertainty that technology has become a pervasive tool for teaching and learning.

Despite an increased push towards the full immersion of technology into the classroom setting, Means (2010) notes that comprehensive and innovative technology use has been slow to advance across the nation's classrooms. Additionally, Rosen and Beck-Hill (2012) address the ongoing debate occurring between researchers, educators, and policymakers on the true effectiveness and benefits for the K-12 educational system. Kposowa and Valdez (2013) bring the cause for this ongoing debate to light identifying the need for a highly skilled workforce that is adaptable to changes and advances in technology for continued economic advancement in and beyond the 21st century. However, as Holfeld (2007) points out, the demand for a positive return in the form of improved student achievement on the significant financial investment for technology required of school districts' budgets is an ongoing consideration. Even if school districts and states move forward to invest in instructional technology, Rakes, Fields, and Cox (2006) point out that integration of imposed reforms does not readily result in quality instructional practices.

Lowther et al. (2008) note findings of thousands of direct classroom observations in which computers are inconsistently utilized or accessed for non-critical thinking lessons like word processing or drill and practice activities. A 2003 report from the United States Department of Education supports these claims citing survey responses from over 90,000 teachers indicating computers were predominantly used for low-level learning in teacher-centered environments. Through their study of Tennessee's statewide technology initiative, Lowther et al. (2008) identified several barriers that impede successful technology integration efforts. These barriers include availability and access to computers, readiness of curriculum materials, teacher beliefs and pedagogy, teacher

technology competency, technical support, and support from fellow staff members. Like many others investigating the impact of technology on student learning, the goal of the study by Lowther et al. was to assess the conditions effective in increasing student achievement and teacher performance through the use of technology.

With these barriers to the effective integration of technology and mixed results on student achievement, there is ongoing debate between whether the use of technology or the design of instruction improves learning in the educational setting (Clark, 2001; Kozma, 2001). While technology allows for timely and virtually unlimited access to learning materials, Clark argues that technology is merely a vehicle to deliver instruction, but does not itself impact student achievement. Clark sites studies on media research in which students gain significant learning benefits with technology over traditional instruction, but notes these same studies suggest the reason for this improved student achievement is the instructional strategies incorporated into the learning materials. Conversely, Kozma contends that technology as a medium does impact learning since technology has the ability to bring real-life models and simulations to the learner. Ally (2004) agrees with Kozma viewing technology as a powerful tool, but believes sound design principles must also be utilized in the development of these real-life models and simulations. Li and Ma (2010) support Kozma's argument that technology cannot replace good teaching, but they contend computer technology should be a key component of any good teaching.

In light of this ongoing technology debate, Ally (2004) notes the need for online learning and technology to provide major benefits to schools and student learning before institutions will make the move in this often expensive direction. Many of these

perceived benefits of technology include greater flexibility in the retrieval of information, access to up-to-date and relevant learning materials, and the ability to design specific learning materials based on individual student needs, level of performance, and desired learning outcomes. Burns et al. (2010) concur; noting teachers face difficult challenges in providing individualized instruction when students perform at such diverse levels of ability and posit that technology-enhanced learning environments offer a cost-effective opportunity to support teachers in meeting the varied learning needs of their students. In their research Rizzo (2013) and Penuel (2006) also site raising student achievement, promoting student engagement, improving technology skills, and increasing economic competitiveness as district goals for implementing 1:1 programs. Additionally, the Farmington, Minnesota School District reports using 1:1 technology devices to continue student learning opportunities during inclement weather school closings and as an alternative to hiring substitute teachers at the secondary level by allowing students to access posted instructional activities during a teacher's absence (Richmond, 2015).

Often, the role of technology and learning come together as educators consider 21st century learning environments and the Common Core State Standards (Rizzo, 2013). Rizzo posits these standards emphasize the need for students to effectively collaborate, solve problems, and assimilate information through the use of digital resources, heightening the focus of 1:1 technology initiatives towards 21st century learning and teaching goals. Hayes-Jacobs (2010) argues that the skills referred to as 21st century have been around for more than 40 years, but that the specific media skills must be cultivated to harness these skills in a new world. For this infusion to occur, Rizzo argues that many schools are attempting to move their central focus beyond the technology initiatives to

concentrate on what technology can offer in the overall learning process. Weston and Bain (2010) support this transition in thinking, viewing the physical device not just as a technology tool, but also as a cognitive tool integrated into the teaching and learning process.

While the popularity of 1:1 initiatives continues to grow and the role of technology in the instructional process expands around 21st century learning, Rizzo (2013) believes many districts still lack specific goals, plans, and structures to successfully implement and support such undertakings. She contends that districts continue to make substantial investments in 1:1 programs despite the criticism of the lack of significant gains on state and national assessments for schools with these technology initiatives. Gibson (2013), however, believes digital technologies from smartphones to cloud computing provide extraordinary opportunities for instruction and assessment. Tucker (2009) concurs: theorizing the quality of instruction will increase through the use of technology-enhanced assessments. Tucker (2009) believes the complex problems with multiple steps for students to solve through technology-enabled assessments will allow educators to gather detailed information about student learning beyond traditional simple right or wrong answers.

While the debate continues amongst educators regarding the most effective use of technology in the classroom setting, Nasah et al. (2010) conclude that today's students are already equipped to learn through the use of technology because these students have grown up in a digital society. As 21st century learners in a digital age, students will be challenged to learn and problem solve in collaborative and creative ways through the Common Core State Standards (Fletcher 2012). While students are accustomed to the use

of technology in their daily lives, Fletcher goes on to stress that teachers must utilize technology in their instruction before engaging in online testing. Schaffhauser (2013) supports this classroom use of technology before online assessment to better ensure student comfort with these devices and platforms especially for students who may not have technology readily available at home.

In their research, Weston and Bain (2010) provide an overview and examination of 1:1 computing initiatives. They note several obstacles that limit the effective use of technology in the instructional process. They also propose a new vision for 1:1 settings in which handheld or laptop computers move beyond being technological tools to becoming cognitive tools holistically infused into the teaching and learning process. Bebell and O'Dwyer (2010) echo this need for a clear instructional vision in 1:1 technology initiatives challenging educators and school leaders to not simply provide hardware for students and teachers, but to focus on how these devices will support, enhance, and extend teaching and learning activities. Findings from Bebell and O'Dwyer (2010) and Cuban (2001) show the use of technology by students and teachers to be a supplemental part of the instructional process. Rosen and Beck-Hill (2012) further state that technology is often used for traditional practices with actual change to the instructional beliefs and practices of educators in these technology-immersed settings being rare. Donovan et al. (2007) corroborate these determinations noting concerns by teachers placed in 1:1 computing settings with having to adapt to instructional devices in conjunction with revamping their instructional approach to student-centered learning. However, as Bebell and O'Dwyer (2010) reviewed various 1:1 computing settings, teachers' pedagogical approaches towards teaching and learning did change over time.

In their book *Inevitable: Mass Customized Learning-Learning in the Age of Empowerment*, Schwahn and McGarvey (2011) challenge the roles of teachers and traditional schools. Schwahn and McGarvey contest the role of technology as the teacher, but rather technology as the enabler for professional educators to customize learning experiences and environments to the specific needs of the individual learner. They envision a learning library, much like Apple's iTunes music platform, in which learner outcomes are tied to technology-driven learning experiences accessible to students at any time to meet and challenge their individual needs. Instead of threatening the traditional role of teachers, Schwahn and McGarvey view this mass customized learning as an opportunity to further professionalize educators for the difficult work of responding to individual student needs and learning styles by harnessing the power of technology.

The United States Department of Education's National Education Technology Plan (NETP) (2010) also calls for the use of technology to engage and empower students. The NETP challenges the educational system to leverage technology to develop relevant, personalized, and authentic learning experiences reflecting students' daily lives as well as future realities. Additionally, the NETP promotes leveraging technologies to provide access to learning resources to a wider base of educators beyond the classroom to enable 24/7 learning and a limitless, lifelong learning mindset.

Technology and Student Achievement

While the popularity of 1:1 technology initiatives continues to expand and the financial investments at the federal, state, and local levels for educational technology continue to increase (Larkin & Finger, 2011; Sell et al., 2012) solid, objective research on the effectiveness and replicable findings of these initiatives may be lacking (Sell et al.,

2012). In their meta-synthesis of 1:1 technology initiatives, Sell et al. (2012) illustrate this point with the example of a superintendent citing what they believe to be a recently published literature review to support purchasing technology for students when in actuality these research findings most likely are published from studies more than a decade old. The significant delays experienced due to lags in the reporting and publishing of research offers inherent limitations on the impact of technology in the educational setting when technology continues to evolve rapidly.

Lowther et al. (2008) conducted a study to investigate the effectiveness of Tennessee's statewide technology program. The goal of Tennessee's robust program was to increase student learning by equipping teachers to develop engaging, critical thinking lessons that utilized computers with the assistance of full-time, on-site technology coaches. While Lowther et al. note the progress made in advancing school cultures to support students through the use of technology, achievement on the state's standardized assessment were mixed. Analysis of state assessment data revealed significant differences in fifth grade mathematics and reading/language arts achievement between schools participating in the state's technology initiative and the control schools. However, there was no difference in student achievement at the eighth grade level in mathematics and reading/language arts.

When looking at 1:1 student computing use, Suhr et al. (2010) found that upper elementary students with individual access to laptops outperformed their peers in traditional settings in English Language Arts on state assessments. Upon closer examination of these findings, Bebell and O'Dwyer (2010) note the most common use of laptops by students was on writing papers and that technology was used more frequently

in the areas of English Language Arts and social studies over science and mathematics. Penuel (2006) also identified better student writing skills in 1:1 computing settings.

Upon reviewing multiple 1:1 initiatives, Bebell and O'Dwyer (2010) found that when compared to the control group of the traditional instructional setting, students with 1:1 accessibility demonstrated measurable differences in teacher practices, student achievement, student engagement, and students' research skills. Lewis (2012) also identified positive outcomes for students with 1:1 access to technology in the areas of student engagement and motivation. A meta-synthesis of research on 1:1 technology by Sell et al. (2012) support these findings showing an overall positive effect contributing to enhanced student engagement and motivation.

Sell et al. (2012) also revealed that most 1:1 initiatives often have goals beyond academic achievement outcomes such as 21st century skills including the abilities to work independently as well as collaboratively, completing complex project-based activities, and the ability to critically consume digital information coincide with 1:1 technology initiatives. While Sell et al. (2012) note there is often less rigor and consistency in these findings, their meta-synthesis characterized a weak to moderate support for these skills.

Martindale et al. (2005) support these findings and believe that computers and web-based resources can positively contribute to create effective learning environments. However, their study of computerized software and web-based games designed to prepare students in Florida for their state's standardized assessment demonstrated mixed results for students who utilized these technology resources and those who did not. Students in fourth grade reading and fifth grade math showed statistically significant effects through

the use of these computerized assessment preparation resources. However, these same resources did not demonstrate a significance effect with tenth grade students in mathematics and showed lower performance by students in eighth grade mathematics for students who used the computerized software compared to students who did not. Mixed results aside, Martindale et al. also noted that these computerized resources can be cumbersome to manage and cost prohibitive, offering no guarantee that these potentially beneficial learning tools will be used.

In a study of 5th, 6th, and 7th grade students, Lowther et al. (2003) showed mixed results in student achievement when comparing laptop classes to control settings. Overall, no significant advantage was found for students in the laptop classes versus their peers. However, when the meaningfulness of computer usage was examined, the 6th grade group of students rated significantly higher. Further examination of the data revealed a favorable and highly significant difference in student achievement in the areas of writing and problem solving for the 6th grade students with ubiquitous laptop access. Larkin and Finger (2011) too noted the benefits for student learning of improved writing, increased media literacy and increased standardized test scores. Additionally, Sell et al. (2012) reported improved writing as the most consistently supported positive achievement outcome in 1:1 technology initiatives with a small to medium effect size of .30-.35.

In his work *Visible Learning*, John Hattie (2009) reviewed 4,875 studies to better understand the impact of technology on student achievement. With such a large number of studies available, Hattie noted the popularity of technology in education today. A meta-analysis review of the information showed a 0.37 average effect size in the use of computer-assisted instruction. These studies also revealed that a positive difference was

made 25 percent of the time with computer-aided instruction. However, Hattie's analysis did not show a correlation of the effect size with the year the study was conducted indicating that even though devices become more sophisticated, the resulting effect size on student achievement does not necessarily increase. Furthermore, no difference was identified across grade levels or student ability levels. Some differences across subject areas were identified, but not to a meaningful degree. While not significantly impactful on student achievement, Hattie notes that computers can promote engagement and positive attitudes towards school and learning. Through his study, Hattie (2009) concluded that, "like many other structural innovations in education, computers can increase the probability of learning, but there is no necessary relation between having computers, using computers, and learning outcomes" (p. 221).

While the overall trends from the meta-analysis did not demonstrate highly desired effects on student achievement, upon closer examination, Hattie was able to identify common themes for the effective use of computers in schools. First, there was a 0.45 effect size for computer work as a supplement when compared to computer usage as a substitute or replacement for teacher instruction at 0.30. Second, the use of computers is more effective when more than 10 hours of teacher pre-training is provided resulting in a 0.53 effect size. Furthermore, Hattie cites findings that less than 10 hours of training may even be counterproductive to student learning. A third way computers might increase student achievement is computer-assisted deliberate practice in which the learner has control or choice in the activity while also receiving immediate feedback on the correctness of the learner's response. Student control over pacing and regulating the technology was a fourth indicator of positive effects on student learning through Hattie's

analysis. Students showed a 0.60 effect size when they experienced control over pacing as compared to a 0.34 effect size when the instructor paced the computer-assisted learning program. Additionally, this concept of control showed an effect of 0.40 in the quality and length of writing where students learned to write using computers in comparison to writing on paper. A fifth indicator identified through Hattie's meta-analysis is that the use of technology is more effective when peer learning is utilized. Students paired during computerized learning activities showed greater effects than small groups, large groups, and individuals. The utilization of pairs improved on-task learning behaviors, student and task success, and required less help from the teacher than students who worked independently. A sixth indicator for improved student achievement with the use of computers is when feedback is optimized. Hattie (2009) notes that computers are indiscriminate in their feedback when it comes to gender, race, or ability. Additionally, students maximized the feedback when presented with an appropriately challenging task while a less rigorous task demonstrated a negative effect size on student learning, causing Hattie to determine that technology assisted learning activities are pointless unless they merit some level of challenge.

Li and Ma (2010) conducted their own meta-analysis on the effects of computer technology focusing on the area of mathematics for student learning. Their examination of the impact of technology on mathematics achievement suggested a statistically significant positive effect. Li and Ma cite studies beginning in the late 1970s and 1980s that report computer-based and computer-assisted instruction raised student math achievement. While the effectiveness of technology rests upon sound instructional pedagogy, Li and Ma note the emphasis that The National Council of Teachers of

Mathematics (NCTM) has placed on technology as an essential component to what is taught while enhancing student learning. As the accessibility and use of computerized technology has increased greatly due to affordability and ease of accessibility, Li and Ma believe further study is required, especially considering the shift from more traditional drill and practice computer assisted technology to interactive, learner-centered classroom learning environments.

Through their meta-analysis, Li and Ma (2010) reported a large favorable effect size of 1.02 standard deviations for utilizing technology in special education classrooms with special need students when compared to the general student population.

Additionally, Li and Ma (2010) identified a 0.79 standard deviation in favor of utilizing technology in schools, practicing a constructivist approach to teaching as compared to learning environments with more traditional approaches to teaching and learning.

Due to the logical use of technology in the areas of science and mathematics, student achievement with laptop initiatives has become a focus of research. In his research on technology-enriched learning environments, Page (2002) found that students with higher levels of accessibility to technology had higher achievement in mathematics when compared to their traditional classroom counterparts. Page noted this difference in achievement may be due to the result of technology infused classrooms creating more student-centered learning experiences. However, Dunleavy and Heinecke (2007) studied the effect of 1:1 laptop usage by middle school students on standardized tests. No significant effect was found in mathematics for students with laptops as compared to those without. However, in the area of science, the researchers noted that male students outperformed female students with 1:1 laptop instruction. Additionally, this pattern of

achievement was also observed in the areas of English and writing with males demonstrating a greater benefit with 1:1 laptop instruction.

The impact on student achievement through 1:1 technology initiatives is also of significant consideration for students in low socioeconomic settings. In his research, Bird (2008) examined the effects of 1:1 laptop use with 4th grade students in an urban poverty setting. Bird's study focused on bridging the digital divide for students who had accessibility to technology at home and those who did not. Examination of district reading, writing, and vocabulary scores showed that students without technology typically did not score as well as peers with technology access at home. However, once 1:1 accessibility was available in the classroom setting, students without technology at home advanced at similar rates in achievement and technology skills though still behind their peers. Bird emphasizes the small sample size and identifies the need for expanded studies and support for students without access to technology beyond the school setting.

A current study by Kposowa and Valdez (2013) examined the ubiquitous use of laptop computers on student achievement. This research focused on 4th and 5th grade students with 1:1 technology access 24 hours / 7 days a week. Findings from their study showed a significant impact in students' academic achievement when compared to students without laptop computers in the areas of English language arts, mathematics and science. When stratified by grade level, an even more dramatic difference was identified in 5th grade mathematics and science achievement for students with ubiquitous laptop usage. While the researchers showed a statistically strong effect for 1:1 initiatives on student achievement, they also noted the need for better teacher professional development in the instructional uses of technology and improved student training in researching

academic information. Based on their research, Kpowosa and Valdez (2013) believe public policies and school initiatives targeted at increasing ubiquitous laptop use in elementary schools have the potential to improve student academic achievement.

Bebell and O'Dwyer (2010) reviewed the outcomes and research from 1:1 educational computing settings. They perceived a widespread belief that increased access and use of technology would lead to increased student achievement and improved instructional practices. This belief has motivated school leaders, educators, and policymakers to make significant investments in educational computing initiatives. Bebell and O'Dwyer point out that with the increase in technology initiatives, technology is often no longer shared in a classroom as all students and teachers have access to a laptop or other computing device at all times. While educational technology initiatives are becoming more prevalent, the research on their effectiveness continues to show mixed results (Cuban 2001; Kposowa & Valdez, 2013; Tamin, 2011).

Summary

This chapter offered background information on the call for increased educational technology in today's classrooms to prepare students for 21st century learning and technology skills. Also provided, was existing research about the impact of 1:1 initiatives on student learning. While research findings were mixed with no definitive correlation between improved student achievement and 1:1 accessibility to technology, several 1:1 initiatives yielding positive outcomes were examined.

Chapter III describes the method used to identify and select Missouri school districts utilizing 1:1 technology initiatives in the 4th grade and outlines the collection of state data for the selected districts as well as demographic areas for study. Chapter IV

offers a presentation of the findings. Chapter V provides a summary of this project and the educational implications and significance of these findings for educational decisions and future studies.

Chapter III

Methodology

Introduction

This quantitative, non-experimental study is designed to determine the impact that access to 1:1 technology use by 4th grade students has on student achievement on Missouri's computerized state assessment. The intent of this study is not to identify a causal relationship between the independent variable of 1:1 technology use and the dependent variable of student achievement, but rather to determine the significance, if any, on the impact of 1:1 technology on student achievement in communication arts and mathematics on Missouri's new computerized assessment. Demographic information to determine the use of technology by 4th grade students was collected through electronic surveys and phone calls. Assessment data was collected from the Missouri Department of Elementary and Secondary Education. The data were analyzed using an independent samples *t*-test.

Participants

The purpose of this quantitative study was to better understand the impact of 1:1 technology on 4th grade student achievement on the computerized Missouri Assessment Program. For the purpose of this study, 1:1 technology is an Internet connected device provided by the school district that students have direct access to throughout the school day. The researcher examined state standardized testing data to determine the impact of 1:1 technology usage on student achievement at the 4th grade level in the following areas:

1. What impact does 1:1 technology have on overall student achievement in communication arts?
2. What impact does 1:1 technology have on overall student achievement in mathematics?

A demographic questionnaire was given to all elementary schools in the state of Missouri to identify the implementation of 1:1 technology initiatives at the 4th grade level. Each 4th grade building administrator was surveyed representing 1,046 school settings with 4th grade students.

In accordance with the guidelines of Southwest Baptist University regarding the protection of human participants, a request for review was submitted to the Research Review Board for approval to provide a questionnaire for all 1,046 participating schools for this study. Upon receiving RRB approval in May of 2015, participant recruitment and data collection began. Participant consent was given through completion of the online questionnaire for involvement in the study. Considering this study sought to identify school districts participating in 1:1 technology initiatives and utilized public state assessment data, participant confidentiality and the lack of any foreseen harm to respondents was outlined in the questionnaire as minimal. School districts who did not complete the online questionnaire were contacted via telephone to verify the demographic information.

Selection/Sampling

The target population for this study was all schools that contain a 4th grade level setting in the state of Missouri. To avoid sampling error and bias, all 1,046 schools were contacted to ensure a comprehensive review of schools with 1:1 technology and those

without. Utilizing the Missouri Department of Elementary and Secondary Education database, a list of all schools containing a 4th grade setting was generated. The associated school administrators from this list were provided an electronic questionnaire to determine 1:1 technology initiatives within their 4th grade classroom settings. Identified schools with incomplete questionnaire data were contacted via email to verify this demographic information. The remaining schools with incomplete questionnaire data were then contacted via telephone to determine 1:1 technology initiatives within their 4th grade classroom settings. The questionnaire was administered electronically using the QuestionPro software platform. One hundred forty-four schools responded to the online QuestionPro survey, 437 schools responded via email, and 465 were identified through telephone calls. Once this demographic information was gathered via electronic survey, follow up emails, and phone calls, standardized assessment results for the Spring 2015 Missouri Assessment Program were retrieved. Utilizing the School Content Area Disaggregated Report (2015) from the Missouri Department of Elementary and Secondary Education public domain reports, data for each school's 4th grade setting was collected for analysis in this quantitative study. Student achievement data from every school in the state of Missouri for all 4th grade settings were used as the population of study in an effort to avoid sampling error and bias. Information obtained through the demographic survey of each school included the following information:

1. School District Name
2. Elementary School/Building Name

3. Does your school have a 1:1 technology initiative for each student in 4th grade consisting of a school provided computer, laptop, tablet or other Internet connected device accessible to students throughout the day?

- a. Yes
- b. No

Research Setting

The scope of this study attempted to encompass all 4th grade classroom settings across the state of Missouri to offer a comprehensive analysis of the impact of 1:1 technology on student achievement in the areas of communication arts and mathematics. Demographic questionnaires were submitted to all school administrators with 4th grade classroom settings to identify the use of 1:1 technology within their schools. Upon successful gathering of this information, public Adequate Yearly Progress (AYP) data from the Missouri Department of Elementary and Secondary Education for student achievement was collected for the 2015 Missouri Assessment Program (MAP) test for 4th grade. This was the first year the state assessment was administered electronically to all students.

Research Design

Demographic questionnaires were provided to administrators across the state to identify the use of 1:1 technology in 4th grade settings for the purposes of this quantitative study. Once these schools were categorized as meeting the 1:1 technology criteria or not, state assessment data was retrieved through the Missouri Comprehensive Data System to collect student achievement information by school. State assessment data was collected utilizing the Missouri student achievement levels for Basic, Below Basic,

Proficient and Advanced for the total population for each school in the areas of communication arts and mathematics for the 2015 testing cycle. Since proficiency is the state target for student achievement on the MAP test, the percentage of students scoring in the Proficient and Advanced categories was examined by total school population for students with 1:1 technology access and for those without.

Instrumentation

The instrument used to measure student achievement in this study is the Missouri Assessment Program (MAP) test. MAP data is reported out yearly by school and district for each grade level and subgroup areas through the Annual Yearly Progress (AYP) Report. The MAP test consists of multiple choice, constructed response, and performance event items. The 2015 assessment cycle was the first year the MAP test was given in a computerized format. The new assessment instrument was developed by the Smarter Balanced Assessment Consortium (SBAC), based on state adopted standards through the Common Core State Standards (CCSS) and was developed utilizing federally funded competitive grants under the Race to the Top program from the United States Department of Education. As a member of SBAC, all students in the state of Missouri were given this online format of the MAP test.

While future versions of the Smarter Balanced assessments will be computer adaptive tests built to respond to the correct or incorrect answers from students, a Missouri Department of Elementary and Secondary Education (DESE) Administrative Memo from February 5, 2015 outlined the inaugural implementation of the SBAC assessment as a computerized fixed format. Three versions of this fixed format assessment were developed in alignment with the Missouri Learning Standards and in

accordance with the Smarter Balanced test blueprint. Assurance of a smooth transition to the new statewide computerized assessment as well as desire to place a lesser demand on the bandwidth required for online assessments were cited as factors for the transition to the fixed format assessments by DESE. The department also predicted that the fixed format tests would be used for the spring 2015 summative assessments and that complete implementation of the computer adaptive testing platform will be in place for the 2015-2016 school year.

In an effort to ensure test questions for the new computerized Smarter Balanced Assessment Consortium (SBAC) were accurate and fair for all students, SBAC conducted field test assessments from March 25 to June 13 of 2014. According to the SBAC Field Test Report (2014), more than 4.2 million students in grades three through eight from 16,549 schools across 21 states and the United States Virgin Islands participated in piloting these assessments, making it the largest online assessment and new assessment field test in the world. The large scope of the field test desired to analyze the computer-delivered questions, the functionality of embedded technology tools and accommodation features within the assessment, and to ensure inclusion criteria for state summative assessments as outlined by the No Child Left Behind Act were met. Additionally, the assessment consortium created and administered a much larger number of test items than required for the secure state assessments in order to develop a representative subset to be utilized for the creation of interim assessments that dependably mirror the rigor and item types of the SBAC summative assessments. In addition to examining assessment items, the field test provided the opportunity for a large-scale trial run of the new assessment

delivery system, the readiness of states, school districts, and school personnel to administer the online assessment, and the readiness of students to take the test.

According to summative assessment form selection information from the Smarter Balanced Assessment Consortium provided to Michael Muenks, Coordinator for Curriculum and Assessment for the state of Missouri, student level response data from items administered through the field test was not available at the time of form selection when creating Missouri's fixed test computerized format (Smarter Balanced, April, 2014). The Missouri Assessment Program Technical Manual is expected to provide reliability for each component of the MAP test in December of 2015. Methods used to calculate test reliability will include Cronbach's coefficient alpha as a measure of internal consistency, overall standard error of measurement to identify random variability in test scores, item response theory based conditional standard error of measurement to determine the degree of error in scale scores accounting for the ability of the students, and inter-rater reliability will be calculated to identify the reliability of scoring by different exam readers. Smarter Balanced also note test selection and reporting adhere to the American Educational Research Association (2014) standards for educational and psychological testing.

Educational Testing Services (ETS) and the Smarter Balanced Assessment Consortium (SBAC) (2014) summary of results for the test pilot reported only items not rejected by data review and only items with an item-total correlation no less than 0.15 were included in the testing item bank used to develop state summative assessments. Additionally, a September 11, 2014 memorandum from Smarter Balanced to the Kindergarten-12 Grade Leads provided a validity overview for the requirements in

developing a valid assessment. In this overview, the SBAC Technical Advisory Committee established their validity framework for test development based on the Common Core content standards, the development of test blueprints specifying the quantity and type of items presented to each student, the conducting of content and bias reviews, the development of the computerized test delivery platform, the implementation of small and large scale pilot tests and field tests, their analysis for alignment of the standards to the assessment, and their establishment of internal validity.

The Smarter Balanced Technical Report (2015) expanded on this original memorandum and extensively outlined the validation framework to be used in regard to this robust assessment system. Adherence to professional testing guidelines set forth by the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 2014) and the U.S. Department of Education (2009) guidelines for peer review in developing assessments under the No Child Left Behind Act were foundational for this validation construct. These established principles, in conjunction with the review of pilot test and field test items, were primary factors in determining the construction of grade level summative assessments, question usage and difficulty, and testing practices. While a large scale pilot test and field test were conducted, the Technical Report notes numerous elements of evidence for test validity were unable to be collected due to the constraints of this large-scale test design for operational administration. Evidence provided for this technical review was reflective of the field test while outlining a comprehensive program for future validation analysis of the summative assessment.

The validation process for the test design included item development, field-testing, item analysis, and vertical scaling and linking of test items (Smarter Balanced,

2015). Selected response items, constructed response items, performance tasks, and computer adaptive test items were piloted, analyzed and evaluated to establish a robust item bank for test development. The computer adaptive test format sampled questions from across the Smarter Balanced test blueprint. This flexible testing format did not allow for classical test reliability for the selected and constructed response items through the computer adaptive test in which fixed items administered to a large number of students could be analyzed. Smarter Balanced noted this lack of fixed assessment forms made the presentation of statistics more difficult and created an inability to define a common test criterion. Item response theory and differential item functioning were used to review decisions regarding test item characteristics. Pearson correlations between the computer adaptive test items and the performance tasks were used for item calibration. Fourth grade English language arts showed a Pearson correlation coefficient of $r = 0.55$ between the computer adaptive tests items and performance task items while fourth grade mathematics demonstrated a Pearson correlation coefficient of $r = 0.65$.

In order to determine internal consistency test reliability, performance task data was utilized on large student samples who responded to the same set of items. The mean Cronbach's alpha for reliability for fourth grade English language arts was 0.65 with the minimum reliability and maximum reliability ranging from 0.07 to 0.74. In fourth grade mathematics, the mean Cronbach's alpha was also 0.65 with the minimum reliability and maximum reliability ranging from 0.53 to 0.77. Smarter Balanced notes that items may have been removed from these performance tasks due to the low reliability. The Technical Report also notes in a comprehensive summative assessment both the computer adaptive test score and the performance task score would contribute to the

overall performance score. Due to the increased number of assessment items, the report predicts the likelihood of “sufficient overall levels of reliability” (Chapter 8, p. 32).

Data Analysis

This quantitative study was conducted to identify the impact of 1:1 technology on student achievement. Overall student achievement for 4th grade students was examined for schools with access to 1:1 technology and for those without. Schools meeting the definition of 1:1 technology as an Internet connected device provided by the school district that students have direct access to throughout the school day were coded as a “1.” Schools not meeting this definition of 1:1 technology were coded as a “0.” Once schools were properly identified and coded, state assessment data were retrieved from the Missouri Comprehensive Data System identifying the number of students scoring in the Basic, Below Basic, Proficient, and Advanced achievement levels. Scores were disaggregated into these four achievement levels for communication arts and mathematics.

Once the data set was compiled, the mean, standard deviation, and confidence interval were calculated, and a two-tailed ANOVA test was completed to test for statistical significance. An independent samples *t*-test was administered using the Statistical Package for the Social Sciences (SPSS) software to test for significance between schools with 1:1 technology access and for those without based on Proficient/Advanced achievement levels on the MAP test. The alpha level of .05 was used to determine significance for these tests.

In addition to the Smarter Balanced technical manual, the Missouri Department of Elementary and Secondary Education contracted with the Data Recognition Corporation

(2015) to release the Missouri Assessment Program Grade-Level Assessment Technical Report. The Technical Report found evidence for test content validity as the test blueprint and test design construction aligned to the Missouri Learning Standards. The final report noted a rigorous test development and test item review selection process utilizing the Smarter Balanced Assessment Consortium item pool. The Technical Report also found accessible reliability coefficients for the 4th grade MAP assessment. Cronbach's coefficient alpha for reliability for communication arts ranged from 0.86 – 0.91 for all test forms. Cronbach's coefficient alpha for reliability for mathematics ranged from 0.87 – 0.91.

Summary

This chapter outlined the process and methodology for this study. A demographic questionnaire was used to identify schools utilizing 1:1 technology with students at the 4th grade level. Once identified, the process for retrieving state assessment was discussed. The development and use of the Smarter Balanced assessment as well as its validity and reliability as the instrumentation for examining student data was also addressed. The plan for analyzing the data was then outlined utilizing the independent samples *t*-test to determine significance.

Chapter I contained a brief overview of the increased implementation of educational technology and the need to examine the impact of 1:1 technology initiatives on student achievement in the elementary setting. Chapter II provided a literature review of 1:1 technology initiatives, the impact on student achievement, and the historical perspective of standardized assessment. Chapter IV will offer an analysis of MAP data for schools with 1:1 technology and those without. Data for whole school 4th grade

populations will be examined to determine the impact of 1:1 technology initiatives on student achievement on Missouri's computerized state assessment. Chapter V will provide a summary of this project, the educational implications, and the significance of these findings for educational decisions and future studies.

Chapter IV

Analysis

Introduction

The final demographic survey results represented 1,046 schools that administered the Missouri Assessment Program test electronically in the spring of 2015 to 67,351 students in the 4th grade. All schools in the state were included in this study with 248 schools representing 13,036 students reporting 1:1 technology initiatives for the 2014-2015 school year. Representing 54,315 students, 798 schools reported not having access to 1:1 computing devices for students during the school day. The School Content Area Disaggregated Report (2015) from the Missouri Department of Elementary and Secondary Education was utilized to retrieve the percentage of students scoring in Below Basic, Basic, Proficient, and Advanced achievement levels on the MAP test for the content areas of communication arts and mathematics.

Upon compiling this data, each school was coded according to their access to 1:1 technology, and the data was uploaded to the IBM Statistical Package for Social Sciences (SPSS) Statistics program for analysis. Descriptive statistics were utilized to present quantitative data in a simple and manageable way. Inferential statistics were utilized to analyze the data to determine any statistical differences between schools reporting access to 1:1 technology and those without on student achievement on the Missouri Assessment Program. An independent samples *t*-test was performed to test the null hypothesis that there is no statistically significant impact on 4th grade students with 1:1 technology access and their achievement in communication arts and mathematics on Missouri's

computerized state assessment. A statistical difference confirms the likelihood that a result or relationship is produced by something other than random chance. When testing for a statistical difference, the researcher looked for p -values representing the probability that random chance could explain the result. When the p -value was five percent or lower ($p < .05$), it was considered statistically significant. Statistical analysis was utilized to interpret the observations of the data on the following research questions:

1. What impact does 1:1 technology have on overall student achievement in communication arts?
2. What impact does 1:1 technology have on overall student achievement in mathematics?

Results for Communication Arts

The scope of this study was to determine the impact of 1:1 technology on student achievement. In Missouri, student proficiency for schools is reported as the percentage of students scoring in the top two levels, Proficient and Advanced, on the state assessment. This percentage is reported as Adequate Yearly Progress (AYP). When examining 4th grade student performance in communication arts, schools with access to 1:1 technology ($N = 248$, $M = 50.99$, $SD = 21.74$) scored numerically lower than schools without access to 1:1 technology ($N = 798$, $M = 58.22$, $SD = 16.37$). The independent samples t -test was associated with a statistically significant effect, $t(1044) = 5.65$, $p = .001$ as shown in Table 1 below.

Table 1
4th Grade Communication Arts Statewide AYP Proficient and Advanced Achievement

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	248	50.99	21.74	1044	0.001*
Without 1:1 Technology	798	58.22	16.37		

* $p < 0.05$

Higher student percentages in these top two performance tiers indicate positive student achievement. Conversely, a lower percentage of students in the Basic and Below Basic performance levels indicate better student performance on the assessment. While schools with 1:1 technology scored numerically lower on AYP than schools without access to 1:1 technology, each level of performance was examined in an effort to provide a more complete picture of the data.

When examining 4th grade student performance in communication arts, the schools with access to 1:1 technology ($N = 248$) level Advanced ($M = 27.40$, $SD = 18.44$) scored numerically lower and significantly different than schools without access to 1:1 technology ($N = 798$) level Advanced ($M = 31.95$, $SD = 15.00$), $t(1044) = 3.93$, $p = .001$ as shown in Table 2 below. Schools with access to 1:1 technology ($N = 248$) level Proficient ($M = 23.59$, $SD = 8.40$) scored numerically lower, but did not differ significantly from schools without access to 1:1 technology ($N = 798$) level Proficient ($M = 26.28$, $SD = 7.80$), $t(1044) = 4.66$, $p = \text{n.s.}$ Schools with access to 1:1 technology ($N = 248$) level Basic ($M = 20.42$, $SD = 7.76$) scored numerically below, but did not differ significantly than schools without access to 1:1 technology ($N = 798$) level Basic ($M = 20.09$, $SD = 7.83$), $t(1044) = 0.58$, $p = \text{n.s.}$ When examining 4th grade student performance, the schools with access to 1:1 technology ($N = 248$) level Below Basic (M

= 28.59, $SD = 18.85$) was numerically below schools without access to 1:1 technology ($N = 798$) level Below Basic ($M = 21.69$, $SD = 12.74$) in communication arts. The Below Basic level was also associated with a statistically significant effect, $t(1044) = 6.58$, $p = .001$ as shown in Table 3 below.

Table 2
4th Grade Communication Arts Statewide Achievement Level Advanced

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	248	27.40	18.44	1044	0.001*
Without 1:1 Technology	798	31.96	15.00		

* $p < 0.05$

Table 3
4th Grade Communication Arts Statewide Achievement Level Below Basic

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	248	28.59	18.85	1044	0.001*
Without 1:1 Technology	798	21.69	12.74		

* $p < 0.05$

School size is often given as a contributing factor for higher student achievement. While class size and district size data were not specifically collected as a part of this study, the Missouri Department of Elementary and Secondary Education guidelines for class size recommendations was utilized to classify schools. Schools with 27 or fewer accountable students in the reporting data were classified as small schools. Schools with more than 27 accountable students for the MAP test were considered larger schools. The data was analyzed by the four disaggregated levels of performance.

When examining 4th grade student performance in communication arts, the small schools with access to 1:1 technology ($N = 54$) level Advanced ($M = 30.04$, $SD = 21.10$) scored numerically higher and differed significantly to schools without access to 1:1 technology ($N = 123$) level Advanced ($M = 26.81$, $SD = 15.22$), $t(175) = 1.15$, $p = .001$ as shown in Table 4 below. Schools with access to 1:1 technology ($N = 54$) level Proficient ($M = 22.81$, $SD = 11.33$) scored numerically lower, but did not differ significantly to schools without access to 1:1 technology ($N = 123$) level Proficient ($M = 28.57$, $SD = 12.30$), $t(175) = 2.93$, $p = \text{n.s.}$ Small schools with access to 1:1 technology ($N = 54$) level Basic ($M = 20.57$, $SD = 10.87$) performed numerically better, but did not differ significantly to schools without access to 1:1 technology ($N = 123$) level Basic ($M = 22.73$, $SD = 11.53$), $t(175) = 1.17$, $p = \text{n.s.}$ When examining 4th grade student performance, the small schools with access to 1:1 technology ($N = 54$) level Below Basic ($M = 26.57$, $SD = 20.50$) was numerically below schools without access to 1:1 technology ($N = 123$) level Below Basic ($M = 21.90$, $SD = 14.44$) in communication arts. The Below Basic level was also associated with a statistically significant effect, $t(175) = 1.73$, $p = .003$ as shown in Table 5 below.

Table 4
4th Grade Communication Arts Small Schools Achievement Level Advanced

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	54	30.04	21.10	175	0.001*
Without 1:1 Technology	123	26.81	15.22		

* $p < 0.05$

Table 5
4th Grade Communication Arts Small Schools Achievement Level Below Basic

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	54	26.57	20.50	175	0.003*
Without 1:1 Technology	123	21.90	14.44		

* $p < 0.05$

Data for schools with more than 27 accountable students were also examined. When examining 4th grade student performance in communication arts, these larger schools with access to 1:1 technology ($N = 194$) level Advanced ($M = 26.67$, $SD = 17.62$) scored numerically lower and differed significantly to schools without access to 1:1 technology ($N = 675$) level Advanced ($M = 32.88$, $SD = 14.78$), $t(867) = 4.93$, $p = .001$ as shown in Table 6 below. Large schools with access to 1:1 technology ($N = 194$) level Proficient ($M = 23.80$, $SD = 7.41$) scored numerically lower and differed significantly to schools without access to 1:1 technology ($N = 675$) level Proficient ($M = 25.86$, $SD = 6.59$), $t(867) = 3.73$, $p = .042$ as shown in Table 7 below. Large schools with access to 1:1 technology ($N = 194$) level Basic ($M = 20.38$, $SD = 6.68$) performed numerically worse, but did not differ significantly to schools without access to 1:1 technology ($N = 675$) level Basic ($M = 19.61$, $SD = 6.85$), $t(867) = 1.39$, $p = n.s$ When examining 4th grade student performance, the large schools with access to 1:1 technology ($N = 194$) level Below Basic ($M = 29.15$, $SD = 18.38$) was numerically greater than schools without access to 1:1 technology ($N = 675$) level Below Basic ($M = 21.65$, $SD = 12.42$) in communication arts. The Below Basic level was also associated with a statistically significant effect, $t(867) = 6.60$, $p = .001$ as shown in Table 8 below.

Table 6
4th Grade Communication Arts Large Schools Achievement Level Advanced

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	194	26.67	17.62	867	0.001*
Without 1:1 Technology	675	32.88	14.78		

* $p < 0.05$

Table 7
4th Grade Communication Arts Large Schools Achievement Level Proficient

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	194	23.80	7.41	867	0.042*
Without 1:1 Technology	675	25.86	6.59		

* $p < 0.05$

Table 8
4th Grade Communication Arts Large Schools Achievement Level Below Basic

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	194	29.15	18.38	867	0.001*
Without 1:1 Technology	675	21.65	12.42		

* $p < 0.05$

Results for Mathematics

When examining overall 4th grade student performance in mathematics for the top two performance levels, schools with access to 1:1 technology ($N = 248$, $M = 42.27$, $SD = 1.50$) scored numerically lower and differed significantly to schools without access to 1:1 technology ($N = 798$, $M = 48.45$, $SD = 0.67$), $t(1044) = 4.23$, $p = .001$ as shown in Table

9 below. When examining 4th grade student performance in mathematics for all four achievement levels, the schools with access to 1:1 technology ($N = 248$) level Advanced ($M = 16.17$, $SD = 14.54$) scored numerically lower and differed significantly to schools without access to 1:1 technology ($N = 798$) level Advanced ($M = 18.51$, $SD = 13.61$), $t(1044) = 2.33$, $p = .016$ as shown in Table 10 below. Schools with access to 1:1 technology ($N = 248$) level Proficient ($M = 26.11$, $SD = 12.50$) scored numerically lower and differed significantly from schools without access to 1:1 technology ($N = 798$) level Proficient ($M = 29.94$, $SD = 79.62$), $t(1044) = 5.08$, $p = .001$ as shown in Table 11 below. Schools with access to 1:1 technology ($N = 248$) level Basic ($M = 33.27$, $SD = 11.00$) performed numerically better, but did not differ significantly to schools without access to 1:1 technology ($N = 798$) level Basic ($M = 34.58$, $SD = 11.46$), $t(1044) = 1.59$, $p = n.s.$ When examining 4th grade student performance, the schools with access to 1:1 technology ($N = 248$) level Below Basic ($M = 24.45$, $SD = 19.755$) was numerically below and differed significantly to schools without access to 1:1 technology ($N = 798$) level Below Basic ($M = 16.97$, $SD = 12.64$), $t(1044) = 7.03$, $p = .001$ as shown in Table 12 below.

Table 9
4th Grade Mathematics Statewide AYP Proficient and Advanced Achievement

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	248	42.27	23.68	1044	0.001*
Without 1:1 Technology	798	48.45	18.85		

* $p < 0.05$

Table 10
4th Grade Mathematics Statewide Achievement Level Advanced

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	248	16.17	14.54	1044	0.016*
Without 1:1 Technology	798	18.51	13.61		

* $p < 0.05$

Table 11
4th Grade Mathematics Statewide Achievement Level Proficient

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	248	26.11	12.50	1044	0.001*
Without 1:1 Technology	798	29.94	9.62		

* $p < 0.05$

Table 12
4th Grade Mathematics Statewide Achievement Level Below Basic

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	248	24.45	19.75	1044	0.001*
Without 1:1 Technology	798	16.97	12.64		

* $p < 0.05$

In regard to school size, 4th grade student performance in mathematics in small schools with access to 1:1 technology ($N = 55$) level Advanced ($M = 16.47$, $SD = 15.87$) scored numerically higher, but did not differ significantly to schools without access to 1:1 technology ($N = 123$) level Advanced ($M = 14.62$, $SD = 14.37$), $t(176) = 0.77$ $p = \text{n.s.}$ Small schools with access to 1:1 technology ($N = 55$) level Proficient ($M = 30.29$, $SD = 13.65$) scored numerically lower, but did not differ significantly to schools without access

to 1:1 technology ($N = 123$) level Proficient ($M = 30.69$, $SD = 13.86$), $t(176) = 0.18$, $p =$ n.s. Small schools with access to 1:1 technology ($N = 55$) level Basic ($M = 32.03$, $SD = 12.12$) performed numerically better and differed significantly to schools without access to 1:1 technology ($N = 123$) level Basic ($M = 36.81$, $SD = 14.88$), $t(176) = 2.10$, $p = .046$ as shown in Table 13 below. When examining 4th grade student performance, the small schools with access to 1:1 technology ($N = 55$) level Below Basic ($M = 21.22$, $SD = 20.60$) was numerically below and differed significantly to schools without access to 1:1 technology ($N = 123$) level Below Basic ($M = 17.88$, $SD = 16.83$), $t(176) = 1.14$, $p = .010$ as shown in Table 14 below.

Table 13

4th Grade Mathematics Small Schools Achievement Level Basic

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	55	32.03	12.12	176	0.046*
Without 1:1 Technology	123	36.81	14.88		

* $p < 0.05$

Table 14

4th Grade Mathematics Small Schools Achievement Level Below Basic

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	55	21.22	20.60	176	0.010*
Without 1:1 Technology	123	17.88	16.83		

* $p < 0.05$

Data for schools with more than 27 accountable students were also examined. When examining 4th grade student performance in mathematics, these large schools with

access to 1:1 technology ($N = 193$) level Advanced ($M = 16.09$, $SD = 14.18$) scored numerically lower and differed significantly to schools without access to 1:1 technology ($N = 675$) level Advanced ($M = 19.22$, $SD = 13.36$), $t(866) = 2.84$, $p = .043$ as shown in Table 15 below. Large schools with access to 1:1 technology ($N = 193$) level Proficient ($M = 24.91$, $SD = 11.92$) scored numerically lower and differed significantly to schools without access to 1:1 technology ($N = 675$) level Proficient ($M = 29.81$, $SD = 8.63$), $t(866) = 6.33$, $p = .001$ as shown in Table 16 below. Large schools with access to 1:1 technology ($N = 193$) level Basic ($M = 33.63$, $SD = 10.66$) performed numerically better, but did not differ significantly to schools without access to 1:1 technology ($N = 675$) level Basic ($M = 34.18$, $SD = 10.68$), $t(866) = 0.63$, $p = \text{n.s.}$ When examining 4th grade student performance, the large schools with access to 1:1 technology ($N = 193$) level Below Basic ($M = 25.37$, $SD = 19.46$) was numerically greater and significantly different to schools without access to 1:1 technology ($N = 675$) level Below Basic ($M = 16.80$, $SD = 11.72$), $t(866) = 7.60$, $p = .001$ as shown in Table 17 below.

Table 15
4th Grade Mathematics Large Schools Achievement Level Advanced

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	193	16.09	14.18	866	0.043*
Without 1:1 Technology	675	19.22	13.36		

* $p < 0.05$

Table 16
4th Grade Mathematics Large Schools Achievement Level Proficient

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	193	24.91	11.92	866	0.001*
Without 1:1 Technology	675	29.81	8.63		

* $p < 0.05$

Table 17
4th Grade Mathematics Large Schools Achievement Level Below Basic

Group	Number of Schools	Mean	Standard Deviation	df	Significance
With 1:1 Technology	193	25.37	19.46	866	0.001*
Without 1:1 Technology	675	16.80	11.72		

* $p < 0.05$

Summary

Demographic information from all 1046 schools with Missouri Assessment Program data reported by the Department of Elementary and Secondary Education was collected to determine if 4th grade students had access to 1:1 technology throughout the school day. Student achievement levels were accessed from DESE and categorized accordingly. Statistical analysis was performed using the SPSS platform. Descriptive statistics identifying the number of schools, average scores and standard deviations were reported. Inferential statistics to determine significance were also utilized through the use of an independent samples *t*-test.

Overall achievement in the areas of communication arts and mathematics were examined as reported by the top two achievement levels of Advanced and Proficient by the state for Adequate Yearly Progress. Further analysis of all four achievement levels

provided a closer examination of overall student performance in communication arts and mathematics as seen below in Table 18 and Table 19 respectively. Additionally, analysis of achievement levels for schools with 27 or fewer students, as well as those schools with more than 27 students, was provided to offer a more complete picture of student performance.

Table 18
Overall 4th Grade Student Achievement Levels for Communication Arts

Achievement Level	With 1:1 Technology	Without 1:1 Technology	Statistical Significance
Advanced	27.40%	31.96%	Yes
Proficient	23.59%	26.28%	No
Basic	20.42%	20.09%	No
Below Basic	28.59%	21.69%	Yes

Table 19
Overall 4th Grade Student Achievement Levels for Mathematics

Achievement Level	With 1:1 Technology	Without 1:1 Technology	Statistical Significance
Advanced	16.17%	18.51%	Yes
Proficient	26.11%	29.94%	Yes
Basic	33.27%	34.58%	No
Below Basic	24.45%	16.97%	Yes

Chapter V

Conclusions and Recommendations

Introduction

The use of technology in the classroom and 1:1 technology initiatives continue to gain momentum as tools for student learning. The drive to develop 21st Century learners, in conjunction with the push for online assessments as a part of the Smarter Balanced Assessment Consortium (SBAC) and the Partnership for Assessment of Readiness for College and Careers (PARCC) tied to The Race to the Top federal initiative, compel school districts to continue to pour funding into technology. While student motivation, collaboration skills, and critical thinking skills are often reported as benefits to students' access to technology, the impact of these computing initiatives on student achievement has been inconclusive. The purpose of this study was to determine the impact of 1:1 technology initiatives on student achievement as measured by Missouri's online statewide achievement test at the 4th grade level in communication arts and mathematics.

Summary of Methods

Upon receiving RRB approval in May of 2015 for this study, statewide achievement data for communication arts and mathematics for the 2015 Missouri Assessment Program test for all 4th grade settings was retrieved from the Missouri Department of Education. An electronic demographic questionnaire to identify if students had access to 1:1 technology throughout the school day was sent to each school administrator through the QuestionPro survey platform. One to one technology was defined as an Internet connected device that students had direct access to throughout the school day. For the purpose of this study, 1:1 devices were provided to the students by

the school district and were not limited by manufacturer, software, or type of device. Follow-up emails were sent to schools with incomplete questionnaires. Finally, telephone calls were made to individual schools with incomplete data to determine if their students had access to 1:1 technology. All 1,046 schools with reported MAP data were contacted and identified as schools with 1:1 technology or schools without 1:1 technology. Upon identifying schools with student access to 1:1 technology and consolidating this information with the state achievement level report, the data was uploaded into the SPSS program for analysis.

Summary of Findings

Analysis of the data associated a statistically significant difference in overall student achievement in the areas of communication arts and mathematics with students in schools with access to 1:1 technology performing below their peers in schools without access to 1:1 technology. Upon closer examination of the data by each achievement level, this pattern of significance continued in communication arts in the Advanced and Below Basic levels, and in the Advanced, Proficient and Below Basic levels for mathematics.

Upon a closer examination on the impact of 1:1 technology on student achievement according to school size, small schools with 27 or fewer students and 1:1 technology performed lower and significantly different from their peers in the Below Basic category of communication arts, as shown in Table 5, and the Below Basic category of mathematics, as shown in Table 14. However, the identified 1:1 small schools performed higher and significantly different from their peers in the Advanced category of communication arts, as shown in Table 4, and in the Basic category for mathematics, as shown in Table 13. In regard to larger schools with more than 27 students, 1:1 schools

performed lower and significantly different in the Advanced, Proficient and Below Basic categories for communication arts, as shown in Table 6, Table 7, and Table 8 respectively, and in the Advanced, Proficient and Below Basic categories of mathematics, as shown in Table 15, Table 16, and Table 17 respectively.

Overall, the findings of this study revealed a difference in the performance of students with access to 1:1 technology and those students without access on Missouri's computerized standardized state assessment. Interestingly, students without 1:1 access to technology generally outperformed their peers with access to 1:1 technology. Notably, a statistically significant difference in performance was found on the opposite ends of the achievement levels with a smaller percentage of students scoring in the Advanced category and a greater percentage of students scoring in the Below Basic category in communication arts and mathematics. This pattern continued across schools with multiple sections per grade levels. Markedly, a statistically significant greater percentage of students with 1:1 technology were found in the Below Basic category in both content areas across all groups in the study. This finding is relevant and noteworthy as schools strive each year to minimize the number of students performing in the Below Basic category.

While the findings of this study revealed students without 1:1 technology generally outperformed their peers with access to 1:1 technology, a statistically significant positive impact on student achievement was found in communication arts among small schools with 1:1 technology initiatives in which a greater percentage of students performed at the Proficient level. Additionally, a statistically significant smaller percentage of students with access to 1:1 technology performed at the Basic level in

mathematics as compared to students in small schools without 1:1 technology. While positive levels of achievement for students with 1:1 technology were identified in these two subgroups, it is unclear if this performance resulted in a positive impact on the small school's Adequate Yearly Progress considering a statistically significant greater percentage of students scored in the Below Basic category in communication arts and mathematics.

Conclusions

The null hypothesis that there is no statistically significant impact on 4th grade students with 1:1 technology access and their achievement in communication arts and mathematics on Missouri's computerized state assessment is rejected. Analysis of the data identifies a difference in overall student achievement in communication arts and mathematics as students with 1:1 technology performed lower and differed significantly from their peers across the state who did not have access to 1:1 technology throughout the school day. The presented data supports that access to 1:1 technology had a negative impact on student achievement, however, these findings do not identify why students without 1:1 technology access outperformed their peers across the state.

As Missouri and other states transition to a computerized assessment platform, a logical supposition might be that students with 1:1 technology would have an advantage over their peers without ubiquitous access to technology. Student and teacher familiarity with the device from daily use as well as exposure to computerized instructional activities and assessments might prove beneficial in regard to the operational administration of the online state test (SBAC, 2014). Furthermore, technology is often viewed as a resource to level the learning playing field for students from smaller schools by providing greater

access to online resources and previously unavailable learning opportunities. Conversely, larger schools often bill technology as a means to individualize and customize instructional opportunities to ensure that students do not get lost in the learning process. While each of these notions may have merit, the findings of this study did not support a statistically significant positive impact on student achievement, but counter intuitively revealed a statistically significant negative impact on 4th grade student achievement in communication arts and mathematics for students with access to 1:1 technology as compared to students without 1:1 technology.

While a difference in student achievement did exist between Missouri schools with access to 1:1 technology and those without, overall, 4th grade Missouri students performed well on the new Smarter Balanced computerized assessment. Tran and Thomas (2015), examined assessment data by state from the inaugural online SBAC test administration. Although 17 states administered the test, only 10 states chose to release their achievement data for comparison. Of the reported states, 4th grade Missouri students ranked first in English Language Arts with 58 percent student proficiency and second in mathematics with 49 percent student proficiency. While Missouri students fared well in this comparison, Tran and Thomas caution against drawing conclusions from these results without a more complete dataset.

The information from this study may be valuable as many districts and superintendents eagerly pursue 1:1 technology initiatives in an effort to improve student achievement on the state's new online assessment platform. The timeliness of these findings is relevant for informing this decision making process as the first year the online assessment was completed within the successive school year. During the course of this

study, most schools commented about their need to increase their students' access to technology with the ensuing new computerized state assessment. While these occurrences were not recorded, many schools commented they would be expanding to 1:1 technology initiatives within the coming school years. Additionally, the scope and scale of this study encompassing the entire state, may offer valuable insights as educators seek to make sound decisions about their reasons for pursuing large-scale technology initiatives. Individual devices may be necessary for state assessments, but access to individual devices may not ensure improved student achievement on the state's assessment. These findings add to the ongoing debate (Cuban, 2001; Larkin & Finger, 2011; O'Dwyer et al., 2008; Rizzo, 2013) over the substantial expense for 1:1 initiatives and the return on investment in terms of student achievement outcomes.

Recommendations

While the overall data from the state demonstrates that 4th grade students with access to 1:1 technology performed lower on Missouri's state achievement test, the disaggregated data report also identified schools who had 90 percent or more of their students performing in the Advanced or Proficient levels on the MAP test. A closer examination of the pedagogy and instructional practices of these schools with 1:1 student technology could provide greater input on effectively utilizing computing devices as a learning tool. Additionally, a further study examining the practices of both schools with and without access to 1:1 technology scoring greater than 90 percent on the MAP test could identify the instructional practices aiding student achievement on the new web-based assessment platform. Nevertheless, school districts should remain focused on best

practices for student learning while placing the emphasis on the computerized test modality as a secondary concern.

As districts consider 1:1 technology initiatives, careful attention to the desired outcomes for student learning and the use of the technology is warranted. Technology has become an invaluable tool that continues to redefine our world shaping the work and social landscape of our society. Employers desire computer-competent citizens, and educational settings strive to adapt to digital learners (ISTE, 2012; NETP 2010; Rosen & Beck-Hill, 2012). However, the findings from this study should reinforce the need for school districts and educators to focus on pedagogy over technology to leverage student learning as supported by Hayes-Jacobs and Wilmarth (2010), Lowther et al. (2008), and Rosen and Beck-Hill (2012). Technology may be an ever-increasingly available tool, but sound instructional strategies are paramount to harness this tool to support student learning and achievement. Much discussion is given to developing 21st Century Skills and next generation learners. Districts must direct their efforts on equipping learners with the skills and capabilities to handle this changing world instead of focusing their resources on the specifications and capacity of the equipment in the learners' hands.

Summary

While this study identified a difference of lower overall achievement for students with access to 1:1 technology versus those without, the expansion of 1:1 technology initiatives as prescribed by the NETP (2010) and the ever-increasing amount of funding spent on educational technology (Sell et al., 2012), it is naïve to conclude that technology will do anything but continue to permeate schools. Technology has become infused in virtually every aspect of our daily lives. In spite of the rampant expansion and

advancement of technology, schools and the education profession continue to lag behind in their efforts to effectively harness this tool for student learning. As technology advances, so must our instructional best practices to ensure teaching and technology work together to support student learning.

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