The Impact of Assessment Delivery Method on Student Achievement in Language Arts

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Submitted to the Graduate Department and Faculty
of the School of Education of Baker University in
partial fulfillment of the requirements for the degree

Doctor of Education
In
Educational Leadership

September 2014

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Abstract

The purpose of this study was to determine to what extent there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a paper/pencil or a computer-based delivery method. The researcher also examined to what extent the difference in student achievement was affected by gender, minority status, and socioeconomic status. A quantitative research design was used in this study.

The population of interest was upper elementary students in the state of Missouri. The sample for the study included approximately 650 fifth and sixth grade students from Mill Creek Upper Elementary during the 2011-2012 school year. At the time of this study, Mill Creek Upper Elementary was a school in the Belton School District located south of Kansas City, Missouri. The dependent variable was the students' Language Arts score from the Acuity Language Arts Diagnostic assessment. Four independent grouping variables included the assessment delivery method (paper/pencil or computer-based) as well as the demographics of gender (male/female), minority status (minority/non-minority) and socioeconomic status (low SES/non-low SES).

Findings revealed a statistically significant difference did exist between the sixth grade males and sixth grade females when taking the computer-based assessment. The mean achievement score for the sixth grade males on the computer-based assessment was more than 10% lower than the mean achievement score for the sixth grade females. Although a statistically significant difference did exist between the sixth grade males and sixth grade females on the computer-based assessment, the same did not hold true for fifth grade male and fifth grade female study participants or for sixth grade male and

sixth grade female participants who took the paper/pencil assessment. Additionally, a relationship between assessment delivery method and minority and socioeconomic status was not statistically significant. This research supports the comparability of paper/pencil and computer-based assessments but encourages those analyzing achievement data to continue to disaggregate the data by the demographics of gender, minority, and socioeconomic status.

Acknowledgements

I wish to convey my deepest and most heartfelt appreciation to all of those who supported me on this doctoral journey.

To my parents, Marion and Brad Baker, who never placed limits on my educational aspirations. Your encouragement and support from a very young age instilled in me that I had the ability to accomplish any goal I set for myself. Furthermore, your constant modeling of hard work, dedication to faith and family, and service to others is what initially led me to teach.

To my advisor, Dr. Verneda Edwards, for your commitment to my completion of the Baker Ed D. program. You have such a supportive nature and encouraging spirit. Your swift feedback throughout this process was motivating.

My sincerest thanks to Ms. Peg Waterman and Dr. Susan Rogers. The time and effort you put into helping this work become a finished product is deeply appreciated. Peg, you helped me understand statistics as much as anyone could. I would also like to thank Dr. Rhonda Hardee for giving of her time to serve on my committee.

To Carrie Rolling for teaching me so much about the writing process and for the friendship we developed I am grateful. The way that you give selflessly of yourself to others makes this world a better place. I have learned so much from you.

To my son, Clayton, you have been my inspiration to complete the last leg of this doctoral journey. Because of your warm smile, your infectious giggles, and your many first-year milestones, Mommy worked harder to complete this document so I can spend more time with you. My prayer for you as you grow up is that you will value education

and come to realize your fullest potential. There are no limits to what you can achieve. Mommy loves you more than you will ever know.

Most importantly, to my husband and best friend, Craig, your unending love and support made all of this possible. You never doubted me for a minute, nor did you ever complain about picking up some extra chores around the house when I was busy writing. Your encouragement and compassion makes me want to be a better person. I love you.

Last, I give praise and thanks to God for blessing me with the aspiration and perseverance needed to attain this goal. It is through Him that all things are possible.

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Chapter One

Introduction

Since the 1980s, researchers have looked at the differences between the delivery of paper/pencil and computer-based testing. Bunderson, Inouye, and Olsen (1989) reviewed twenty-three studies comparing paper/pencil and computer-based testing. Of the twenty-three studies, three indicated that participants obtained higher scores when tested on a computer, nine showed higher results when participants were tested using paper/pencil, and eleven reported that there was no difference in achievement between the two test delivery methods. Additional studies have also indicated inconclusive results with regard to a preferred testing delivery method (Mazzeo & Harvey, 1988; Wise & Plake, 1989). However, these studies included mostly small samplings of college-age students. Kim and Huynh (2007) conducted an analysis of individual students' scale scores from Algebra and Biology end-of-course exams that were administered using either paper/pencil or a computer. Fifteen schools from five districts volunteered to participate in the study. Kim and Huynh (2007) found nothing to suggest a difference in student performance based on the two delivery methods. Because of these studies and their dissimilar results (across three decades) there continues to be a need for additional research to closely examine the impact gender, minority, and socioeconomic status have with regard to paper/pencil and computer-based testing among school-aged children.

A study of this nature, in relation to previous studies, is not a direct comparison because today's students are digital natives, whereas, in the 1980's, students were digital immigrants. Prensky (2001) defined digital natives as those who are "native speakers of the digital language" (p. 1). Prensky (2001) went on to explain that speaking the digital

language may include being proficient with computers, cell phones, video games, video cameras, digital music devices, and other devices that include digital components. Later, Prensky (2013) asserted that technology has moved from supporting brain activity to being integrated into and interdependent on brain activity. Prensky (2013) made it clear that the way today's technology natives think and learn is different from how learning took place for technology immigrants. This study explored the difference in assessment delivery methods using digital natives as the population.

While there have been significant changes to how learning occurs for those who were students (digital natives) at the time of this study, assessment in education has also undergone change. At the time of this study, schools had to meet the most rigorous academic standards ever placed upon them, while also meeting the needs of an increasingly diverse student population (Missouri Department of Elementary and Secondary Education, 2014). The objective of the No Child Left Behind Act of 2001 (NCLB) was for all students to be proficient in Language Arts and Mathematics by 2014 (No Child Left Behind, 2002). To meet this requirement, each state adopted a standardized test that determined how well students were progressing toward proficiency. Consequently, states focused on identifying a testing delivery method that would yield the highest achievement results (Wang, Jiao, Young, Brooks, & Olson, 2008). "The implementation of the NCLB Act has increased the stakes for testing. Education stakeholders have been exploring more efficient measurement tools in place of traditional paper-and-pencil tests (PPTs)" (Wang et al., 2008, p. 6).

As a component of the NCLB Act, Adequate Yearly Progress (AYP) benchmarks were identified by each state to measure academic progress. Additionally, they were

used to identify high-needs schools in each state and consequences were imposed when schools failed to meet incremental benchmarks (No Child Left Behind, 2002). Since schools not meeting their AYP targets were facing sanctions from the United States Department of Education, the need for students to do their best on assessments became an intense focus for stakeholders. This increased focus on standardized testing has required educators to take a closer look at the delivery method they use to assess students. The increased significance of the role technology started to play exacerbated the need to evaluate technology-based assessment delivery methods. "For the digital age, we need new curricula, new organization, new architecture, new teaching, new student assessments, new parental connections, new administration procedures, and many other elements," (Prensky, 2005, para. 28). Technology has shaped the way educators teach and assess students (Prensky, 2005).

Missouri's 2001 Senate Bill 319 [Missouri's Department of Elementary and Secondary Education (DESE) School Laws, 2008] legislation required fourth grade students who were in regular education and were English proficient to be retained if the students scored below a third grade reading level. Additionally, the Senate Bill 319 legislation required that schools provide reading tutoring and individualized reading plans for all fourth through sixth grade students who were more than one grade level behind in reading. This legislation also mandated that school districts utilize a uniform assessment for measuring the reading ability of students. Under the law, each school district had the flexibility to determine measures to use for assessing students' reading levels (Missouri's DESE School Laws, 2008). The No Child Left Behind Act of 2001 and Missouri's 2001 Senate Bill 319 legislation have ensured schools in Missouri would be held accountable

for underperforming students. The Senate Bill 319 legislation required student reading levels be no further behind than two academic years for all students regardless of demographics (Missouri's DESE School Laws, 2008).

According to Protheroe (2008), most underperforming schools consist of students from low socioeconomic status (low SES), and have increased numbers of minority students, and English Language Learners (ELL). Historically, some school stakeholders have suggested that certain demographic variables may imply more or less experience with technology for some subgroups when compared with others (Sutton, 1991). Since Sutton's (1991) work, computer usage proved to be related to socioeconomic status (Quick & Gallagher, 2004). As more schools have turned to technology to assess the learning of students and have been required to report assessment results for identified subgroups of students, educators and administrators should know the effect computerized assessment delivery methods have on those subgroups' scores.

Background

The Belton School District #124 is a public school district that educates students from the city of Belton, Missouri, a suburb of Kansas City, Missouri. During the 2011-2012 school year, Belton had an approximate enrollment of 5100 in grades kindergarten through twelve (Belton School District, 2012). At the time of this study, five elementary schools housed kindergarten through fourth grade students. Mill Creek Upper Elementary housed all fifth and sixth grade students within the school district (Belton School District, 2012). When students entered Mill Creek Upper Elementary at the beginning of the 2011-2012 school year, it was the first time their entire grade level, district wide, was housed in one location. After Mill Creek Upper Elementary, students

moved to Yeokum Middle School where they spent their seventh and eighth grade years (Belton School District, 2012). From there, students advanced to the Freshmen Center. Finally, students made their last transition to the Belton High School where tenth, eleventh, and twelfth graders reside (Belton School District, 2012). At the time of this study, the Belton School District was unique to Missouri in that their students transitioned through five buildings while completing their K-12 education experience.

More specific district demographic data, as well as each school's individual building demographics, are presented in the tables below. The data was provided by the Belton School District, rather than the Missouri Department of Elementary and Secondary Education (DESE). Using information from the school district was more current than what was available from DESE.

The demographic data from the Belton School District found in Table 1 focuses on gender by school. Data related to gender was gathered from parents and/or guardians during the open enrollment process through the Belton School District (2012). Mill Creek Upper Elementary had approximately 10% more males than females in attendance at the time of this study. The gender makeup of the schools was relatively similar with the exception of the Freshmen Center and Scott Elementary, each of which had a higher percentage of females.

Table 1

Gender Data for the Belton School District 2011-2012

Schools	Total Enrollment	Male	Female
Cambridge Elementary	336	53.7%	46.3%
Gladden Elementary	370	50.7%	49.3%
Hillcrest Elementary	328	54.6%	45.4%
Kentucky Trail Elementary	530	52.3%	47.7%
Scott Elementary	366	44.9%	55.1%
Mill Creek Upper Elementary	720	54.4%	45.6%
Yeokum Middle School	708	52.7%	47.3%
Freshmen Center	344	48.4%	51.6%
Belton High School	963	50.0%	50.0%
All Schools	5,065	51.7%	48.3%

Note: Adapted from "Student Enrollment Summary Report," by the Belton School District, 2012, February 27. Retrieved from http://ic.bsd124.org/campus/main.xsl.

Table 2 contains the total enrollment at each school in the Belton School District. During the 2011-2012 school year, Mill Creek Upper Elementary served approximately 720 students (Belton School District, 2012). The demographic makeup of Mill Creek students closely mirrored the demographic makeup of the district. Table 2 also contains demographic data related to minority status that was gathered from parents and/or guardians during the open enrollment process through the Belton School District. When parents and/or guardians enrolled their child/children in the Belton School District for the

2011-2012 school year, they identified them as being American Indian, Asian/Pacific Islander, Black, Hispanic/Latino, Multi-Racial, White, or Other. The researcher categorized those identified as American Indian, Asian/Pacific Islander, Black, Hispanic/Latino, Multi-Racial, or Other as minority and those identified as White as non-minority.

Table 2

Minority Status Data for the Belton School District 2011-2012

Schools	Total Enrollment	Non-Minority	Minority
Cambridge Elementary	336	73.5%	26.5%
Gladden Elementary	370	74.6%	25.4%
Hillcrest Elementary	328	64.0%	36.0%
Kentucky Trail Elementary	530	78.7%	21.3%
Scott Elementary	366	79.2%	20.8%
Mill Creek Upper Elementary	720	77.8%	22.2%
Yeokum Middle School	708	74.9%	25.1%
Freshmen Center	344	75.9%	24.1%
Belton High School	963	75.6%	24.4%
All Schools	5,065	75.1%	24.9%

Note: Adapted from "Student Enrollment Summary Report," by the Belton School District, 2012, February 27. Retrieved from http://ic.bsd124.org/campus/main.xsl.

Demographic data from the Belton School District related to socioeconomic status is housed in Table 3. Data related to socioeconomic status was gathered through the

Belton School District's Student Enrollment Summary Report (Belton School District, 2012). For the purpose of this study, students who received free or reduced meal prices were categorized as being low socioeconomic status. It is important to note, with the exception of Belton High School, all buildings in the Belton School District had a free and reduced lunch population that exceeded 50%. Mill Creek Upper Elementary School had a low socioeconomic status population of 53.5% at the time data was collected for this study. The distribution was rather similar for all schools with the exception of Belton High School, Hillcrest Elementary, and Scott Elementary.

Table 3

Socioeconomic Status (SES) Data for the Belton School District 2011-2012

Schools	Total Enrollment	Low SES	Non-low SES
Cambridge Elementary	336	53.5%	46.5%
Gladden Elementary	370	53.8%	46.2%
Hillcrest Elementary	328	64.0%	36.0%
Kentucky Trail Elementary	530	50.4%	49.6%
Scott Elementary	366	65.0%	35.0%
Mill Creek Upper Elementary	720	53.5%	46.5%
Yeokum Middle School	708	51.1%	48.9%
Freshmen Center	344	55.0%	45.0%
Belton High School	963	41.3%	58.7%
All Schools	5,065	52.5%	47.5%

Note: Adapted from "Student Enrollment Summary Report," by the Belton School District, 2012, February 27. Retrieved from http://ic.bsd124.org/campus/main.xsl.

In an effort to meet the academic needs of a racially and socioeconomically diverse school district, the Belton School District began administering the Acuity

Predictive assessments during the 2010-2011 school year (Belton School District, 2012). These formative assessments were intended to provide a prediction of each student's performance on the state assessment and were administered to all students' grades three through eight. During the 2011-2012 school year, the Belton School District continued administration of the Acuity Language Arts Predictive assessments (administered in January, 2012) and, additionally, the Acuity Language Arts Diagnostic assessments (administered in May, 2012) (R. Poisal, personal communication, August 6, 2011).

Statement of the Problem

As required by No Child Left Behind (NCLB), in addition to reporting overall student performance, states had to report assessment results for identified subgroups of students. When NCLB expired at the end of the 2013-2014 school year, each state continued to have its own accreditation model (DESE, 2013). Missouri required subgroup reporting; the Missouri School Improvement Program's fifth cycle (MSIP 5) required Missouri school districts to report assessment results for a super subgroup composed of the following subgroups: Asian/Pacific Islander, Black, Hispanic, American Indian, White, Multi-Racial, Free or Reduced Lunch, Individualized Education Plan, and Limited English Proficiency (DESE, 2013). While overall achievement gains were important, it was also critical for schools to show improvement among subgroup achievement.

During the 2002-2003 school year, thirteen states were among the first to administer computer-based state assessments after the NCLB Act was put into effect. Two additional states joined one year later (Olson, 2003). As of 2012, the delivery method by which students were assessed was left up to individual states (DESE, 2013).

Research has been conducted to identify whether differences exist in student performance between students taking paper/pencil or computer-based assessments (Baumer, Roded, & Gafni, 2009; Bhoola-Patel & Laher, 2011; Bugbee, 1996; Pomplun, Ritchie, & Custer 2006; Wang et al., 2008). However, little research has been conducted to determine how subgroups respond to the different testing delivery methods. In a synthesis of more than 80 studies comparing paper/pencil and computer-based assessments Kingston (2009) concluded the majority of studies did not focus on varying subgroups of students and their comparability. Kim and Huynh (2010) found similar performance between students assessed using paper/pencil and computer-based assessments. Additionally, Kim and Huynh (2010) noted the following:

> Many of the previous studies concerning statewide computer-based assessments focused mainly on the performance of the student body as a whole, not on the performance of student subgroups. Only a few studies have directly investigated the mode effect for subgroups of students in the K-12 large-scale assessment. (p. 109)

NCLB heightened the importance of assessment results and forced educators to focus on testing practices to comply with new requirements (Wang et al., 2008). Language Arts was the most highly tested content area, albeit not the only tested area, according to Stenner (1996). With the emphasis on Language Arts subgroup achievement and the increase in states using computer-based testing, it has become imperative that the differences related to gender, minority, and socioeconomic status be further investigated with regard to Language Arts assessment practices.

Purpose of Study

The purpose of this study was to determine whether there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a paper/pencil or a computer-based delivery method. The researcher also examined whether the difference in student achievement was affected by gender, minority, and socioeconomic status. Participants were of upper elementary age (fifth or sixth grade) at the time of the study.

Significance of Study

During the 1980s, researchers began to look at the differences between paper/pencil and computer-based testing (Mazzeo & Harvey, 1988; Wise & Plake, 1989). In the 1990s, Bugbee (1996) continued to examine the differences between the testing delivery methods. Clariana and Wallace (2002) further investigated testing delivery methods in the 2000s. The research has shown varied outcomes with Bugbee (1996) finding little difference between students tested using different delivery methods and Clariana and Wallace (2002) noting increased achievement on computer-based assessments. The current study contributed to the scholarly body of literature and educational profession by identifying the differences in achievement when students were tested using paper/pencil compared with when they were tested on a computer-based delivery method; furthermore, the study disaggregated the results by looking at the subgroup data of gender, minority, and socioeconomic status.

Multiple studies have examined the effects of technology on Language Arts instruction, and some have also assessed the impact of technology on Language Arts assessments (Bauer, 2005; Gordon, 2011; Millsap, 2000). Fewer studies have examined

the effect of the delivery method (paper/pencil or computer-based) on the relationship between the gender, minority, and socioeconomic status of students and their Language Arts assessment results (Flowers, Do-Hong, Lewis, & Davis, 2011; Kim & Huynh, 2009). The results of this study could aid policy makers, educational leaders, and classroom teachers as they make decisions with regard to holding schools accountable using standardized testing. This research may encourage decision makers, when selecting assessment delivery methods, to consider the advantages or disadvantages a particular gender, minority, or socioeconomic group may experience.

Delimitations

"Delimitations are self-imposed boundaries set by the researcher on the purpose and scope of the study" (Lunenburg & Irby, 2008, p. 134). The researcher used the following delimitations to limit the scope of the current study:

a) All participants were students enrolled during the 2011-2012 school year.
b) All participants were students who attended one public school district located in Belton, Missouri.
c) Only scores in the content area of Language Arts were compared.

Assumptions

Assumptions are the proposals that are considered operational during a research study (Lunenburg & Irby, 2008). This study was conducted based on the following assumptions:

a) Fifth and sixth grade students who participated in this study were comparable with other students of the same age.

b) The Acuity Language Arts Diagnostic assessment and the Acuity Predictive C Language Arts assessment are accurate measures of study participants' Language Arts ability.

c) Assessment proctors implemented the Acuity Diagnostic assessment with fidelity.

d) The reading abilities of Groups A and Groups B students were equal due to the utilization of systematic selection and Language Arts achievement used when forming groups.

e) Paper/pencil Acuity Diagnostic assessments were accurately scored and entered into archival records using a manual system.

f) Computer-based Acuity Diagnostic assessments were accurately scored using an automated system that transferred the data into archival records.

g) Students who participated in the study answered assessment questions to the best of their cognitive ability.

h) Students' familiarity with computers and access to computers in the school setting was equal before this study.

i) Teachers providing instruction to those participating in the study followed district-required curriculum and pacing guides.

Research Questions

Research questions give the study direction and contain the essence of the study for those who review them (Lunenburg & Irby, 2008). The following research questions guided this study:

RQ1. To what extent is there a statistically significant difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method?

RQ2. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by gender?

RQ3. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by minority status?

RQ4. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by socioeconomic status?

RQ5. To what extent is there a statistically significant difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method?

RQ6. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth

grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by gender?

RQ7. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by minority status?

RQ8. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by socioeconomic status?

Definition of Terms

This section of the study identified and defined key terms that were used throughout the study.

Acuity Language Arts Diagnostic Assessment©. This is an assessment created by CTB/McGraw-Hill designed to align with local curriculum and state Grade Level Expectations. The assessment could be administered using a paper/pencil delivery method or on a computer. Student data was provided to teachers immediately following students completing a given assessment. This assessment provided a comprehensive view of assessed students' strengths and weaknesses related to Grade Level Expectations in fiction, nonfiction, and poetry. The assessment also reports findings in comprehension, text features, vocabulary, grammar usage, and punctuation/capitalization. The Language Arts benchmark assessments were developed for grades two through twelve (CTB/McGraw-Hill, 2011a).

Acuity Predictive C Language Arts assessment©. This is the third assessment in the predictive series created by CTB/McGraw-Hill designed to predict students' performance on the Missouri Assessment Program using test questions that were in alignment with Grade Level Expectations. Acuity Predictive C Language Arts assessment was designed to fully measure the tested grade levels content and standards. Predictive assessments were designed to be used with students in grades three through eight (CTB/McGraw-Hill, 2011a).

Computer based delivery method. A computer-based delivery method is defined as an assessment administered to students using a computer or over the Internet. Students read the assessment on a computer and answered a given set of questions at the desired performance level using a computer keyboard and a mouse (Choi & Tinkler, 2002).

Ethnic groups. For the purpose of this study, a minority was someone who was African American, Hispanic/Latino, or from another ethnic group that was not classified as White. African Americans were defined as "A person having origins in any of the Black racial groups in Africa" (Rastogi, Johnson, Hoeffel, & Drewery, 2011, p. 2). Hispanic/Latinos were defined as "A person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race" (Ennis, Rios-Vargas, & Albert, 2011, p. 2). The term Hispanic was most common in the eastern part of the United States, while the term Latino was most common in the western portion of the United States (U.S. Office of Management and Budget, 1997). For the purpose of this study, a non-minority was, defined as,

> ‘White’ refers to a person having origins in any of the original peoples of Europe, the Middle East, or North Africa. The White racial category included people who marked the “White” checkbox on the 2010 United States Census. It also included respondents who reported entries on the 2010 United States Census such as Caucasian or White; European entries, such as Irish, German, and Polish; Middle Eastern entries, such as Arab, Lebanese, and Palestinian; and North African entries, such as Algerian, Moroccan, and Egyptian. (Hixson, Hepler, & Kim, 2011, p. 2)

Language Arts. In the state of Missouri the Department of Elementary and Secondary Education have define Language Arts as:

> speaking and writing standard English (including grammar, usage, punctuation, spelling, capitalization); reading and evaluating fiction, poetry and drama; reading and evaluating nonfiction works and material (such as biographies, newspapers, technical manuals); writing formally (such as reports, narratives, essays) and informally (such as outlines, notes); comprehending and evaluating the content and artistic aspects of oral and visual presentations (such as story-telling, debates, lectures, multi-media productions); participating in formal and informal presentations and discussions of issues and ideas; identifying and evaluating relationships between language and culture. (DESE, 1996, para. 4)

Paper/pencil delivery method. A paper/pencil delivery method is defined as an assessment administered to students using paper and a pencil. Students read the assessment on paper and answered a given set of questions at the desired performance level using paper and a pencil (CTB/McGraw-Hill, 2011a).

Socioeconomic status. For the purpose of this study, Low Socioeconomic Status (Low SES) were students identified when they qualified for and participated in the free and reduced meal program (see Appendix A). Non-Low Socioeconomic Status (Non-Low SES) students were identified when they did not qualify for or participate in the free and reduced meal program. The Missouri Department of Elementary and Secondary Education set the standards for the Free and Reduced Meal Program (DESE, 2011).

Subgroup. A group of students with more than thirty members sharing the same gender, minority status (African American, Hispanic/Latino, White), or socioeconomic status as categorized by free or reduced meal benefits (Missouri Department of Elementary and Secondary Education, 2004).

Overview of Methods

A quantitative research design was used to identify the extent of the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, of 5th and 6th grade students using a paper/pencil delivery method or computer-based delivery method. In addition, the researcher also examined the effect of gender, minority, and socioeconomic status on the difference in academic achievement in Language Arts as measured by the Acuity Language Arts Diagnostic assessments. Purposive sampling was used to narrow data collection to fifth and sixth grade students enrolled at Mill Creek Upper Elementary School in the Belton School District. The Belton School District collected the Acuity Language Arts Predictive C assessment data in January 2012, and the researcher gathered the Acuity Language Arts Diagnostic assessment data in May 2012. The data was then compiled onto one spreadsheet. The eight research questions concerning the assessment delivery method

were analyzed to determine if a difference existed between assessment delivery methods as well as between participants from different gender, minority, and/or socioeconomic groups.

Organization of the Study

This study is presented in five chapters. Chapter one introduced the study and addressed the background of the study, statement of the problem, purpose, significance, delimitations, assumptions, research questions, definition of terms, and overview of methods. Chapter two contains a review of the literature related to current assessment practices. Additionally, the chapter is divided into four sections: the historical perspective of assessments, computer-based testing and implications for schools, the impact of computer-based testing for students, and the demographics of gender, minority, and socioeconomic status and their impact on testing. Chapter three describes the methodology used in this study and includes a description of the research design; population and sample; sampling procedures; instrumentation: measurement, validity, and reliability; data collection procedures; data analysis and hypotheses testing; and limitations of the study. Chapter four presents the results of the analysis of the data, including the descriptive statistics and hypothesis testing. To close, chapter five provides a study summary that includes an overview of the problem, purpose statement and research questions, and review of methodology. The chapter ends with the findings related to the literature and conclusions, which include implications for action, recommendations for future research, and concluding remarks.

Chapter Two

Review of Literature

Student performance on state-required assessments has played a vital role in education. In 2002, as a component of No Child Left Behind (NCLB), states had to report assessment results for identified subgroups of students in addition to overall student performance. Furthermore, the performance of subgroups has been a variable for school and district accreditation. When NCLB expired at the end of the 2013-2014 school year, each state continued to have its own accreditation model. In Missouri, that model included data from the performance of student subgroups (DESE, 2013).

Considering the national focus on student performance, the impact of assessment delivery method on student performance has been of interest to the research community. Research has been conducted from the 1980s (Bugbee, 1996; Mazzeo & Harvey, 1988; Wise & Plake, 1989) through the 2000s (Clariana & Wallace, 2002) exploring the differences between paper/pencil and computer-based testing. This research has shown varied outcomes with Bugbee (1996) finding little difference between testing delivery methods and Clariana and Wallace (2002) noting increased achievement on computer-based assessments. This chapter provides the historical perspective of assessments, computer-based testing and implications for schools, advantages and disadvantages of computer-based testing for students, and the influence of demographics.

Historical Perspective on Assessments

For more than a century, assessments in schools have been a reality for teachers and students in the United States. According to Linn (2000), beginning in the early 1900s, the United States government initiated assessment practices in American schools.

Over time, popularity grew for administering standardized testing, such as the Intelligence Quotient (IQ), in public schools (Linn, 2000). The rationale behind assessing students was to determine the innate ability of students and to predict their future performance (Public Broadcasting Service, 2001). Early assessments centered more on students' current proficiencies rather than assessing student learning over time. In the 1920s the Scholastic Aptitude Test was developed to help determine which students had the ability to attend higher education. At the time of this study proficiency based test scores, like the ACT and Scholastic Aptitude Test, continue to be used to determine one's ability to attend higher education, but they were also used to determine whether students had mastered specific academic concepts. However, some educational stakeholders were in opposition to this practice asserting gender, minority status, and socioeconomic test bias (Linn, 2000; Walsh, 2003).

In the 1920s, the business side of educational assessment focused on publishing and distributing paper/pencil testing materials that were graded by human scorers (Walsh, 2003). Historically, the Stanford Achievement Test, the Iowa Test of Basic Skills (ITBS), and the California Achievement Test (CAT) dominated the publishing markets because developing new, valid, and reliable assessments would have been cost prohibitive (Walsh, 2003).

Until the 1950s, technology played a minimal role in educational assessment. Beginning in the 1950s, the development of scanners (devices capable of reading and scoring pencil marks on a page) allowed for the capability of grading marked answers. The same decade saw an increase in multiple-choice assessments (Parshall, Spray, Kalohn, & Davey, 2002). Users were impressed with the timeliness and accuracy with

which assessments were scored, and it was concluded that test takers perform better when completing multiple-choice questions than short answer (Parshall et al., 2002).

In the 1960s assessments became an instrument used for compensatory education and the government began evaluating federally funded programs (Linn, 2000). Linn (2002) ascertained, "The congressional demands for evaluation and accountability for the funds distributed under Title I of Elementary and Secondary Education Act [ESEA] as well as several other programs of that era proved to be a boon to test publishers" (p. 5). Thus, test makers were profiting from the rise in educational accountability.

The 1970s brought about minimum-competency testing. This form of assessment could be used with all students and focused on monitoring the lower range of achievement, or basic academic skills (Linn, 2000). By the end of the 1970s over half of the states were using a minimum-competency exam as a high school graduation requirement (Linn, 2000). Also taking place in the 1970s was the use of the IBM 1500, which was said to be the first computer specifically designed for an instructional and assessment purpose, rather than for general use (Kinzer, Sherwood, & Bransford, 1986). Nevertheless, narrow computer capabilities coupled with high costs of implementation reduced the ability of schools to use computer-based assessments in this era (Kim & Huynh, 2007).

Even though computer-based testing was introduced in the 1970s, it was not until the technology advancements of the 1980s and 1990s that there was an increase in the number of schools administering what was once a traditional paper/pencil assessment, through use of a computer. Some initial users of computer-based testing systems believed they could gather more information about testers than more traditional

paper/pencil methods because the efficiency of computer-based testing assessment more information in the same time frame (Wise & Plake, 1989). However, early integration of assessments and technology focused on logistical efficiencies such as swift scoring in a cost effective manner (Bennett, 2008; Bugbee & Bernt, 1990; Quellmalz & Pellegrino, 2009). Some of the first computer-based testing systems included Blackboard, QUIZIT, WebCT, ASSYST, and PILOT (AL-Smadi & Gütl, 2008). Each of these systems allowed testers to take and be scored on an assessment using a computer-based model (AL-Smadi & Gütl, 2008). The 2008 research conducted by AL-Smadi and Gütl showed that some standardized paper/pencil assessment instruments were converted into a computer-based delivery method using similar test questions and formatting.

Bleske-Rechek, Zeug, and Webb (2007) conducted an analysis on systematic assessment data from three psychology classes to determine which measures were more accurate: multiple-choice or short-answer. The study included approximately170 college-age students. In their study over exam and achievement data Bleske-Rechek, et al. (2007) drew a similar conclusion to Parshall, Spray, Kalohn, and Davey (2002). Through the research (Bleske-Rechek et al., 2007), it was determined that when professors used multiple-choice questions, compared to short-answer questions, the multiple-choice version produced a more accurate assessment measure, since the multiple-choice assessment was able to eliminate subjectivity from the scoring process.

In a study conducted by Bontis, Hardie, and Serenko (2009) that included 1551 participants, it was concluded that multiple-choice assessments were the most accurate measure of student achievement. The researchers used a quantitative analysis over various components of course grades for students who had completed a Business Policy

and Strategic Management class. According to Douglas, Wilson, and Ennis (2012), multiple-choice assessments decreased the level of assessment bias and increased the level of scoring accuracy since the completed multiple-choice assessment could be scored more objectively than other forms of assessments. For these reasons, multiple-choice assessments became increasingly popular.

The No Child Left Behind (NCLB) Act of 2001 (2002) altered the way in which schools, districts, and states utilized assessments and communicated their results. The prominence of school accountability led to an increased focus on the delivery method through which students were being assessed (Edwards, Chronister, Bushweller, Skinner, & Bowman, 2003). Even though there was a call for increased accountability from the federal and state governments, there was some flexibility as individual states were allowed to select their own assessment and delivery method.

At the national level, individual states were being supported financially in their efforts to make decisions surrounding the improvement of high quality assessment systems. Since the implementation of NCLB, funding for Title I grants going to high-poverty schools increased by 63% ("Fact Sheet," n.d.). Additionally, special education programs saw an increase of 67% in their funding since the inception of NCLB in 2001 ("Fact Sheet," n.d.). Furthermore, states were encouraged to develop high quality assessments that allowed for accurate measurement of student progress as well as the progress of teachers, administrators, schools, and districts. With school accountability being greater than ever, a continued emphasis on quality assessments, student performance, and score reporting were imperative (Whitaker, Williams, & Dodd, 2011).

Some school stakeholders had concerns about NCLB's effectiveness. Since the beginning of the Obama administration, attention had been given to the disparities that existed between the levels of rigor at which standards were being assessed among varying states (Sloan, 2010). In 2009, U.S. Secretary of Education, Arne Duncan asserted:

> We want to raise the bar dramatically in terms of higher standards. What we have had as a country, I'm convinced, is what we call a race to the bottom. We have 50 different standards, 50 different goal posts. And due to political pressure, those have been dumbed down. We want to fundamentally reverse that. We want common, career-ready internationally benchmarked standards. (as cited in Sloan, 2010, para. 2)

The spotlight on the varying levels of rigor between states on their individual state assessments led to the Recovery and Reinvestment Act of 2009, which focused on aligning the academic expectations and their measures in public education (United States Department of Education, 2013).

The Race to the Top Assessment Program, operating under the American Recovery and Reinvestment Act of 2009, authorized funding to assessment consortia in an attempt to create valid and reliable state assessments regarding what students understood and were able to produce (United States Department of Education, 2013). The objective was for standards to be in place that would ensure essential college and career readiness skills were being written, taught, and tested. The new assessments were significant, as the purpose was to acquire and utilize data that would improve teaching and learning (United States Department of Education, 2013). Furthermore, the

assessments would help the nation keep pulse on progress being made towards President Obama's goal of being a world leader of college graduates by 2020 (United States Department of Education, 2013).

The U.S. Department of Education (2010) distributed $330 million to two consortia (The Smarter Balanced Assessment Consortium and The Partnership for Assessment of Readiness for College and Careers) to develop assessments that aligned with the new Common Core State Standards. Several states chose to partner with both consortia (Fisher & Frey, 2013; Hwang, McMaken, Porter, & Yang, 2011). The Partnership for Assessment of Readiness for College and Careers (PARCC) received $176 million and represented over twenty-five states, while the Smarter Balanced Assessment Consortium (SBAC) was awarded $160 million and represented over thirty states (Fisher & Frey, 2013). The objective for the consortia was to design and implement new common state assessments beginning in third grade and continuing through high school. These are scheduled to be implemented during the 2014-2015 academic year (Fisher & Frey, 2013).

At the time of this study, both PARCC and SBAC plan to use computer-based assessments during the pilot study. The SBAC consortium will use adaptive computer-based assessments; students answer questions whose difficulty increase or decrease depending on correct and/or incorrect student responses. It was unclear whether or not PARCC would be adaptive (Aspen Institute, 2012; Fisher & Frey, 2013).

Assessment has been a constant component in education, regardless of the testing delivery method (Rowe, 2004; Serwata, 2003). With bountiful research surrounding the comparison of the two delivery methods, it was obvious that this was an important issue

in education and one that was likely to remain at the forefront of national, state, and local discussions. NCLB required that states, districts, and schools publicize their state assessment results. In addition, the U.S. Department of Education Office of Planning (2010) encouraged educators to utilize assessment information as they adjusted instruction and communicated with students and families.

The shifts from traditional paper/pencil tests to computer-based tests made some question the compatibility of assessment results. Kapes and Vansickle (1992) conducted a study with 61 undergraduate students who took two assessments, paper/pencil and computer-based, within a two-week testing window using the test-retest design. They discovered that the computer-based assessments were more reliable than the same exam in a paper/pencil format. It was concluded that numerous assessment companies had hastily entered into the transformation from paper/pencil to computer-based assessments without determining if student results would be compromised. This prompted a variety of research studies (Bugbee, 1996; Kim & Huynh, 2007; Neuman & Baydoun, 1998; Peak, 2005; Poggio, Glasnapp, Yang, & Poggio, 2005) centered on whether testing students using technology was equivalent to using a paper/pencil. Bugbee (1996) conducted an examination of existing research to determine the equivalency between paper/pencil and computer-based assessments. From this research it was determined that during the 1980s and 1990s paper/pencil and computer-based assessment scores were comparable. The ability of the two delivery methods (paper/pencil and computer-based) to measure student performance equally determined whether the two test methods could

be interchangeable (Neuman & Baydoun, 1998). Current literature (Kim & Huynh, 2007; Peak, 2005; Poggio, et al., 2005) supports Bugbee's historical findings that the two testing delivery methods were comparable.

Computer-Based Testing and Implications for Schools

In the late 1970s, the notion of personal computers became a reality for few U.S. residents. The impact computers have made on society over the last few decades is undeniable:

> Since the 1990s, the prevalence of computer use has grown exponentially. Computers have permeated our households, businesses, and schools, leading us to a point in time where many cannot remember or even imagine what life was like before they existed. (Fritts & Marszalek, 2010, p. 441)

Personal computers changed the way tasks were executed in many aspects of life and at an alarming rate.

Rabinowitz and Brandt (2001) pointed out the swiftness in which assessment technologies evolved. The ways in which computers and similar handheld technological devices have been used were a distant imagination only a generation ago (Rabinowitz & Brandt, 2001). When considering the infrastructure of technology, advances have been seen in speed, capacity, and computer availability. Rabinowitz and Brandt (2001) predicted that software such as database structures, simulations, and artificial intelligence models might someday become assessment tools with regard to administering, scoring, and reporting. Rabinowitz and Brandt (2001) also predicted advancements with computer-based assessments were on the horizon, and Lesage, Riopel, and Raîche (2010) confirmed their forecast. Lesage et al. (2010) also introduced a new assessment model

known as the cluster assessment. Cluster assessment allowed a person to be assessed regardless of their geographical location since these assessments were administered via an online system. Furthermore, it was capable of being formative or summative in nature. Lesage et al. (2010) asserted the cluster assessment enhanced computer-based assessments, artificial intelligence, and database management.

Researchers and experts in the field of education have weighed in on the pros and cons of computer-based assessments. With increased accountability from the federal government through the NCLB Act, and more recently through the Race to the Top education initiative, it was essential that educators understood the advantages and disadvantages of using a particular assessment delivery method. Both PARCC and SBAC planned to use adaptive computer-based assessments that included summative and interim assessments (Aspen Institute, 2012; Fisher & Frey, 2013). Interim assessments were defined as those that could be given between formative and summative assessments so that progress could be monitored frequently (Perie, Marion, Gong, & Wurtzel, 2007). Having a firm understanding of the advantages and disadvantages that exist between different delivery methods would allow educators to make informed decisions when selecting an assessment method to be used for high-stakes testing.

Computer-based delivery methods. Researchers have accepted that using a computer-based method of assessment was the most effective and efficient method available (Bugbee, 1996; Graham, Mogel, Brallier, & Palm, 2008). The growing use of technology stems from the affordability and timeliness of utilizing technology when assessing student learning (Bushweller, 2000; Trotter, 2002). Improvements in technology have stimulated the use of computer software as a delivery method for

educational testing (Pomplun, Ritchie, & Custer, 2006). However, there was still debate surrounding the delivery method that was most advantageous to increased student performance. During the early stage of familiarization with computer-based testing, states allowed schools to choose their preferred delivery method: paper/pencil or computer-based (Flowers et al., 2011). With two delivery methods being accessed, it was imperative that the comparability of scores be understood (Flowers et al., 2011).

Although research was not lacking with regard to the two delivery methods used for testing, consensus among the research had not yet been reached. There was still much room for debate when it came to the delivery method of testing that yielded the highest achievement results. Historically, Bugbee (1996) concluded from his work in the 1980s and early 1990s that little difference existed between the two delivery methods. However, in a study of 105 college students enrolled in a Computer Fundamentals course, Clariana and Wallace (2002) concluded students scored higher on computer-based assessments when compared to paper/pencil exams. For study participants in the paper/pencil group the mean score was 76%. Their counterparts in the computer-based group outperformed them with a mean score of 83% (Clariana & Wallace, 2002). Some of the more recent studies showed lower student performance on computer-based methods when students were required to read and respond to lengthy reading passages (Pommerich, 2004; Peak, 2005). In 1998 and 2000 Pommerich (2004) conducted comparability studies by using a passage-based and multiple-choice assessment to examine how student achievement was impacted when students were required to navigate through a passage when responding to a test question. Comparisons were made between the paper/pencil and computer-based assessment administration. There were over 10,000

11th and 12th grade participants included in each of the comparison studies (Pommerich, 2004). The results of both studies revealed that small differences between delivery methods did exist between the assessments (Pommerich, 2004). For instance, Pommerich (2004) ascertained that one should not expect the same assessment performance between different delivery methods at the beginning, middle, and end of an assessment. Peak (2003) reviewed research that took place between 1993 and 2004 that explored the comparability of paper/pencil and computer-based assessments. They concluded that although the two delivery methods were comparable, in some cases there were differences when the reading of long passages was involved (Peak, 2005). Their review of existing research concluded that students performed better on paper/pencil assessments when lengthier reading passages were involved.

Additional studies have shown evidence of comparability between the two testing delivery methods (Kim & Huynh, 2008; Poggio et al., 2005). Kim and Huynh (2008) compared student test scores on paper/pencil and computer-based assessments that were administered for a statewide end of course test. They concluded that the assessment results were comparable between the two delivery methods. Poggio et al. (2005) conducted an investigation on the impact the delivery method (paper/pencil or computer-based) had on test scores. Participants in this study were comprised of more than 600 seventh grade students from the state of Kansas. Poggio et al. (2005) found little performance difference between the two delivery methods.

Advantages of computer-based assessments for schools. There have been numerous advantages identified when using computer-based testing in lieu of traditional paper/pencil assessments. Advantages of computer-based assessments included the

ability to test more frequently, test more concepts, provide quicker feedback, assess in a variety of ways, heightened objectivity, decreased time on grading, and decreased manual work. Perhaps among the most obvious advantages was efficient scoring and immediate feedback on assessment performance (Parshall, Spray, Kalohn, & Davey, 2002; Pellegrino & Quellmalz, 2010).

Researchers have found the use of computer-based assessments provided increased standardization for test administration, timely administration and scoring, and immediate feedback of assessment results (Parshall, Spray, Kalohn, & Davey, 2002; Pellegrino & Quellmalz, 2010). Edwards et al. (2003), echoed this sentiment, "Unlike traditional standardized tests on paper, which can take weeks or even months to score and return to schools, computer-based assessments can provide almost immediate feedback" (p. 9). Educators are shifting away from paper/pencil testing to computer-based testing due to the minimal grading effort and ability to assess more often (Erturk, Ozden, & Sanli, 2004). Timely feedback provides enrichment and intervention to students as appropriate, allowing for a more targeted approach to instruction (Erturk et al., 2004). In the era of high-stakes testing, it is crucial for educators to receive assessment results in a timely manner. Assessment results are used to make vital educational decisions in the best interest of students.

Most test takers preferred to be assessed through a computer-based delivery method (Erturk et al., 2004). In a study designed to evaluate the impact of student perceptions regarding the use of computer-based assessments on the instructional process, Erturk et al. (2004) discovered at least 70% of study participants indicated that the feedback provided using computer-based assessments assisted them in the learning

process. Yet, using assessment feedback to provide interventions to students was only as valuable as the reliability of the assessment method being used (Kingston, 2009). Kingston (2009) determined this after conducting a meta-analysis of 81 studies occurring between 1997 and 2007. Studies included in the meta-analysis compared computer-based assessments to paper/pencil assessments.

Additionally, as technology became more sophisticated, software developers continued to refine their abilities to develop computer-based assessments that were easy to use (Kingston, 2009). For instance, educators would be able to use formative assessment data to make informed decisions regarding appropriate academic instruction for individual students to meet their unique academic needs. By targeting instructional concepts and strategies based on timely assessment data, one may have anticipated an increase in student achievement. Interventions would be a reality for low-performing students due to the availability of immediate feedback for teachers and students from administered assessments (Kim & Huynh, 2010).

Immediately receiving formative assessment data allowed teachers to quickly identify students' strengths and growth areas. Furthermore, educators were able to provide academic enrichment and interventions as appropriate, according to the data. Without the computer-based system, it would be challenging to recreate this form of tailored interventions through the feedback system (Pellegrino & Quellmalz, 2010). This challenge stemmed from the lag time that existed between administering assessments paper/pencil and manually having to score the assessments and compile results, a concern minimized with the computer-based delivery system. Using feedback to provide students

with swift and individualized interventions was a clear advantage to the use of computer-based assessment systems.

Educators were merely scratching the surface in terms of the ways computer-based testing could be used to impact student achievement. Computer-based assessments had the capability of providing accommodations for students with special needs. For instance, computer-based assessments may read test questions aloud to test takers with reading disabilities or provide a split computer screen with text on one side and sign language on the other for students with hearing impairments (Galley, 2003).

Technology not only entered the assessment realm, but it also played a role in test preparation. Computer-based test-preparation was at the forefront of increasing student achievement scores on state exams. Some test-preparation activities offered immediate feedback to students and teachers; and may have even provided students with instructional assistance on the skills they lacked on the test-preparation assignment (Borja, 2003). This added instructional support came during a time when improved results on high-stakes testing exams were at a premium.

As the focus remained on assessment results, educators began to rethink what computer-based testing entailed. Traditionally, computer-based testing had focused on multiple-choice questions. Yet, with the upsurge of computer availability, the use of computer-based and computer-adaptive assessments is on the rise (Clariana & Wallace, 2002; Stocking & Swanson, 1993; Wainer, 1990). Computer-adaptive testing software has the ability to create tests that are specifically designed for the individual test taker. Computer-adaptive testing software operates off the notion of item response. When a test

taker answers a question incorrectly, the testing software adapted, adjusting the level of difficulty until it reached an appropriate level (Fritts & Marszalek, 2010).

Even with the advancements in computer-based testing quality, accommodations, and computer adaptive testing, computer-based assessments are capable of much more than what is currently being done. In the future, we can anticipate observing the use of groundbreaking and interactive state assessment systems (Olson, 2003). A new era of assessments has begun to transform how we test and how the results affect instruction and learning (Pellegrino & Quellmalz, 2010).

Although placing initial infrastructure such as computers, software, Information Technology departments, and connectivity has had associated financial costs, once in place, computer-based testing has proven to be less expensive overall than its paper/pencil counterpart (Edwards et al., 2003). Researchers have noted it is probable that computer-based assessments will be far more cost effective than paper/pencil assessments once the computer-based testing products are implemented (Edwards et al., 2003). This cost-saving advantage came during a time when schools and districts were going to extremes to reduce expenses.

Numerous arguments have been made in support of computer-based testing. Researchers (Edwards et al., 2003) pointed out it was an efficient testing method that provides timely feedback that could improve teaching and learning. Furthermore, computer-based testing has become more sophisticated with time, thus minimizing some of the concerns that existed during the early phases of computer-based assessments. Moreover, computer-based exams allowed accommodations to be provided more simply to students. Computer-based exams had the capability to adjust to the ability level of the

examinee, and play a role in test preparation (Trotter, 2003). Last, some believed that the cost of implementing computer-based assessments could ultimately be less than its traditional paper/pencil counterpart (Edwards et al., 2003; Trotter, 2003).

Disadvantages of computer-based assessments for schools. Even though some believe selecting a computer-based assessment method was the clear choice, several disadvantages were also presented in the literature. Educators argued that a lack of familiarity with computers could hinder a student's performance on computer-based assessments (Galley, 2003). There have been concerns with the implementation of computer-based assessments due to the inequity of technology hardware, software, and/or proficiency levels of exam administrators among individual schools (Kim & Huynh, 2010; Olson, 2003). Furthermore, Kingston (2009) concluded in a meta-analysis of 81 studies that were conducted between 1997 and 2007 that examinees could be using different hardware from one assessment to the next. When appropriate bandwidth used to transmit Internet connection signals was lacking, it was shown that students perform worse than when using paper/pencil exams due to increased levels of frustration caused by an inefficient technology connection (Kingston, 2009).

Some predicted the lack of technological infrastructure would worsen in the future due to budget deficits and limited existing resources (Edwards et al., 2003). The Enhancing Education Through Technology (EETT) initiative was designed as a result of the No Child Left Behind Act to provide schools with federal grants that could be used to support purchasing educational technology and training educators in its use (MacMillan, 2009). However, this funding fell short in that it did not provide schools with the funds needed to support the inevitable upkeep of infrastructure, training, and maintenance that

came with the addition of more devices (MacMillan, 2009). In 2002, the EETT program was awarded $690 million. This amount was scheduled to decline to only $100 million in 2010 (MacMillan, 2009). While funding dwindled, the pressure for schools to add more instructional technology to their classrooms still existed without always having the infrastructure to support more devices.

The inconsistency among infrastructure posed a reliability and validity problem for computer-based assessments (MacMillan, 2009). The comparability between students in different settings participating in computer-based tests remained in question. For tests to be comparable, any variations in the assessment setting should not impact the results. However, technology equipment has varied between states, districts, schools, and even classrooms. Thus, adjusting for variations in performance results remained a concern (Olson, 2003). Using different computer equipment could create an unwanted testing variable.

Another unwanted variable could stem from the variety in computer proficiency among test takers. Some worried that computer-based exams may have underestimated the proficiencies of students who lacked basic computer skills (Galley, 2003). More recently, Gullen (2014) ascertained that although some students were proficient with technological devices for entertainment purposes this did not mean proficiency would transfer to a different device. Gullen (2014) also suggested:

> Computerized and online assessments, educators are discovering, will require kids to have certain digital skills: using a mouse, highlighting text, dropping and dragging text, drawing lines and creating graphs on a screen, operating an online calculator, using scroll bars, and keyboarding, to name a few. (p. 69)

One must consider the variation in the technology abilities of students as well as the level of training students received from teachers to help them acquire digital skills that were required for computer-based assessments (Galley, 2003).

Additionally, those providing assessment support may lack the skills necessary to utilize the software (Galley, 2003). According to Gullen (2014), computer-based assessment skills must be integrated into classroom instruction prior to students participating in computer-based assessments. Thus, to truly obtain an accurate score that represents students' academic abilities, all of those providing assessment support as well as the test takers would need to be proficient with their ability to navigate technology on high-stakes assessments.

Another disadvantage of computer-based testing were the preparation programs educators often used. Computer-based testing programs surged in popularity, and thus, there was an increase in the use of computer-based test-preparation programs (Borja, 2003). Web-based programs are able to tailor themselves to meet the individual needs of each student, support lessons, and provide instructors with student data (Borja, 2003). Yet, some gave caution to those using computer-based test preparation programs in hopes of improving state exam results. Fears surrounding students receiving an unbalanced education arose since computer-based test-preparation programs traditionally concentrated on basic skills (Borja, 2003). When teachers focused on teaching basic skills so students perform well on an assessment, other important academic areas may have inadvertently been left behind (Borja, 2003).

Software creators were still working on minimizing the computer variables such as font size, screen brightness, and scrolling that existed between paper/pencil and

computer-based exams. Some researchers (Edwards, 2003; MacMillan, 2009) asserted that, along with improvements software creators were attempting, schools and districts needed to focus on improving the quality of their technological infrastructure. Lastly, some questioned the depth and rigor of computer-based assessments that relied primarily on multiple-choice formats (MacMillan, 2009). With both advantages and disadvantages to computer-based testing presented, there was little room to wonder why consensus had not been reached among educators with regard to a preferred assessment delivery method.

The Impact of Computer-Based Testing for Students

When evaluating the differences between paper/pencil and computer-based testing, it was important to note the advantages and disadvantages of a computer-based delivery system for assessments from the perspectives of the students taking those assessments. Messineo and DeOllos (2005) conducted a study designed to explore the perceptions of students with regard to computer competency. This study included 233 students enrolled in a medium-sized mid-western university (Messineo & DeOllos, 2005). The majority of survey respondents were white females. Of the 233 study participants, 99.6% indicated they had computer experience and 76.4% admitted that the use of technology was a motivator when participating in coursework and assessments. This study also found that although students had plenty of experience with computers, they were less confident when using their technology skills for academic versus personal reasons. As evidenced by the literature cited below, student anxiety and student motivation were important factors in any testing environment.

Student anxiety. There was an increase in popularity of computer-based assessments due to the many advantages they offered (Bugbee 1996; McDonald, 2002; Parshall et al., 2002). In light of these advantages, it was important for educators to consider the impact computer anxiety and motivation may have had on assessment results. As personal computers became commonplace in homes and schools, McDonald (2002) defined computer anxiety as "the fear experienced when interacting with a computer or anticipating the interaction" (p. 305).

During the early stages of computer use by the general population, researchers noticed behavioral and physiological behaviors that sometimes resulted when one experienced computer anxiety. Such behaviors included avoidance of locations with computers, negative comments regarding computers, expedited use of computers, high blood pressure, and nausea (Maurer & Simonson, 1984; Wienberg & Fuerst, 1984). McIlroy, Bunting, and Tierney (2001) conducted a study utilizing undergraduate social science students. They used the Computer Anxiety Rating Scale and the Computer Thoughts Surveys to gauge attitudes and anxieties study participants had towards computers. McIlroy, Bunting, and Tierney (2001) experienced similar findings to the previously mentioned studies conducted by Maurer and Simonson (1984) and Wienberg and Fuerst (1984) regarding anxiety from some populations when they interacted with or anticipated interacting with computers. More recently, Gullen (2014) ascertained that although some students were proficient with technological devices for entertainment purposes this did not mean proficiency would transfer to a different device. With so much pressure to increased performance on high-stakes testing, educators may need to address the adversarial effects of computer anxiety.

Addressing the effects of computer anxiety began with understanding the cause of such anxiety. Much research has produced the notion that computer anxiety exists in those who lack familiarity with computers (Chua, Chen, & Wong, 1999; Levine & Donitsa-Schmidt, 1998). Students became less comfortable when they were asked to perform above their technology skill base to accomplish an academic task (Messineo & DeOllos, 2005). Fritts and Marszalek (2010) conducted a study that compared anxiety levels between students who participated in a computerized adaptive test and those who participated in a paper/pencil test. Ninety-four students were assessed using the computerized adaptive test and 65 students completed the paper/pencil exam. All students were of middle school age and attended one of two large school districts located in mid-western cities. When anxiety was high with a given assignment and the perceived ability to perform well on such assignment was slim, there was an increased likeliness that the examinee would begin removing himself from additional cognitive efforts (Fritts & Marszalek, 2010). What the above research showed was that helping examinees become proficient with computers prior to participating in computer-based assessments may have decreased existing computer anxiety levels.

Clarinia and Wallace (2005) conducted a study where student performance was evaluated on two assessments. The first assessment was administered paper/pencil; the second assessment was administered using a computer-based system. Participants in this study included over 200 undergraduate freshman business majors enrolled in a computer skills course. Students with little to no experience with computers were not the only group who may have suffered heightened anxiety during computer-based testing. In fact, female and African American subgroups might have been prone to experience additional

computer anxiety than others (Clarinia &Wallace, 2005). This research may help educators identify those who need the most assistance with computer familiarity and comfort.

Stephens (2001) conducted a study, which involved 46 Library and Information Science/Study undergraduate students who participated in two assessments. The first was a Computer Assisted Assessment, and the second was paper/pencil. The study took place in the United Kingdom and was designed to identify any benefits to staff or students that may be present when using a Computer Assisted Assessment. By ensuring examinees were proficient with computers prior to testing, examiners should help minimize computer anxiety through the delivery of in-depth preparation with students prior to the assessment and diligent monitoring of students during the assessment (Stephens, 2001). This clarity would aid test takers in their ability to understand a given task. Keeping computer anxiety levels low may help improve student performance. In a review of existing studies, McDonald (2002) pointed out links of increased levels of anxiety to decreased levels of working memory. Additionally, McDonald (2002) highlighted the common misconception that increased exposure to computers could produce a decrease in computer anxiety, and he has noted the conflicting results of various studies on this topic. The purpose of McDonald's work was to better understand the impact individual differences of test takers have on the equivalence between paper/pencil and computer-based assessments.

It has been shown that assessment software itself caused test-takers anxiety. In a 2010 study, Fritts and Marszalek compared the amount of test anxiety experienced with Computer Adaptive Testing (CAT) system with the anxiety experienced on a

paper/pencil test. CAT assessments were able to tailor test questions based on the ability level of the test taker. If test takers comprehended that the assessment was becoming increasingly simpler or more complex, they began to hypothesize about their performance, which could result in heightened levels of anxiety (Fritts & Marszalek, 2010). In their study, Fritts and Marzalek (2010) determined the CAT system was a cause for some computer anxiety in their study. This increased anxiety could have produced lower assessment results. The sample of this study consisted of 94 middle school CAT examinees and 65 middle school paper/pencil examinees. The anxiety level of students in both examinee groups were measured by the State-Trait Anxiety Inventory for Children (STAIC) after the students had completed a CAT standardized achievement test.

Student motivation. Computer anxiety was not the only variable at play when it came to computer-based assessments. Some researchers have discovered that students were motivated by access to technology during testing (Bridgeman, Lennon, & Jackenthal, 2001; Flowers et al., 2011; Higgins, Russell, & Hoffmann, 2005; Park, 2003). Additionally, motivational levels corresponded with the level in which a student would experience academic success; thus, motivation was essential to learning and achievement (Marzano, 2003). It was equally important to emphasize heightened levels of motivation, as it was to work towards decreasing computer anxiety.

Research has shown that some students have a preference when it comes to selecting an assessment delivery method. Horton and Lovitt (1994) conducted a study involving 72 students from middle and high school science and social studies classes. The purpose of their study was to compare group reading inventory outcomes between

paper/pencil and computer-based methods. The result of Horton and Lovitt's (1994) study, "revealed no significant difference between the assessment methods" (p. 378). However, the students who claimed a preference for the computer-based assessment cited the computer as a motivational factor. Further research indicated that many students preferred to test using a computer-based method versus paper/pencil since test takers perceived the computer-based delivery method to be less tiring (Bridgeman et al., 2001; Higgins, et al, 2005).

According to Millsap (2000), student motivation for computer-based assessments was derived more from the efficiency and timeliness of the results than the simplicity of the exam. It was also important to note that confidence with a delivery method could lead to increased motivation, and some research (Park, 2003) implied that test takers believed computer-based assessments were easier than paper/pencil assessments. In a 2003 Oregon survey conducted by state education officials, 740 third grade students and 730 high school students located in various parts of the state reflected on their paper/pencil and computer-based assessment experiences (Park, 2003). Students in this study testified that they were motivated by computer-based assessment because they found them to be more efficient and more enjoyable than their paper/pencil counterparts. Survey participants also reported feeling more confident in their performance on computer-based assessments (Park, 2003).

In a study evaluating the effects of computer variables (screen brightness, font size, and resolution on testing performance) Bridgeman et al. (2001) discovered that 44% of study participants preferred computer-based assessment to their paper/pencil counterparts. Additionally, 20% of participants were indifferent in a study that included

357 high school juniors who were college bound. The majority of participants also felt participating in computer-based assessments was less tiring than paper-pencil assessments (Bridgeman et al., 2001).

Higgins et al., (2005) examined the effects of transitioning paper/pencil reading comprehension assessments to the computer for over 200 fourth grade students from eight schools located in Vermont. An analysis was conducted regarding students' perspectives of computer-based assessments based on their responses to four open-ended survey questions (Higgins et al., 2005). The analysis revealed that of the 135 participants, 82.2% felt it was easier to complete the computer-based assessment than the paper/pencil version (Higgins et al., 2005).

In a comparison study of paper/pencil and computer-based assessments Flowers et al., (2011) administered a survey following a computer-based assessment to more than 600 third through eleventh grade students located in a southeastern state. The majority of students (77%) felt they performed better when being assessed on the computer when compared to paper/pencil (Flowers et al., 2011). Students reported that they could work at their own pace, pay attention to the assessment, and be more independent when participating in the computer-based delivery method (Flowers et al., 2011). Furthermore, 259 staff members were surveyed and 79% of them reported observing higher levels of engagement from students who participated in computer-based assessments versus paper/pencil (Flowers et al., 2011).

As technology has continued to improve, certain subgroups may have found increased benefits from using computer-based assessment systems. Some have believed that students with disabilities experienced increased participation and higher achievement

results when using computer-based testing programs due to an increase in motivation (Flowers et al, 2011). This positive impact could have been due to the ability of software programs to provide necessary accommodations, thus reducing students' frustration and increasing their motivation (Flowers et al, 2011). However, it was important to note a test taker's preference toward computer-based testing did not necessarily produce higher achievement results (Flowers et al., 2011; Higgins et al., 2005).

Demographics and Their Impact on Testing

Equity has been an important component when comparing different assessment delivery methods. However, the majority of researchers who conducted studies that compared the delivery method of paper/pencil with computer-based assessments did not evaluate the comparability of varying gender, minority status, and socioeconomic demographics and their impact on achievement when comparing delivery methods (Kingston, 2009). Of the few studies available, one found that students with less access to and familiarity with computers may be at a disadvantage when participating in computer-based assessments (Flowers et al., 2011).

When utilizing computer assessments, it was difficult to account for the individual differences of each examinee (The National Center for Fair and Open Testing, 2002). In fact, the existing achievement gap between people from different genders, minority statuses, and socioeconomic backgrounds may indeed have expanded due to the use of computer-based assessments (The National Center for Fair and Open Testing, 2002; Weaver & Raptis, 2001). The potential for an expansion in the already evident achievement gap caused some to work toward a solution. One recommendation was to allow all examinees to become comfortable with the computer before administering a

computer-based assessment (Kingston, 2009). Even if factors were put in place to level the playing field for testers from all subgroups, it would continue to be important to disaggregate the assessment data. Kim and Huynh (2009) concluded it is critical to examine student subgroups because data comprising the entire student population may conceal findings of particular subgroups.

Gallagher, Bridgeman, and Cahalan (2002) conducted a meta-analysis from multiple national testing companies to determine if there was a difference in performance between gender groups. The researchers analyzed three studies, using data from the GRE General Test Graduate Management Admissions Test (GMAT), SAT I: Reasoning (SAT), and Praxis Professional Assessments for Beginning Teachers. The researchers concluded small but consistent patterns of performance change between gender groups did exist. Gender differences were apparent on two out of twelve subtests that female test takers completed, pointing researchers to believe that females perform slightly better on paper/pencil assessments than on computer-based assessments (Gallagher et al., 2002).

In a synthesis of existing research, Clariana and Wallace (2005) reported the differences of genders in computer-based assessments as well as paper/pencil assessments. Since males tended to report more access to, knowledge of, and learning experiences with computers, females may have been at a disadvantage when it came to computer-based assessments (Clariana & Wallace, 2005; Cooper, 2006). Clariana and Wallace (2005) concluded that in addition to fewer experiences with computers, females experienced higher levels of computer anxiety than males. Specifically, African American females reported experiencing the most computer anxiety. The studies synthesized by Clariana and Wallace (2005) implied that limited computer experience, as

well as the testing stress, might have lead females to perform more poorly than males on computer-based assessments, even more poorly than they would on paper/pencil assessments. These results emphasized the importance for educators to have a solid understanding of advantages and/or disadvantages that may be present for one gender group over another depending on the assessment delivery method. Clariana and Wallace (2005) claimed, "because of the increasing use of online testing, it seems critical at this time to determine factors that differentially affect computer-administered test performance in order to decrease the amount of measurement error in online tests" (p. 18).

In addition to gender, minority and socioeconomic status may have had an effect on assessment results when comparing paper/pencil and computer-based testing. The higher the percentage of low socioeconomic and minority populations were in a given school, the less likely students were to have technology in schools or home (Clariana & Wallace, 2005; The National Center for Fair and Open Testing, 2002; Sutton, 1991).

Early studies implied students with less computer experience would perform worse on computer-based exams (Sutton, 1991; Urban, 1986). There were fewer opportunities for students to access high quality educational resources at home for students from low socioeconomic backgrounds than there were for students from middle or high socioeconomic backgrounds (U.S. Department of Education National Center for Educational Statistics, 2000; Viadero, 2000). Having less access to computers may have led to a decrease in performance. Gallagher et al. (2002) examined data from multiple national testing companies to see if there was a difference in performance among gender and minority groups. By reviewing data from previous studies, the researchers sought to

identify performance patterns across assessments and among subgroups. Segall (1997) and Gallagher et al. (2002) found small, but consistent patterns of performance change between gender and minority groups. African-Americans and, to a smaller extent, Hispanics benefited somewhat from the computer-based delivery method. It was important to note that in this study all test takers experienced a stronger performance on computer-based delivery systems than when being assessed paper/pencil (Gallagher et al., 2002).

A decrease in performance for some may have been tied to unfamiliarity with the attributes of the computer such as screen size and resolution, font size, and computer settings (Bridgeman, Lennon, & Jackenthal, 2003). With less frequent, at-home opportunities to become proficient with technology, students from lower socioeconomic backgrounds may have faced additional challenges on computer-based assessments. MacCann (2006) noted a slight effect from SES in a small study using Australian students as the sample. Nearly identical scores were reported for non-low SES students on the two testing methods and no significant difference in achievement levels were identified (MacCann, 2006). However, differences did exist that favored the paper/pencil method over the computer-based method for students identified as low SES students. MacCann (2006) pointed out that low SES students might have had less experience with performing computer functions necessary for a successful computer-based testing experience. "In addition, affective responses, in part created by computer inexperience, could conceivably reduce scores differentially on the computer-based mode" (MacCann, 2006, p. 88). It was clear that consensus had yet to have been reached in terms of the

degree to which socioeconomic status impacted performance for test takers on paper/pencil versus computer-based versus delivery methods.

Bridgeman et al. (2003) asserted experience may have been a key factor in test takers' comfort level with using a computer-based versus paper/pencil assessment delivery system. Some research has suggested there is a discrepancy in terms of access to technology for female, minority, and low SES students (Facer & Furlong, 2001). After conducting a study in which more than 800 students between the ages of 9 and 14 were surveyed, Facer and Furlong (2001) called into question the postulations that all students were "cyberkids," who were skilled and comfortable with technology. Participants in this study were located in southwest England and southeast Wales.

Summary

The content in this chapter provided a historical perspective of paper/pencil and computer-based assessments and specifically focused on a broad history of assessments in education. A review of current types of assessments being used in the present higher stakes environment was also conducted. Computer-based testing and its implications for schools were addressed by reviewing the advantages and disadvantages of delivery methods. Advantages and disadvantages of computer-based testing for students were also a focus of this chapter by analyzing the impacts of student anxiety and motivation on testing. In closing, findings of existing research were reported with regard to demographics and their impact on student performance on each assessment delivery method: paper/pencil and computer-based. Specifically, gender, minority, and socioeconomic status were examined. Chapter three provides the methodology used in the study.

Chapter Three

Methods

The purpose of this study was to determine whether the delivery method in which an assessment was administered, paper/pencil versus computer-based, made a difference in fifth and sixth grade student's Language Arts achievement results. Specifically, this study determined whether the assessment delivery method made a difference on the achievement of test takers as affected by gender, minority, and socioeconomic status. This chapter includes a description of the research design; population and sample; sampling procedures; instrumentation: measurement, validity, and reliability; data collection procedures; data analysis and hypotheses testing; and limitations of the study.

Research Design

The researcher utilized a quantitative research design in this study. Specifically, a quasi-experimental research design was used. The dependent variable was the students' Language Arts score from the Acuity Language Arts Diagnostic assessment. Four independent grouping variables included the assessment delivery method (paper/pencil or computer-based) as well as the demographics of gender (male or female), minority status (minority or non-minority) and socioeconomic status (low SES or non-low SES).

Population and Sample

The population of interest was upper elementary students in the state of Missouri. The sample for the study included fifth and sixth grade students from Mill Creek Upper Elementary during the 2011-2012 school year. At the time of this study, Mill Creek Upper Elementary was a school in the Belton School District located south of Kansas City, Missouri.

Sampling Procedures

Purposive sampling was used in this study and involved identifying a sample related to the researcher's prior knowledge of the group being sampled (Lunenburg & Irby, 2008). One criterion for inclusion in the study was that participants had to be enrolled as fifth or sixth grade students at Mill Creek Upper Elementary located in Belton, Missouri from January through May of the 2011-2012 school year. Additionally, a prerequisite for participants was having a score from the district-required Acuity Predictive C Language Arts assessment administered in January 2012. The score from the Acuity Predictive C Language Arts assessment allowed the researcher to create academically balanced Groups A and Groups B regarding students' Language Arts ability prior to their participation in the Acuity Language Arts Diagnostic assessments.

Instrumentation

Two assessments were used in this study. The first was the district-required assessment, a CTB/McGraw-Hill Company Acuity Predictive C Language Arts assessment. The Predictive Assessment was used to place students into academically balanced groups. This non-timed, computer-based assessment measures grade level content in Language Arts and predicts future student performance. Assessment questions are both multiple-choice and constructed response. The predictive assessment offers multiple-choice questions in which all four multiple-choice answers provide meaningful feedback to the teacher. When students answer a multiple-choice question accurately, it displays understanding of a given concept. When an incorrect answer is selected, meaningful information is gathered based on which incorrect answer is selected. Each incorrect answer allows teachers to conclude something different in terms of where

meaning breaks down for a student (CTB/McGraw-Hill, 2011a). All multiple-choice questions are worth one point. Regardless of which incorrect answer may be selected the point value remains the same.

On both the fifth and sixth grade Acuity Predictive C Language Arts assessments, students are instructed to read two passages and answer questions related to the reading. Accompanying the story passages and constructed response questions are 30 multiple-choice questions. There are two constructed response questions where students are responsible for developing their answer independent of a selection bank, one for each reading passage, included on each assessment.

On the fifth grade assessment, the first constructed response question is worth three points and the second constructed response question is worth two points. The sixth grade assessment has the same total point value but differs in that the first constructed response question is worth two points while the second constructed response question is worth three points. On the fifth grade assessment 73.3% of the multiple choice questions are related to the story passages and 26.6% assessed skills are independent of the story passages. On the sixth grade assessment 70% of the multiple choice questions are related to the story passages and 30% assessed items are independent of the story passages. Both the fifth and sixth grade Predictive C assessments are worth a total of 35 points (CTB/McGraw Hill, 2011a).

The second assessment used in this study was the CTB/McGraw-Hill Acuity Language Arts Diagnostic assessment for grades five and six. These benchmark assessments measures grade-level content based on Missouri standards (CTB/McGraw Hill, 2011a). Furthermore, the purpose of the Acuity Language Arts Diagnostic

assessments is to assess the strengths and weakness of test takers with regard to Language Arts skills. The paper/pencil and computer-based versions of the Acuity Language Arts Diagnostic assessments are comparable (CTB/McGraw-Hill, 2008). CTB/McGraw-Hill (2008) published a set of guidelines that focused on score interchangeability, factors that could influence comparability of scores, comparability studies, and how one could attain score equivalence. Specifically, CTB/McGraw-Hill (2008) noted that the requirement that assessment scores be interchangeable from one delivery method to the next is one of assessment score equivalence or comparability.

For the purpose of this study, fifth grade students were assessed using the Acuity Missouri Language Arts Grade 5 Diagnostic. Participants read five short text passages provided on the assessment including fiction, nonfiction, and poetry. Fiction and nonfiction passages ranged from 348 to 504 words, and the poem consisted of 181 words. Each text passage included a visual image to aid reading comprehension. The fifth grade form included 30 multiple-choice questions with four possible answers for each question. Each correct response was worth one point. The total questions answered accurately were converted into the test taker's percent correct out of 100. All questions assessed the fifth grade Language Arts standards of comprehension, text features, vocabulary, grammar usage, and punctuation/capitalization (CTB/McGraw-Hill, 2011a).

For the purpose of this study, sixth grade students were assessed using the Acuity Missouri Language Arts Grade 6 Diagnostic. Participants read five short text passages provided on the assessment including fiction and nonfiction. Passages ranged from 342 to 453 words. Each text passage included a visual image to aid reading comprehension. The sixth grade form included 35 multiple-choice questions with four possible answers

for each question. Each correct response was worth one point. The total questions answered accurately were converted into the test taker's percent correct out of 100. All questions assessed the sixth grade Language Arts standards of comprehension, text features, vocabulary, grammar usage, and punctuation/capitalization (CTB/McGraw-Hill, 2011a).

All Language Arts Diagnostic assessments were untimed for fifth and sixth grade participants regardless of their assessment delivery method. For fifth and sixth grade participants taking Acuity Language Arts Diagnostic assessments using the paper/pencil delivery method, the test setting was a typical classroom with no more than 30 students from their same grade level. Each student sat at a desk at least three feet away from other testers. The researcher as well as a classroom teacher proctored the administration of the paper/pencil assessment. For fifth and sixth grade participants taking Acuity Language Arts Diagnostic assessments using the computer-based delivery method, the test setting was a school computer lab with no more than 30 students from their same grade level. Each participant sat at a computer station located at least three feet away from other testers. The researcher as well as a classroom teacher proctored the administration of the computer-based assessment.

Measurement. Scores from the diagnostic assessments were analyzed and served as the dependent variable in this study to measure fifth and sixth grade students' Language Arts performance. The diagnostic assessments provide an understanding of which skills were and were not mastered by test takers. Skills assessed on diagnostic assessments aligned with Missouri content standards such as vocabulary, comprehension, text features, punctuation, and capitalization (CTB/McGraw-Hill, 2011b). There are 30

points possible on the Acuity Language Arts Diagnostic fifth grade assessment and 35 points possible on the Acuity Language Arts Diagnostic sixth grade assessment. All questions on each of the Diagnostic assessments are multiple-choice with only one correct response.

The independent variables in this study were assessment delivery method, gender, minority, and socioeconomic status. The two testing delivery methods were paper/pencil and computer-based. Study participants from different minority statuses were collapsed into two categories: minority (American Indian, Asian/Pacific Islander, Black, Hispanic/Latino, Multi-Racial, Other) and non-minority (White). The researcher collapsed study participants from different socioeconomic status into two categories: low socioeconomic status and non-low socioeconomic status. Participants who qualified for the statewide free or reduced meal program were categorized as low SES; all other study participants were categorized as non-low SES.

Validity and reliability. Lunenburg and Irby (2008) identified content validity as the degree an instrument measures what it reasons to measure. Aligning with the Missouri Grade Level Expectations, information measured on the Acuity Predictive C Language Arts assessment achieved construct validity (CTB/McGraw-Hill, 2011a). The Acuity Predictive C Language Arts assessments were created using the same content standards used to establish the MAP assessment. By using content and construct validity, information measured on the district-required Acuity Predictive C Language Arts assessment was in alignment with Missouri Grade Level Expectations.

Content and construct validity were also achieved through the alignment of the Acuity Diagnostic Assessments to the Common Core State Standards (S. Reed, personal

communication, May 30, 2014) (see Appendix E for complete report). When developing the Acuity Language Arts Diagnostic assessments, comprehensive item specifications aligned to content standards were used as the first level of specificity. The second level of specificity came from sub-content standards, and indicators were used as the third level of specificity. "These design foundations support both the content and construct validity of these assessments; this approach to test development should result in the measurement of the same overall construct," (S. Reed, personal communication, May 30, 2014, p. 1). When solidifying final assessment forms for the Predictive assessments, an item analysis was conducted to ensure high-quality measurement. "For all test forms, the reliability coefficients met accepted psychometric standards for tests of these lengths," (CTB/McGraw-Hill, 2011a, p. 10). CTB/McGraw-Hill conducted a distractor analysis to ensure an acceptable number of students were selecting the correct answer rather than the distractor.

Reliability is the extent to which an instrument dependably measures what it is intended to measure (Lunenburg & Irby, 2008). Cronbach's alpha coefficients were calculated to determine the reliability of the Predictive assessments (CTB/McGraw-Hill, 2011a). Coefficients for the 2009-2010 district-required Acuity Predictive C Language Arts assessment based on an operational/field-test ranged from 0.85 to 0.91 (CTB/McGraw-Hill, 2011a). Therefore, the district-required Acuity Predictive C Language Arts assessment met the accepted psychometric standards for assessments of this length (CTB/McGraw-Hill, 2011a).

The Feldt-Raju method for estimating reliability was utilized for the Acuity Diagnostic Assessments in 2009-2010 (S. Reed, personal communication, May 30, 2014).

> The reliability coefficient is a ratio of the variance of true test scores to those of the observed scores, it is a positive correlation coefficient of true test score to observed scores with the values ranging from 0 to 1. The closer the value of the reliability coefficient is to 1, the more consistent the scores. (S. Reed, personal communication, May 30, 2014, p. 1)

Reliability coefficients for the Acuity Language Arts Diagnostic assessments were unavailable; therefore, the researcher conducted a reliability analysis and found the Cronbach's Alpha to be .864 ($N = 681$).

When finalizing assessment forms for the Acuity Language Arts Diagnostic assessments, a thorough classical test and item analysis was conducted to ensure high-quality measurement. CTB/McGraw-Hill conducted a "classical analyses included p-values, point biserials, distractor analyses, Mantel-Haenszel differential item functioning (bias) indices, and test reliability coefficients," (S. Reed, personal communication, May 30, 2014, p. 2). Additionally, an empirical approach was used to assist with identifying biased test items. Differential item functioning studies were conducted to decide if students with equal underlying ability levels had the same prospect for selecting a correct response (S. Reed, personal communication, May 30, 2014). If the differential functioning studies concluded a difference existed, inclusion of such test items was minimized (S. Reed, personal communication, May 30, 2014).

Data Collection Procedures

An Institutional Review Board (IRB) application was submitted to Baker University requesting permission to conduct the quasi-experiment (see Appendix B). Additionally, a request to conduct the study and publish school district information was submitted to Andrew Underwood, Superintendent of the Belton School District. Data collection began once the Baker University IRB and the Belton School District approved the requests of the researcher (see Appendices C and D).

An Acuity Predictive C scale score report was created for all fifth grade and sixth grade students. This report allowed the researcher to place study participants in the appropriate groups. Systematic assignment was used to create four equally distributed groups for the purpose of determining which students participated in either the paper/pencil delivery method (Grade 5 Group A; Grade 6 Group A) or the computer-based delivery method (Grade 5 Group B; Grade 6 Group B). Data that was collected from the Acuity Predictive C Language Arts assessment was used to rank order students within their respective grade level, from the highest scoring to the lowest scoring. Grade 5 Group A and Grade 6 Group A were created by taking all odd-numbered students from the district-required Acuity Predictive C Language Arts assessment achievement rankings; Grade 5 Group B and Grade 6 Group B were formed by taking all even-numbered students from the district-required Acuity Predictive C Language Arts assessment achievement rankings. Since students were only ranked against other students in their same grade level, all Groups A and Groups B had an effectively equal number of fifth grade and sixth grade students. Thus, the researcher created academically equal groups with similar subsamples.

Random assignment was used to determine which group of students was tested using paper/pencil and which group of students was tested using a computer. A coin was flipped to determine how Groups A and Groups B students were tested. The coin toss resulted in Groups A students being tested using paper/pencil and Groups B students being tested using a computer. Finally, study participants had to complete the Diagnostic assessment during the five-day testing window in May 2012. All students who met the criteria participated in the study.

During May 2012, all study participants completed the Acuity Language Arts Diagnostic assessment. Participants in both Groups A read and answered questions from the Diagnostic form one of their respective grade levels using a pencil to fill in multiple-choice response bubbles. Upon completion, Groups A participants turned in their assessment to the examiner. Participants in both Groups B read and answered the assessment questions from the Diagnostic form one of their respective grade levels using a computer. Answers were selected by students using the drag and click feature of a mouse. Upon completion, participants submitted their responses electronically.

The paper/pencil assessments were hand graded by the researcher using the answer key provided by CTB/McGraw-Hill. The researcher created a template to use during the grading process. The template covered up all parts of the assessment with the exception of the accurate multiple-choice responses. Scores of the participants were tallied and entered into an Excel database by an administrative intern completing internship hours in the Belton School District. The Acuity Diagnostic system scored the responses of Groups B. The researcher pulled Groups B's data from the Acuity system and entered it into the same Excel database used for Groups A. An Acuity Language

Arts Diagnostic test form was administered to each study participant, and all results were housed in one database.

Data Analysis and Hypotheses Testing

Data analyses for testing the hypotheses were conducted using the Statistical Package for the IBM® Social Sciences SPSS® Statistics Faculty Pack 22.0 software for Windows. Each research question with its corresponding hypothesis and the data tool used to test that hypothesis follows below. The significance level for all tests was set at $\alpha = .05$.

RQ1. To what extent is there a statistically significant difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method?

H1. There is a statistically significant difference in Acuity Language Arts Diagnostic scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

A two-factor analysis of variance (ANOVA) was conducted to test H1 and H2. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery method (paper/pencil or computer) and gender (male and female). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for gender, and a two-way interaction effect (assessment delivery method x gender). The main effect for assessment delivery method was used to test H1.

RQ2. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by gender?

H2. Gender affects the difference in Acuity Language Arts Diagnostic scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

The first two-factor analysis of variance (ANOVA) was conducted to test H2. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery method (paper/pencil and computer) and gender (male and female). The interaction effect for assessment delivery method by gender was used to test H2.

RQ3. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by minority status?

H3. Minority status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

A second two-factor analysis of variance (ANOVA) was conducted to test H3. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery

method (paper/pencil and computer) and minority status (minority and non-minority). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for minority status, and a two-way interaction effect (assessment delivery method x minority status). The interaction effect for assessment delivery method by minority status was used to test H3.

RQ4. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by socioeconomic status?

H4. Socioeconomic status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

A third two-factor analysis of variance (ANOVA) was conducted to test H4. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery method (paper/pencil and computer) and socioeconomic status (low SES and non-low SES). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for socioeconomic status, and a two-way interaction effect (assessment delivery method x socioeconomic status). The interaction effect for assessment delivery method by socioeconomic status was used to test the interaction of H4.

RQ5. To what extent is there a statistically significant difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method?

H5. There is a statistically significant difference in Acuity Language Arts Diagnostic scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers.

A fourth two-factor analysis of variance (ANOVA) was conducted to test H5 and H6. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method (paper/pencil or computer) and gender (male and female). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for gender, and a two-way interaction effect (assessment delivery method x gender). The main effect for assessment delivery method was used to test H5.

RQ6. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by gender?

H6. Gender affects the difference in Acuity Language Arts Diagnostic scores between sixth grade students who were assessed using paper/pencil and sixth students who were assessed using computers.

The fourth two-factor analysis of variance (ANOVA) was conducted to test H6. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method (paper/pencil and computer) and gender (male and female). The interaction effect for assessment delivery method by gender was used to test H6.

RQ7. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by minority status?

H7. Minority status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers.

A fifth two-factor analysis of variance (ANOVA) was conducted to test H7. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method (paper/pencil and computer) and minority status (minority and non-minority). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for minority status, and a two-way interaction effect (assessment delivery method x minority status). The interaction effect for assessment delivery method by minority status was used to test H7.

RQ8. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by socioeconomic status?

H8. Socioeconomic status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers.

A sixth two-factor analysis of variance (ANOVA) was conducted to test H8. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method (paper/pencil and computer) and socioeconomic status (low SES and non-low SES). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for socioeconomic status, and a two-way interaction effect (assessment delivery method x socioeconomic status). The interaction effect for assessment delivery method by socioeconomic status was used to test the interaction of H8.

Limitations

Lunenburg and Irby identify limitations as factors that are beyond the control of the researcher (2008). The limitations of this study included:

1) The potential for error existed when hand grading the assessments for study participants in Groups A.

2) The quality of Language Arts instruction may have differed for students depending on the quality of the instructor.
3) Some students were enrolled in Mill Creek Upper Elementary after the beginning of the school year, but before the Acuity Predictive C Language Arts assessment, and thus, they would not have experienced the same Language Arts instruction as the students who did attend Mill Creek for the entirety of the 2011-2012 school year.

Summary

This chapter described the research design, population and sample, sampling procedures, instrumentation, experimentation, data collection procedures, data analysis and hypotheses testing, and limitations of the study. Measurement, validity, and reliability were explained in the instrumentation section. Chapter four presents the results of the hypotheses testing.

Chapter Four

Results

The primary purpose of this study was to determine whether there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a paper/pencil or a computer-based delivery method. The study examined data from one Acuity Language Arts Diagnostic assessment administered during the 2011-2012 school year to fifth grade and sixth grade students in one upper elementary school located in the Belton School District. The researcher also examined if the difference in student achievement between assessment delivery methods was affected by gender, minority, and socioeconomic status. This chapter contains the eight research questions (RQ), the hypothesis tested to address each RQ, the statistical analysis conducted to address each RQ, and the hypothesis testing results.

Hypothesis Testing

In this section, hypothesis testing results are reported along with the descriptive statistics associated with each test.

RQ1. To what extent is there a statistically significant difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method?

H1. There is a statistically significant difference in Acuity Language Arts Diagnostic scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

A two-factor analysis of variance (ANOVA) was conducted to test H1 and H2. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery method (paper/pencil or computer) and gender (male and female). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for gender, and a two-way interaction effect (assessment delivery method x gender). The main effect for assessment delivery method was used to test H1. The level of significance was set at .05. The results of the analysis indicated there was not a statistically significant difference between the average score for students who participated in the paper/pencil and those who participated in the computer-based assessment, $F = .283$, $df = 1, 335$, $p = .595$. See Table 4 for the means and standard deviations for this analysis.

Table 4

Descriptive Statistics for the Results of the Test for H1 (Fifth Grade Students)

Assessment Delivery Method	M	SD	N
Paper/Pencil	70.595	18.537	170
Computer	69.654	19.105	169

RQ2. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by gender?

H2. Gender affects the difference in Acuity Language Arts Diagnostic scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

The first two-factor analysis of variance (ANOVA) was conducted to test H2. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery method (paper/pencil and computer) and gender (male and female). The interaction effect for assessment delivery method by gender was used to test H2. The level of significance was set at .05. The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = .809$, $df = 1, 335$, $p = .369$. See Table 5 for the means and standard deviations for this analysis.

Table 5

Descriptive Statistics for the Results of the Test for H2 (Fifth Grade Students)

Assessment Delivery Method	Gender	M	SD	N
Paper/Pencil	Male	68.953	19.146	92
	Female	72.532	17.718	78
Computer	Male	69.707	19.568	89
	Female	69.596	18.700	80

RQ3. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by minority status?

H3. Minority status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

A second two-factor analysis of variance (ANOVA) was conducted to test H3. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery method (paper/pencil and computer) and minority status (minority and non-minority). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for minority status, and a two-way interaction effect (assessment delivery method x minority status). The interaction effect for assessment delivery method by minority status was used to test H3. The level of significance was set at .05. The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = .004$, $df = 1, 335$, $p = .947$. See Table 6 for the means and standard deviations for this analysis.

Table 6

Descriptive Statistics for the Results of the Test for H3 (Fifth Grade Students)

Assessment Delivery Method	Minority Status	M	SD	N
Paper/Pencil	Minority	63.291	22.358	34
	Non-Minority	72.059	18.383	126
Computer	Minority	62.609	19.649	43
	Non-Minority	72.059	18.383	126

RQ4. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between fifth grade students using a paper/pencil delivery method and fifth grade students using a computer-based delivery method affected by socioeconomic status?

H4. Socioeconomic status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between fifth grade students who were assessed using paper/pencil and fifth grade students who were assessed using computers.

A third two-factor analysis of variance (ANOVA) was conducted to test H4. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for fifth grade students, were assessment delivery method (paper/pencil and computer) and socioeconomic status (low SES and non-low SES). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for socioeconomic status, and a two-way interaction effect (assessment delivery method x socioeconomic status). The interaction effect for assessment delivery method by socioeconomic status was used to test the interaction of H4. The level of significance was set at .05. The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = 1.195$, $df = 1, 335$, $p = .275$. See Table 7 for the means and standard deviations for this analysis.

Table 7

Descriptive Statistics for the Results of the Test for H4 (Fifth Grade Students)

Assessment Delivery Method	SES	M	SD	N
Paper/Pencil	Low SES	65.638	19.447	94
	Non-Low SES	76.726	15.377	76
Computer	Low SES	66.965	19.553	101
	Non-Low SES	73.649	17.820	68

RQ5. To what extent is there a statistically significant difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method?

H5. There is a statistically significant difference in Acuity Language Arts Diagnostic scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers.

A fourth two-factor analysis of variance (ANOVA) was conducted to test H5 and H6. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method (paper/pencil or computer) and gender (male and female). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for gender, and a two-way interaction effect (assessment delivery method x gender). The main effect for assessment delivery method was used to test H5. The level of significance was set at .05. The results of the analysis indicated there was not a statistically significant difference between the average score for students who participated in the paper/pencil and those who participated in the computer-

based assessment, $F = .047$, $df = 1, 338$, $p = .829$. See Table 8 for the means and standard deviations for this analysis.

Table 8

Descriptive Statistics for the Results of the Test for H5 (Sixth Grade Students)

Assessment Delivery Method	M	SD	N
Paper/Pencil	60.261	16.884	171
Computer	59.756	16.063	171

RQ6. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by gender?

H6. Gender affects the difference in Acuity Language Arts Diagnostic scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers.

The fourth two-factor analysis of variance (ANOVA) was conducted to test H6. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method (paper/pencil and computer) and gender (male and female). The interaction effect for assessment delivery method by gender was used to test H6. The level of significance was set at .05. The results of the analysis indicated there was a statistically significant difference between at least two of the means, $F = 7.427$, $df = 1, 338$, $p = .007$. A follow up post hoc was conducted to determine which pairs of means were different. The Tukey's Honestly Significant Difference (HSD) critical value was 6.56. The

differences between the means had to be greater than this value to be considered significantly different. One of the differences was greater than this value. The results of the analysis indicated that there was a statistically significant difference between sixth grade males and the sixth grade females. Males who took the computer-based assessment (M = 54.658) scored lower than females who took the computer-based assessment (M = 65.288). See Table 9 for the means and standard deviations for this analysis.

Table 9

Descriptive Statistics for the Results of the Test for H6 (Sixth Grade Students)

Assessment Delivery Method	Gender	M	SD	N
Paper/Pencil	Male	59.815	17.707	100
	Female	60.889	15.754	71
Computer	Male	54.658	16.511	89
	Female	65.288	13.631	82

RQ7. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by minority status?

H7. Minority status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers.

A fifth two-factor analysis of variance (ANOVA) was conducted to test H7. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method

(paper/pencil and computer) and minority status (minority and non-minority). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for minority status, and a two-way interaction effect (assessment delivery method x minority status). The interaction effect for assessment delivery method by minority status was used to test H7. The level of significance was set at .05. The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = .436$, $df = 1, 338$, $p = .509$. See Table 10 for the means and standard deviations for this analysis.

Table 10

Descriptive Statistics for the Results of the Test for H7 (Sixth Grade Students)

Assessment Delivery Method	Minority Status	M	SD	N
Paper/Pencil	Minority	57.541	16.104	39
	Non-Minority	61.064	17.084	132
Computer	Minority	59.193	14.079	41
	Non-Minority	59.933	16.686	130

RQ8. To what extent is the difference in student Language Arts achievement, as measured by the Acuity Language Arts Diagnostic assessment, between sixth grade students using a paper/pencil delivery method and sixth grade students using a computer-based delivery method affected by socioeconomic status?

H8. Socioeconomic status affects the difference in student Language Arts achievement scores as measured by the Acuity Language Arts Diagnostic assessment scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers.

A sixth two-factor analysis of variance (ANOVA) was conducted to test H8. The two categorical variables used to group the dependent variable, Acuity Language Arts Diagnostic assessment scores for sixth grade students, were assessment delivery method (paper/pencil and computer) and socioeconomic status (low SES and non-low SES). The two-factor ANOVA can be used to test three hypotheses including a main effect for assessment delivery method, a main effect for socioeconomic status, and a two-way interaction effect (assessment delivery method x socioeconomic status). The interaction effect for assessment delivery method by socioeconomic status was used to test the interaction of H8. The level of significance was set at .05. The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = .778$, $df = 1, 338$, $p = .378$. See Table 11 for the means and standard deviations for this analysis.

Table 11

Descriptive Statistics for the Results of the Test for H8 (Sixth Grade Students)

Assessment Delivery Method	SES	M	SD	N
Paper/Pencil	Low SES	57.810	16.168	101
	Non-Low SES	63.797	17.379	70
Computer	Low SES	58.676	15.335	105
	Non-Low SES	61.473	17.137	66

Summary

Chapter four included a summary of the statistical testing and analysis. Six two-factor analysis of variance (ANOVA) were conducted for each of the eight hypotheses and was used to determine whether there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a

paper/pencil or a computer-based delivery method. The researcher specifically examined the extent to which the difference in student achievement between assessment delivery methods was affected by gender, minority, and socioeconomic status. The result of the analyses revealed a statistically significant difference did exist between sixth grade males and sixth grade females who participated in the computer-based assessment delivery method. A follow up post hoc using Tukey's Honestly Significant Difference (HSD) was conducted and revealed sixth grade males performed lower on the computer-based assessment than sixth grade females. In all other areas a statistically significant difference was not present. Chapter five includes the study summary, overview of the problem, purpose statement and research questions, review of the methodology, major findings, findings related to the literature, conclusions, implications for action, and recommendations for future research.

Chapter Five

Interpretation and Recommendations

As technology continues to become more prevalent in today's schools it is understandable that high stakes testing will be moved from a paper/pencil delivery method to a computer-based delivery method. The purpose of this study was to determine whether there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a paper/pencil versus a computer-based delivery method. The researcher also examined how that difference was affected by gender, minority, and socioeconomic status. Participants were of upper elementary age (fifth grade or sixth grade) at the time of the study. This chapter contains a summary of the study, which includes an overview of the problem, purpose statement, and research questions, and a review of the methodology. Furthermore, this chapter presents the major findings of the study and how the findings are related to the literature. Finally, this chapter includes implications for action as well as recommendations for future research.

Study Summary

This study determined whether there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a paper/pencil or a computer-based delivery method. Specifically, this study examined how the difference in student achievement between assessment delivery methods was affected by gender, minority, and socioeconomic status.

Overview of the problem. Little research has been conducted to determine how subgroups respond to the different testing delivery methods (paper/pencil or computer-based). In a synthesis of more than 80 studies comparing paper/pencil and computer-based assessments, Kingston (2009) concluded the majority of studies did not focus on varying subgroups of students and their comparability. Kim and Huynh (2010) also found that earlier studies focused primarily on overall student performance, rather than disaggregating data into student subgroups.

Earlier studies lack a focus on student subgroups, and many of the existing studies are dated and include primarily small samples of college-aged students. Bunderson et al. (1989) reviewed twenty-three studies comparing paper/pencil and computer-based testing. Of the twenty-three studies, three indicated that participants obtained higher scores when tested on a computer, nine showed higher results when participants were tested using paper/pencil, and eleven reported that there was no difference in achievement between the two test delivery methods. Many of these studies included small samples of college-aged students. Additional studies have also indicated inconclusive results with regard to a preferred testing delivery method (Mazzeo & Harvey, 1988; Wise & Plake, 1989). Because schools and districts are adopting more technology to support instruction and assessment, it is important to keep exploring the impact that the use of technology has on assessment results.

With increased accountability from the federal government through the NCLB Act, and more recently through the Race to the Top education initiative, it was essential that educators understood the advantages and disadvantages of using a particular assessment delivery method. Both PARCC and SBAC planned to use adaptive

computer-based assessments that included summative and interim assessments (Aspen Institute, 2012; Fisher & Frey, 2013). Since the increase usage of computer-based testing, it has become imperative that the differences related to gender, minority, and socioeconomic status be further investigated with regard to assessment practices.

Purpose statement and research questions. The purpose of this study was to determine whether there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a paper/pencil or a computer-based delivery method. This study also examined whether that difference was affected by gender, minority, and socioeconomic status.

Review of the methodology. This quantitative study involved Mill Creek Upper Elementary, a school in the Belton School District located south of Kansas City, Missouri. Specifically, the researcher used a quasi-experimental research design. The dependent variable was the students' Language Arts score from the Acuity Language Arts Diagnostic assessment. Four independent grouping variables included the assessment delivery method (paper/pencil or computer-based) as well as the demographics of gender (male/female), minority status (minority/non-minority) and socioeconomic status (low socioeconomic status/non-low socioeconomic status). Multiple two-factor ANOVAs were conducted to determine whether there was a difference in student achievement, as measured by the Acuity Language Arts Diagnostic assessment, between students using a paper/pencil or a computer-based delivery method and to determine if the demographics of gender, minority, and socioeconomic status affected the difference.

Major findings. There were no statistically significant differences found between students who were assessed using paper/pencil and students who were assessed using a computer with one exception. The assessment delivery method did not make a difference and the demographics of gender, minority, and socioeconomic status did not change this except for in the sixth hypothesis. The sixth hypothesis stated that gender would affect the difference in Acuity Language Arts Diagnostic scores between sixth grade students who were assessed using paper/pencil and sixth grade students who were assessed using computers. A statistical analysis of the data was conducted by completing multiple two-factor analysis of variance (ANOVA). The test results revealed a statistically significant difference did exist between the sixth grade males and sixth grade females when taking the computer-based assessment. The mean achievement score for the sixth grade males on the computer-based assessment was more than 10% lower than the mean achievement score for the sixth grade females. Although a statistically significant difference did exist between the sixth grade males and sixth grade females on the computer-based assessment, the same did not hold true for fifth grade male and fifth grade female study participants or for sixth grade male and sixth grade female participants who took the paper/pencil assessment. Additionally, there was not a statistically significant difference between minority and non-minority study participants or between low socioeconomic status and non-low socioeconomic status study participants.

Findings Related to the Literature

The researcher conducted a review of literature related to paper/pencil and computer-based testing and the implications for schools and students. A review of existing literature regarding demographics (gender, minority, and socioeconomic status)

and their impact on testing was also conducted. While literature surrounding whether or not differences exist between paper/pencil and computer-based assessments was abundant (Bugbee, 1996; Kim & Huynh, 2007; Neuman & Baydoun, 1998; Peak, 2005; Poggio et al., 2005) fewer had researched the role demographics may have on assessment delivery methods (Clariana & Wallace, 2005; Gallagher et al., 2002). Most of the existing literature explored college-age students who were identified as digital immigrants (Prensky, 2001). Some of this research has become dated, as today's students are digital natives (Prensky 2001).

According to Pellegrino and Quellmalz (2010), advantages of computer-based assessments included the ability to test more frequently, the ability to test more concepts, the ability to provide quicker feedback, the ability to assess in a variety of ways (multiple-choice, short answer, etc.), heightened objectivity, decreased time on grading, and decreased manual work. Although many of these advantages may allow educators to use their time more effectively, these advantages do not appear to be linked to increased student achievement on computer-based assessment delivery methods based on the results from the current study.

The same held true for disadvantages that have been linked to computer-based delivery methods in that they did not seem to hinder study participants' performance on computer-based assessments in the current study. Kingston (2009) concluded in a meta-analysis of 81 studies that were conducted between 1997 and 2007 that examinees could be using different hardware from one assessment to the next, leading to increased levels of frustration by the student. Additionally, when appropriate bandwidth used to transmit

Internet connection was lacking, it was shown that students perform worse than when using paper/pencil exams (Kingston, 2009).

The results of this study provided evidence that the paper/pencil delivery method and computer-based assessment delivery method are comparable, with only one exception reported in this study (the impact of gender of sixth grade computer-based study participants). This conclusion is consistent with previous findings (Bugbee, 1996; Kim & Huynh, 2007; Neuman & Baydoun, 1998; Peak, 2005; J. Poggio, Glasnapp, Yang, & A. Poggio, 2005). These findings indicated that paper/pencil and computer-based assessment scores were comparable.

The results of this study provided evidence that there was no difference in achievement between fifth grade male and fifth grade female participants based on the assessment delivery method. However, a statistically significant difference did exist between sixth grade male and sixth grade female participants who completed the computer-based assessment, with sixth grade females achieving a mean achievement score of greater than 10% more points overall on computer-based assessments than sixth grade males. This finding differs from the results of a meta-analysis by Gallagher et al. (2002). Gallagher et al. (2002) collected data from multiple national testing companies to determine if there was a difference in performance between gender groups. The researchers concluded slight differences in achievement did exist between males and females. Gender differences were apparent on two out of twelve subtests that female test takers perform slightly better on paper/pencil assessments than on computer-based assessments (Gallagher et al., 2002). However, in all other areas that assessed the

influence gender had on assessment delivery methods, a statistically significant difference did not exist.

In a synthesis of existing research, Clariana and Wallace (2005) reported the differences gender had on student achievement on paper/pencil and computer-based assessments. Since males tended to report more access to, knowledge of, and learning experiences with computers, females may have been at a disadvantage when it came to computer-based assessments (Clariana & Wallace, 2005; Cooper, 2006). The researcher of the current study came to a different conclusion than Clariana and Wallace (2005), finding that sixth grade females outperformed sixth grade males on the computer-based assessment.

In addition to gender, this study examined the effect minority status had on assessment results when comparing paper/pencil and computer-based delivery methods. Segall (1997) and Gallagher et al. (2002) found small but consistent patterns of differences in performance between minority groups. African-Americans and, to a smaller extent, Hispanics benefited somewhat from the computer-based delivery method. It was important to note that in Gallagher et al.'s study all test takers experienced a stronger performance on computer-based delivery systems than when being assessed by paper/pencil (Gallagher, Bridgeman, & Cahalan, 2002). Unlike the studies above, the current study provided no evidence for a statistically significant difference between the assessment delivery methods and minority/non-minority students.

The current study also explored the effect of a low socioeconomic or a non-low socioeconomic status had on assessment results when comparing paper/pencil and computer based delivery methods. Earlier researchers found there were fewer

opportunities for children from low socioeconomic backgrounds to access high quality educational resources at home than there were for students from non-low socioeconomic backgrounds (U.S. Department of Education, 2000; Viadero, 2000). MacCann (2006) noted nearly identical scores were reported for non-low socioeconomic status students on the two assessment delivery methods. However, differences did exist that favored the paper/pencil method over the computer-based method for students identified as low socioeconomic status students. Contrary to the studies above, the current study found no statistically significant difference between the two assessment delivery methods and participants from a low socioeconomic status and those from a non-low socioeconomic status.

Conclusions

This section contains implications for school districts when identifying the most reliable and advantageous assessment delivery method regarding student use. The implications of this study could be used to help educators interpret assessment data leading them to draw more accurate conclusions and thus make sound decisions regarding student improvement. Furthermore, recommendations for future research are presented as a result of the findings from the current study. Last, concluding remarks close this chapter.

Implications for action. The findings from this study have implications for states, districts, and schools that will begin using computer-based assessment delivery methods when the PARCC and SBAC assessments are first administered during the 2014-2015 school year. The data from the current study reveals that the results between paper/pencil and computer-based assessments were comparable. When analyzing

demographic data, the current study revealed that minority and socioeconomic status did not influence participant achievement regardless of the assessment delivery method. However, gender may be a variable that districts and schools should be mindful of as they analyze their own student achievement data. It is important for those interpreting assessment data to disaggregate the data by subgroups to ensure achievement levels are comparable. By combining the overall assessment results into various subgroups, a system can more accurately draw conclusions and ensure improvement. Analysis of the data from this study can provide information that may be utilized by states, districts, or schools as they work to interpret initial student assessment scores from the first round of PARCC and/or SBAC assessment results.

Recommendations for future research. The current study allowed the researcher to evaluate student achievement data on two assessment delivery methods and disaggregate the data based on gender, minority, and socioeconomic status. The recommendations below are made for others interested in conducting a study involving the assessment delivery methods.

1. Replicate the current study using participants in grades three, six, and nine. This may present new information that school stakeholders could generalize to both elementary and secondary students. The increased technology skill level in a particular grade/age of student may have an impact on student assessment results when comparing different delivery methods.
2. Replicate the current study using different types of technological devices such as tablets or smart phones. For instance, instead of using the variables of

paper/pencil and computer-based, one may analyze the delivery methods of computers versus tablets.

3. Replicate the current study using a larger sample size. Doing so may help provide clarity to the statistically significant difference that was identified in the current study between sixth grade males and females participating in the computer-based assessment.
4. Conduct a similar study using constructed response assessments instead of multiple-choice assessments, which were used in the current study. Constructed response assessments would allow school stakeholders to generalize the results across assessment type.
5. Replicate the current study using other content areas in lieu of Language Arts. Doing so would allow school stakeholders to generalize the results across the disciplines.

Concluding remarks. Technology integration will continue to expand in schools across the United States. As this happens, paper/pencil assessments will continue to dwindle while computer-based assessments will be on the rise. Furthermore, the U.S. Department of Education will continue to drive advances in the area of state, district, and school accountability through the use of national assessments such as those developed by the PARCC and SBAC. As this happens, it will be essential for states, districts, and schools to ensure the authenticity of such scores for each of their students. This research supports the comparability of paper/pencil and computer-based assessments but encourages those analyzing achievement data to continue to disaggregate the data by the demographics of gender, minority, and socioeconomic status.

References

AL-Smadi, M., & Gütl, C. (2008, September). *Past, present and future of e-assessment: Towards a flexible e-assessment system.* Paper presented at the Conference ICL, Villach, Austria. Retrieved from http://www.scribd.com/doc/6947351/Past-Present-and-Future-of-EAssessmentTowards-a-Flexible-EAssessment-System

Aspen Institute. (2012). *Common Core State Standards: An introduction for families and other stakeholders* [Fact sheet]. Retrieved from http://www.aspendrl.org/portal/browse/DocumentDetail?documentId=1595&download

Bauer, H. (2005). *The relationship between technology integration reading instruction and reading achievement in high-performing campuses as reported by PEIMS and third grade classroom teachers in selected south Texas school districts* (Doctoral dissertation). Retrieved from http://search.proquest.com.proxyb.kclibrary.org

Baumer, M., Roded, K., & Gafni, N. (2009). Assessing the equivalence of internet-based vs. paper-and-pencil psychometric tests. In D. J. Weiss (Ed.), *Proceedings of the 2009 GMAC conference on computerized adaptive testing.* Paper presented at the California Comparability Symposium, Burlingame, CA. Retrieved from http://publicdocs.iacat.org/cat2010/cat09roded.pdf

Belton School District. (2012). *Student enrollment summary report.* Acquired from student information data at http://ic.bsd124.org/campus/main.xsl

Bennett, R. E. (2008). *Technology for large-scale assessment.* (ETS Report No. RM-08-10). Princeton, NJ: Educational Testing Service.

Bhoola-Patel, A., & Laher, S. (2011). The influence of mode of test administration on test performance. *Journal of Psychology in Africa, 21*(1), 139-144.

Bleske-Rechek, A., Zeug, N., & Webb, R. M. (2007). Discrepant performance on multiple-choice and short answer assessments and the relation of performance to general scholastic aptitude. *Assessment & Evaluation in Higher Education, 32*(2), 89-105.

Bontis, N., Hardie, T., & Serenko A. (2009). Techniques for assessing skills and knowledge in a business strategy classroom. *International Journal of Teaching and Case Studies, 2*(2), 162-180.

Borja, R. R. (2003, May). Preparing for the big test: Students turn to the Web to get ready for high-stakes exams. *Education Week, 22*(35), 23-26.

Bridgeman, B., Lennon, M. L., & Jackenthal, A. (2001). *Effects of screen size, screen resolution, and display rate on computer-based test performance* (Research Report No. 01-23). Princeton, NJ: Educational Testing Service.

Bridgeman, B., Lennon, M. L., & Jackenthal, A. (2003). Effects of screen size, screen resolution and display rate on computer-based test performance. *Applied Measurement in Education, 16*(3), 191-205. doi: 10.1207/S15324818AME1603_2

Bugbee, A. C., Jr., (1996). The equivalence of paper-and-pencil and computer-based testing. *Journal of Research on Computing in Education, 28*(3), 282-299. Retrieved from http://proxyb.kclibrary.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=9605221096&site=ehost-live

Bugbee, A. C., Jr., & Bernt, F. M. (1990). Testing by computer: Findings in six years of use 1982-1988. *Journal of Research on Computing in Education, 23*(1), 87-100. Accession Number: 9609221569

Bunderson, C. V., Inouye, D. K., & Olsen, J. B. (1989). The four generations of computerized educational measurement. In R. L. Linn (Ed.), *Educational measurement* (3rd ed.) (pp. 367-407). New York, NY: American Council on Education-Macmillan.

Bushweller, K. (2000). Electronic exams. *American School Board Journal, 187*(6), 20-24.

Choi, S. W., & Tinkler, T. (2002). *Evaluating comparability of paper and computer based assessments in a K-12 setting.* Paper presented at the Annual Meeting of the National Council on Measurement in Education, New Orleans, LA.

Chua, S. L., Chen, D. T., & Wong, A. F. L. (1999). Computer anxiety and its correlates: A meta-analysis. *Computers in Human Behavior, 15*(5), 609-624.

Clariana, R. B., & Wallace, P. (2002). Paper-based versus computer based assessments: Key factors associated with the test mode effect. *British Journal of Educational Technology, 33,* 593-602.

Clariana, R. B., & Wallace, P. (2005). Gender differences in computer-administered versus paper-based tests. *International Journal of Instructional Media, 32*(2), 171-179.

Cooper, J. (2006). The digital divide: The special case of gender. *Journal of Computer Assisted Learning, 22*(5), 320-334. doi: 10.1111/j.1365-2729.2006.00185.x

CTB/McGraw-Hill. (2008). *The computer based or online administration of paper and pencil tests.* Retrieved from http://www.ctb.com/ctb.com/control/assetDetailsViewAction?articleId=665&assetType=article&currentPage=1&p=library

CTB/McGraw-Hill. (2011a). *Acuity assessment focused on learning: State of Missouri* (Technical Report). Monterey, CA: Author.

CTB/McGraw-Hill. (2011b). *Drive achievement for all students with Acuity Missouri.* Monterey, CA: Author.

Douglas, M., Wilson, J., & Ennis, S. (2012). Multiple-choice question tests: A convenient, flexible and effective learning tool? A case study. *Innovations in Education and Teaching International, 49*(2), 111-121.

Edwards, V., Chronister, G., Bushweller, K., Skinner, R., & Bowman, D. (2003). Technology counts 2003: Technology's answer to testing. *Education Week, 35*(22), 8-9.

Ennis, S. R., Rios-Vargas, M., & Albert, N. G. (2011). *The Hispanic population: 2010 census briefs.* (C2010BR-04). Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-04.pdf

Erturk, I., Ozden, Y., & Sanli, R. (2004). Students' perceptions of online assessment: A case study. *Journal of Distance Education, 19*(2), 77-92.

Facer, K. & Furlong, R. (2001). Beyond the myth of the 'Cyberkid': Young people at the margins of the information revolution. *Journal of Youth Studies, 4*(4), 451-469).

Fact sheet: No child left behind has raised expectations and improved results. (n.d.). *White House archives, education reform: No Child Left Behind*. Retrieved from http://georgewbush-whitehouse.archives.gov/infocus/education/

Fisher, D., & Frey, N. (2013). In *Common core English language arts in a PLC at work grades 3-5.* Bloomington, IN: Solution Tree Press.

Flowers, C., Do-Hong, K., Lewis, P., & Davis, V. (2011). A comparison of computer-based testing and pencil-and-paper testing for students with read-aloud accommodation. *Journal of Special Education Technology, 26*(1), 1-12.

Fritts, B. E., & Marszalek, J. M. (2010). Computerized adaptive testing, anxiety levels, and gender differences. *Social Psychology of Education, 13*(3), 441-458. doi: 10.1007/s11218-010-9113-3

Gallagher, A., Bridgeman, B., & Cahalan, C. (2002). The effect of computer-based tests on racial-ethnic and gender groups. *Journal of Educational Measurement, 39*(2), 133-147.

Galley, M. (2003, May). The teacher's new test: Computerized exams finding a niche in classroom assessment. *Education Week, 22*(35), 31-33.

Gordon, N. L. (2011). *Integrating technology-based instruction in middle grades language arts: Motivating and engaging at-risk learners in reading comprehension* (Doctoral dissertation). Retrieved from http://search.proquest.com.proxyb.kclibrary.org

Graham, J. M., Mogel, L. A., Brallier, S. A., & Palm, L. J. (2008). Do you online?: The advantages and disadvantages of online education. *Bridges On-Line Journal, 19*, 27-36. Retrieved from http://www.coastal.edu/bridges/winter2008.html

Gullen, K. (2014). Are our kids ready for computerized tests? *Educational Leadership, 71*(6), 68-71.

Higgins, J., Russell, M., & Hoffmann, T. (2005). Examining the effect of computer-based passage presentation on reading test performance. *Journal of Technology, Learning, and Assessment, 3*(4), 1-35. Retrieved from http://ejournals.bc.edu/ojs/index.php/jtla/article/view/1657/1499

Hixson, L., Hepler, B. B., & Kim, M. O. (2011). *The white population: 2010 census briefs*. (C2010BR-05). Retrieved from http://www.census.gov/prod/cen2010/briefs/c2010br-05.pdf

Horton, S. V., & Lovitt, T. C. (1994). A comparison of two methods of administering group reading inventories to diverse learners: Computer versus pencil and paper. *Remedial and Special Education, 15*(6), 378-390. doi: 10.1177/074193259401500606

Kapes, J. T., & Vansickle, T. R. (1992). Comparing paper-pencil and computer-based versions of the Harrington-O'Shea Career Decision-Making System. *Measurement and Evaluation in Counseling and Development, 25*(1), 5-13. Accession Number: 9709042738

Kim, D. H., & Huynh, H. (2007). Comparability of computer-based and paper-and-pencil testing for algebra and biology. *Journal of Technology, Learning, and Assessment, 6*(4). Retrieved from http://escholarship.bc.edu/jtla/vol6/4/http://escholarship.bc.edu/jtla/vol6/4/

Kim, D. H., & Huynh, H. (2008). Computer-based and paper-and-pencil administration mode effects on the statewide end-of-course English test. *Educational and Psychological Measurement, 68*(4), 554-570. doi: 10.1177/0013164407310132

Kim, D. H., & Huynh, H. (2009). Transitioning from paper-and pencil to computer-based testing: Examining stability of Rasch latent trait across gender and ethnicity. In E. V. Smith & G. E. Stone (Eds.), *Criterion-referenced testing: Practice analysis to score reporting using Rasch measurement* (pp. 121-137). Maple Grove, MN: JAM Press.

Kim, D. H., & Huynh, H. (2010). Equivalence of paper-and-pencil and online administration modes of the statewide English test for students with and without disabilities. *Educational Assessment, 15*(2) 107-121. doi: 10.1080/10627197.2010.491066

Kingston, N. M. (2009). Comparability of computer- and paper-administered multiple-choice test for k-12 populations: A synthesis. *Applied Measurement in Education, 22*(1), 22-37. doi: 10.1080/08957340802558326

Kinzer, C. K., Sherwood, R. D., & Bransford, J. D. (1986). *Computer strategies for education*. Columbus, OH: Merrill Publishing Co.

Lesage, M., Riopel, M., & Raîche G. (2010). Cluster assessment: A complimentary aspect of cluster learning in J. Sanchez & K. Zhang (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2010* (1959-1966). Chesapeake, VA: AACE.

Levine, Y., & Donitsa-Schmidt, S. (1998). Computer use, confidence, attitudes, and knowledge: A casual analysis. *Computers in Human Behavior, 14*(1), 125-146.

Linn, R. L. (2000, March). Assessments and accountability. *Educational Researcher, 29*(2), 4-16. doi: 10.3102/0013189X029002004

Lunenburg, F. C., & Irby, B. J. (2008). *Writing a successful thesis or dissertation: Tips and strategies for students in the social and behavioral sciences.* Thousand Oaks, CA: Corwin Press.

MacCann, R. (2006). The equivalence of online and traditional testing for different subpopulations and item types. *British Journal of Educational Technology, 37*(1), 79-91. doi: 10.1111/j.1467-8535.2005.00524.x.

MacMillan, D. (2009, July). Tech in schools: Federal cuts sow concern. *Bloomberg Businessweek Technology*. San Francisco, CA. Retrieved from http://www.businessweek.com/technology/content/jul2009/tc20090710_519786.htm

Marzano, R. J. (2003). *What works in schools: Translating research into action.* Alexandria, VA: Association for Supervision and Curriculum Development.

Maurer, M., & Simonson, M. (1984, January). Development and validation of a measure of computer anxiety. In: M. Simonson. *Proceedings of Selected Research Paper Presentations, the 1984 Convention of the Association for Educational Communications and Technology* (pp. 310-330). Paper presented at The Convention of the Association for Educational Communications and Technology, Dallas, TX.

Mazzeo, J., & Harvey A. (1988). *The equivalence of scores from automated and conventional educational and psychological tests: A review of the literature* (Research Report No. CBR-87-8), ETS RR-88-21). Retrieved from http://research.collegeboard.org/sites/default/files/publications/2012/7/researchreport-1988-8-equivalence-scores-automated-conventionall-tests.pdf

McDonald, A. S. (2002). The impact of individual differences on the equivalence of computer-based and paper-and-pencil educational assessments. *Computer & Education, 39*(3), 299-312. doi: 10.1016/S0360-1315(02)00032-5

McIlroy, D., Bunting, B., & Tierney, K. (2001). The relation of gender and background experience to self-reported computer anxieties and cognitions. *Computers in Human Behavior, 17*(1), 21-33.

Messineo, M., & DeOllos, I. Y. (2005). Are we assuming too much?. *College Teaching, 53*(2), 50-55.

Millsap, C. M. (2000). *Comparison of computer testing versus traditional paper and pencil testing* (Doctoral dissertation). Retrieved from http://search.proquest.com.proxyb.kclibrary.org

Missouri Department of Elementary and Secondary Education. (1996, January). *The Show-Me Standards.* Retrieved from http://dese.mo.gov/show-me-standards

Missouri Department of Elementary and Secondary Education. (2004). *Questions & answers about No Child Left Behind: 2004 update.* Retrieved from http://dese.mo.gov/divimprove/fedprog/grantmgmnt/documents/QA_NCLB_08162004.pdf

Missouri Department of Elementary and Secondary Education. (2008, Nov. 12). *State policies on reading assessment, "Reading improvement plans," student retention and MAP testing.* Retrieved August 2, 2014, from http://dese.mo.gov/college-career-readiness/curriculum/english-language-arts/senate-bill-319

Missouri Department of Elementary and Secondary Education. (2011). *Free and reduced price application and direct certification: Information and procedures.* Retrieved from http://dese.mo.gov/sites/default/files/FreeandReduced-DirectCertbooklet2011-2012.doc

Missouri Department of Elementary and Secondary Education. (2013). *MSIP 5 Performance Standards* [PowerPoint slides]. Retrieved from http://dese.mo.gov/webinar/documents/MSIP5PerformanceStandards3-1-13.pdf

Missouri Department of Elementary and Secondary Education, (2014). *Quick facts: District and school information.* Retrieved from http://mcds.dese.mo.gov/quickfacts/Pages/District-and-School-Information.aspx

National Center for Fair and Open Testing. (2002). *Computerized testing: More questions than answers* (Fact Sheet). Retrieved from http://fairtest.org/facts/computer.html

Neuman, G., & Baydoun, R. (1998). Computerization of paper-and –pencil test: When are they equivalent? *Applied Psychological Measurement, 22*(1), 71-83. doi: 10.1177/01466216980221006

No Child Left Behind Act of 2001, Pub. L. No. 107-110 § 101 (2002).

U.S. Office of Management and Budget. (1997). *Revisions to the standards for the classification of federal data on race and ethnicity.* Retrieved from http://www.whitehouse.gov/omb/fedreg_1997standards/

Olson, L. (2003, May). Legal twists, digital turns: Computerized testing feels the impact of 'No Child Left Behind'. *Education Week, 22*(35), 11-14.

Park, J. (2003). A test-taker's perspective. *Education Week, 22*(35), 15.

Parshall, C. G., Spray, J. A., Kalohn, J. C., & Davey, T. (2002). *Practical considerations in computer-based testing.* doi: 10.1007/978-1-4613-0083-0_1

Peak, P. (2005). *Recent trends in comparability studies.* (Research Report no. 0505). Retrieved from Pearson Educational Measurement website: www.pearsonassessments.com/NR/rdonlyres/.../OnlineorPaper.pdf

Pellegrino, J. W., & Quellmalz, E. S. (2010). Perspectives on the integration of technology and assessment. *Journal of Research on Technology in Education, 43*(2), 119-134.

Perie, M., Marion, S., Gong, B., & Wurtzel, J. (2007). The role of interim assessments in a comprehensive assessment system. *Measures that Matter* [Policy Brief]. Retrieved from http://www.achieve.org/files/TheRoleofInterimAssessments.pdf

Poggio, J., Glasnapp, D. R., Yang, X., & Poggio, A. J. (2005). A comparative evaluation of score results from computerized and paper and pencil mathematics testing in a large scale state assessment program. *Journal of Technology, Learning, and Assessment, 3*(6). Retrieved from http://www.jtla.org

Pommerich, M. (2004). Developing computerized versions of paper-and-pencil tests: Mode effects for passage-based tests. *Journal of Technology, Learning, and Assessment 2*(6). Retrieved from http://escholarship.bc.edu/jtla/vol2/6/

Pomplun, M., Ritchie, T., & Custer, M. (2006). Factors in paper-and-pencil and computer reading score differences at the primary grades. *Educational Assessment, 11(2),* 127-143. doi: 10.1207/s15326977ea1102_3

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common core standards: The new U.S. intended curriculum. *Educational Researcher, 40*(3), 103-116.

Prensky, M. (2001). Digital natives, digital immigrants. *MCB University Press, 9*(5), 1-6. Retrieved from http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf

Prensky, M. (2005, December). *Shaping tech for the classroom.* Retrieved from http://www.edutopia.org/adopt-and-adapt-shaping-tech-for-classroom

Prensky, M. (2013). Our brains extended. *Educational Leadership, 70*(6), 22-27.

Protheroe, N. (2008). District support for school improvement. *Principal, 87*(3), 36-39.

Public Broadcasting Service. (2001). Master timeline [1900]. *School: The story of American public education, roots in history.* Retrieved from https://www.pbs.org/kcet/publicschool/roots_in_history/choice_master3.html

Quellmalz, E. S., & Pellegrino, J. W. (2009). Technology and testing. *Science, 323*(5910), 75-79. doi: 10.1126/science.1168046

Quick, H. E., & Gallagher, L. P. (2004, April). *A closer look at the digital divide: Computer access and use for disadvantaged students.* Paper presented at annual meeting of the American Educational Research Association, San Diego, CA.

Rabinowitz, S., & Brandt, T. (2001). Computer-based assessment: Can it deliver on it's promise? *Knowledge Brief.* Retrieved from: http://wested.org

Rastogi, S., Johnson, T. D., Hoeffel, E. M., & Drewery Jr., M. P. (2011). *The black population: 2010 census briefs.* (C2010BR-06). Retrieved from: United States Census Bureau http://www.census.gov/prod/cen2010/briefs/c2010br-06.pdf

Rowe, N. C. (2004). Cheating in online student assessment: Beyond plagiarism. *Online Journal of Distance Learning Administration, 7*(2), 1-10. Retrieved from http://www.westga.edu/~distance/ojdla/summer72/rowe72.html

Segall, D. (1997). Equating the CAT-ASVAB. In W. Sands, B. Waters, & J. McBride (Eds.), *Computerized adaptive testing: From inquiry to operation* (pp. 181-198). Washington, DC: American Psychological Association.

Serwata, J. (2003). Assessment in on-line CISs courses. *Journal of Computer Information Systems, 44,* 16-20.

Sloan, W. (2010, December). Coming to terms with common core standards. *ASCD, 16*(4). Retrieved from http://www.ascd.org/publications/newsletters/policy-priorities/vol16/issue4/full/Coming-to-Terms-with-Common-Core-Standards.aspx

Smarter Balanced Assessment Consortium. (2012). *If states administer a paper-and-pencil version of the assessment, will scores be comparable with the computer adaptive test?* [FAQ]. Retrieved from http://www.smarterbalanced.org/faq/36-if-states-administer-a-paper-and-pencil-version-of-the-assessment-will-scores-be-comparable-with-the-computer-adaptive-test/

Stenner, A. J. (1996, October). *Measuring reading comprehension with the Lexile framework.* Paper presented at the California Comparability Symposium, Burlingame, CA.

Stephens, D. (2001). Use of computer assisted assessment: Benefits to students and staff. *Education for Information, 19*(4), 265-275.

Stocking, M. L., & Swanson, L. (1993). A method for severely constrained item selection in adaptive testing. *Applied Psychological Measurement, 17,* 277-292.

Sutton, R. E., (1991). Equity and computers in the schools: A decade of research. *Review of Educational Research, 61*(4), 475-503.

Trotter, A. (2002). Testing computerized exams. *Education Week, 20*(37), 30-35.

Trotter, A. (2003). A question of direction. *Education Week, 22*(35), 17-20.

Urban, C. M. (1986). *Inequities in computer education due to gender, race, and socioeconomic status* (Doctoral dissertation). Retrieved from http://eric.ed.gov/?id=ED279594

U.S. Department of Education, National Center for Educational Statistics, (2000). *Digest of educational statistics.* Retrieved from nces.ed.gov/programs/digest/d00/dt424.asp

U.S. Department of Education, Office of Planning, Evaluation and Policy Development, ESEA. (2010). *Blueprint for reform: The reauthorization of elementary and secondary education act.* Retrieved from http://www2.ed.gov/policy/elsec/leg/blueprint/blueprint.pdf

U.S. Department of Education. (2013, May). *Race to the top assessment program.* Retrieved from http://www2.ed.gov/programs/racetothetop-assessment/index.html

Viadero, D. (2000, March). Lags in minority achievement defy traditional explanations. *Education Week, 19*(28), 18-22.

Wainer, H. (1990). *Computerized adaptive testing: A primer.* Hillsdale, NJ: Erlbaum.

Walsh, M. (2003, May). Marketing to the test: Companies envision profits in computer-based assessment. *Education Week's Technology Counts, 22*(35), 34-39.

Wang, S., Jiao, H., Young, M. J., Brooks, T., & Olson, J. (2008). Comparability of computer-based and paper-and-pencil testing in K-12 reading assessments: A meta-analysis of testing mode effects. *Educational and Psychological Measurement, 68*(1), 5-24. doi: 10.1177/0013164407305592

Weaver, A. J., & Raptis, H. (2001). Gender differences in introductory atmospheric and oceanic science exams: Multiple choice versus constructed response questions. *Journal of Science Education and Technology, 10*(2), 115-126.

Whitaker, T. A., Williams, N. J., & Dodd, B. G. (2011). Do examiners understand score reports for alternate methods of scoring computer-based tests?. *Educational Assessment, 16*(2), 69-89.

Wise, S. L., & Plake, B. S. (1989). Research on the effects of administering tests via computers. *Educational Measurement: Issues and Practice, 8*(3), 5-10. doi: 10.1111/j.1745-3992.1989.tb00324.x

Wienberg, S. B., & Fuerst, M. (1984). *Computerphobia: How to slay the dragon of computer fear.* Wayne, PA: Banbury Books.

Appendices

Appendix A: Maximum Annual Household Income Eligible for Free and Reduced Priced Meals

Household Size	Reduced Priced Meals	Free Meals
1	20,147	14,157
2	27,214	19,123
3	34,281	24,089
4	41,348	29,055
5	48,415	34,021
6	55,482	38,987
7	62,549	43,953
8	69,616	48,919
For each additional person, add	+7,067	+4,966

Note: Adapted from "Missouri Department of Elementary and Secondary Education School Food Service Section," by the Missouri Department of Elementary and Secondary Education, 2011 May 5. Retrieved from http://dese.mo.gov/divadm/food/.

Appendix B: Baker University IRB Application

Date:_____

SCHOOL OF EDUCATION
GRADUATE DEPARTMENT

IRB PROTOCOL NUMBER _____
(IRB USE ONLY)

IRB REQUEST
Proposal for Research
Submitted to the Baker University Institutional Review Board

I. Research Investigator(s) (Students must list faculty sponsor first)

Department(s) **School of Education Graduate Department**

Name	Signature	
1. Dr. Verneda Edwards	_____	Major Advisor
2. Margaret Waterman	_____,	Research Analyst
3. Dr. Susan Rogers		University Committee Member
4. Dr. Robert Poisal		External Committee Member

Principal Investigator: Alisa Elaine Seidelman
Phone: 816.645.9016
Email: aseidelman@bsd124.org
Mailing address: 3223 SW Amber Court
Lee's Summit, Missouri 64082

Faculty sponsor: Dr. Verneda Edwards
Phone: 913.344.1227
Email: vermeda.edwards@bakeru.edu
Expected Category of Review: ____Exempt X Expedited ____Full

II: Protocol Title
A COMPARISON OF READING COMPREHENSION SCORES OBTAINED BY FIFTH AND SIXTH GRADE STUDENTS: PAPER/PENCIL VERSUS COMPUTER ASSESSMENTS

Summary

The following summary must accompany the proposal. Be specific about exactly what participants will experience, and about the protections that have been included to safeguard participants from harm. Careful attention to the following may help facilitate the review process:

In a sentence or two, please describe the background and purpose of the research.

The purpose of this study is to explore the difference between paper/pencil Communication Arts Acuity Diagnostic scores and computer-based Communication Arts Acuity Diagnostic scores for fifth and sixth grade students at Mill Creek Upper Elementary in Belton, Missouri. Mill Creek Upper Elementary is a low-socioeconomic school from a midsized, suburban public school district. This study will also determine how race, gender, and socioeconomic status contribute to Communication Arts Acuity Diagnostic scores with the use of technology and without the use of technology.

Briefly describe each condition or manipulation to be included within the study.

There is no manipulation within this study. The condition in the study is test mode (paper/pencil or computer-based). Each participant will take the exact same test, but the mode of the test will vary depending on their group placement. Systemic assignment will be used to form Group A and Group B. All students will be ranked within their respective fifth and sixth grade level peers, in number order from highest scoring to lowest scoring based on their Acuity Predictive C scale scores. Group A will be created by taking all odd numbered students from the fifth and sixth grade Acuity Predictive C achievement rankings, and Group B will be formed by taking all even numbered students from the fifth and sixth grade Acuity Predictive C achievement rankings. The Acuity Predictive C scores will be pulled from archival data from the Belton School District.

What measures or observations will be taken in the study? If any questionnaire or other instruments are used, provide a brief description and attach a copy.

Student reading ability will be measured using historical Acuity Predictive C data from January 2012. Additionally, student reading achievement will be measured in May 2012 by taking the highest score obtained by each student from the Acuity Diagnostic form one and the Acuity Diagnostic form two. Fifth and sixth grade Acuity Diagnostic assessments differ based on what is grade level appropriate for the respective groups. All measures that will be used in this study were created by CBT/McGraw-Hill LLC and have been purchased for student use by the Belton School District. No observations will be conducted and no questionnaires will be utilized in this study.

Will the subjects encounter the risk of psychological, social, physical, or legal risk? If so, please describe the nature of the risk and any measures designed to mitigate that risk.

The subjects will not encounter any psychological, social, physical, or legal risk in this study.

How will you ensure that the subjects give their consent prior to participating? Will a written consent form be used? If so, include the form. If not, explain why not.

The Acuity Diagnostic assessments are a part of the regular school day. Therefore, there is no need to obtain consent from individuals.

Will any aspect of the data be made a part of any permanent record that can be identified with the subject? If so, please explain the necessity.

Individual identification will not occur in any final report for this study. All information that identifies individual student identity will be destroyed or will remain in the school district's possession. If data remains in the school district's possession, standard district protocol will be followed to ensure the data is securely stored.

Will the fact that a subject did or did not participate in a specific experiment or study be made part of any permanent record available to a supervisor, teacher or employer? If so, explain.

Individual data will not be published. Students who are in the paper/pencil group will not have Acuity Diagnostic data made part of any permanent record. Students who are in the computer-based group will have their Acuity Diagnostic assessments scored by the computer and stored in the Acuity database. This database is accessible to teachers and administrators. Acuity assessments were purchased by the school district for student use as a part of the regular school day.

What steps will be taken to ensure the confidentiality of the data?

Data gathered will be reviewed by the researcher and will remain confidential. Individual names will not be associated with personal data or responses reported in the results of the study. Participants who take the Acuity Diagnostic assessment on the computer will have their data retrieved by the researcher from the computer database. Participants who take the Acuity Diagnostic assessment using paper/pencil will have their data entered into an Excel document by an administrative intern completing internship hours in the Belton School District. Data from the Excel document will be destroyed after the study, and data from the computer will go into a database in which teachers and administrators have access. Data available to teachers and administrators is data that the schools district collects during the regular school day.

If there are any risks involved in the study, are there any offsetting benefits that might accrue to either the subjects or society?

There are no risks involved in this study. Benefits of this study are to add to the knowledge based of earlier studies investigating reading comprehension scores when comparing assessment results taken on a computer versus paper/pencil. Additionally, this study will help educators understand how different subgroups based on race, gender, and socioeconomic status may respond differently to reading assessments taken on a computer versus paper/pencil.

Will any stress to subjects be involved? If so, please describe.

No stress will be experienced by any of the subjects in this study.

Will the subjects be deceived or misled in any way? If so, include an outline or script of the debriefing.

The subjects will not be deceived or misled in any way.

Will there be a request for information that subjects might consider to be personal or sensitive? If so, please include a description.

No personal or sensitive information will be requested from the subjects. All personal demographic data is archival and currently available from the Belton School District.

Will the subjects be presented with materials that might be considered to be offensive, threatening, or degrading? If so, please describe.

The subjects will not be presented with materials that might be considered offensive, threatening, or degrading.

Approximately how much time will be demanded of each subject?

It is expected that each assessment will require 20-30 minutes to complete, equaling a total of 40 minutes to 1 hour in length.

Who will be the subjects in this study? How will they be solicited or contacted? Provide an outline or script of the information which will be provided to subjects prior to their volunteering to participate. Include a copy of any written solicitation as well as an outline of any oral solicitation.

Fifth and sixth grade students at Mill Creek Upper Elementary in the Belton School District will be the subjects in the study. There is no need to solicit or contact students since the study will be conducted during the school day with assessment materials purchased and utilized by the Belton School District.

What steps will be taken to ensure that each subject's participation is voluntary? What if any inducements will be offered to the subjects for their participation?

The Acuity Diagnostic assessments are a part of the regular school day. Therefore, there is no need to ensure participation is voluntary.

Will any data from files or archival data be used? If so, please describe.

Acuity Predictive C data will be retrieved from Mill Creek Upper Elementary School's electronic archives located in the Acuity database. Only data from students enrolled during the 2011-2012 school year will be used to create balance among Group A and Group B. Individual students will not be identified in this study.

Appendix C: Belton School District Approval Letter

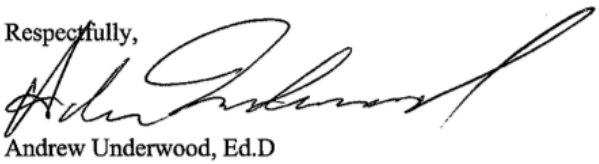
April 9, 2012

To Whom it May Concern:

After reading the proposal for research submitted by Alisa Seidelman on March 31, 2012, please accept this letter as my approval for this project. This approval includes the use of the Belton School District name as well as that of individual schools within the Belton School District. Additionally, permission is granted for Mrs. Seidelman to access Mill Creek Upper Elementary School's Acuity Predictive C archival data as well as collect Acuity Diagnostic data from fifth and sixth grade students at Mill Creek Upper Elementary. It is my understanding that this data will be collected, examined, and presented in the form of a dissertation by Mrs. Seidelman. I would only ask that the information be shared with the Belton School District upon its completion.

If there are any questions or concerns regarding my support for this project, please do not hesitate to contact me. I look forward to reviewing the findings of this research.

Respectfully,



Andrew Underwood, Ed.D

Appendix D: Baker University IRB Approval Letter

BAKER UNIVERSITY
Own Confidence

April 17, 2012

Ms. Alisa Elaine Seidelman
3223 SW Amber Court
Lee's Summit, MO 64082

Dear Ms. Seidelman:

The Baker University IRB has reviewed your research project application (E-0135-0412-0417-G) and approved this project under Expedited Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

The Baker University IRB requires that your consent form must include the date of approval and expiration date (one year from today). Please be aware of the following:

1. At designated intervals (usually annually) until the project is completed, a Project Status Report must be returned to the IRB.
2. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
3. Notify the OIR about any new investigators not named in original application.
4. Any injury to a subject because of the research procedure must be reported to the IRB Chair or representative immediately.
5. When signed consent documents are required, the primary investigator must retain the signed consent documents for at least three years past completion of the research activity. If you use a signed consent form, provide a copy of the consent form to subjects at the time of consent.
6. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.

Please inform Office of Institutional Research (OIR) or myself when this project is terminated. As noted above, you must also provide OIR with an annual status report and receive approval for maintaining your status. If your project receives funding which requests an annual update approval, you must request this from the IRB one month prior to the annual update. Thanks for your cooperation. If you have any questions, please contact me.

Sincerely,

Carolyn Doolittle, EdD
Chair, Baker University IRB

Appendix E: Acuity Research Synopsis Prepared for Alisa Seidelman

ACUITY

Research Synopsis Prepared for Alisa Seidelman
Belton SD 124, Belton, MO
Dissertation Evidence

The diagnostic assessments can be used to provide a better understanding of students' mastery of skills, aligned to the Common Core standards. The diagnostic assessments can be also used to provide educators with an ongoing formative assessment tool to better understand students' mastery of skills, aligned to the Common Core standards, to be taught according to the curriculum. The diagnostic assessments will report student performance on Common Core standards. In addition to the diagnostic pre-built forms, the diagnostic item bank can be used by educators to build their own custom diagnostic forms with content targeted for specific instructional periods, for low, average, and high-performing students, as well as create multiple forms of the tests. Fewer skills per standard could also be assessed if desired, so there could be more items per skill to provide an even more detailed diagnostic report to better guide instruction.

CTB implements its classical analyses of the common core diagnostic assessments and item bank using our Standard Operating Procedures (SOP) for each data processing step. Each step in the SOP includes a detailed review of output and programmed quality control procedures.

There are three very important criteria that need to be considered when judging the technical quality of a test or assessment system. First and foremost is validity—does the test measure what it is intended to measure and can we justify the inferences we make from the results of the test? Second is reliability, which is a necessary but not sufficient requirement for validity. Reliability estimates provide the test user with evidence that what is being measured is being measured consistently. The third is fairness—the test does not provide an unfair advantage to one group of students and/or provide a disadvantage to another.

Validity

The content and construct validity and generalizability of the common core items and forms are supported by the alignment of the assessments to the Common Core State Standards. Our assessment strategy is to develop detailed item specifications that are aligned to a specific content standards (first level of specificity), sub-content standard (second level of specificity), and indicator (third level of specificity). The diagnostic assessments for each grade and course model available information from the test blueprints in terms of content coverage given to each standard and its objectives; the content coverage on the common core assessments reflect the Common Core State Standards. These design foundations support both the content and construct validity of these assessments; this approach to test development should result in the measurement of the same overall construct. In addition, the items in the item bank can be used to construct a variety of assessments aligned to pre-specified blueprints.

Reliability

Estimating reliability for tests that contain only items that can be scored dichotomously (multiple-choice, fill-in-the blank, or matching items, for example) is different than estimating reliability for constructed-response items and tasks where multiple score points are possible. A reliability model that reflects these differences in score points must be used for tests with constructed-response items. The Feldt-Raju approach to estimating reliability was used for the *diagnostic assessments* as these exams contain both multiple-choice and constructed-response items.

The reliability coefficient is a ratio of the variance of true test scores to those of the observed scores, it is a positive correlation coefficient of true test score to observed scores with the values ranging from 0 to 1. The closer the value of the reliability coefficient is to 1, the more consistent the scores.

ACUITY

Research Synopsis Prepared for Alisa Seidelman
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Dissertation Evidence

Item Analysis

Items in the *diagnostic assessments* undergo rigorous classical test and item analyses after data is collected. Classical analyses included p-values, point biserials, distractor analyses, Mantel-Haenszel differential item functioning (bias) indices, and test reliability coefficients.

Item Difficulty

The p-value of a multiple-choice item is the proportion of students responding correctly to the item. For a constructed-response item, the p-value is the average number of score points obtained divided by the total number of score points possible. For example, if the average for a 2-point item is a score of 1, then the p-value for the item is 0.5. A broad range of p-values is desired to measure a diverse range of students.

Point-Biserial Correlation

The point-biserial is a measure of internal consistency (i.e., reliability) that can range from -1 to 1. The point-biserial is a correlation of students' response to the item relative to their performance on the rest of the assessment. Positive point-biserials for the correct response indicate that students who tended to do well on the test overall also tended to respond successfully to the item. Negative point-biserials for the distractors indicate that students who tended to score lower on the test overall also tended to pick the incorrect distractor. It is desirable for the point-biserial correlation for the correct option to be positive and the point-biserial correlation for the incorrect distractor to be negative.

Distractor Analysis

Distractor analyses for multiple-choice items examine the percent of students selecting each response option, or distractor. It is desirable for the proportion of students selecting the correct answer to be greater than the proportion of students selecting any of the other distractors.

Differential Item Functioning Analyses

Item reviewers often find it difficult to ascertain which items perform differently between specific subgroups of students, apparently because some of their ideas about how students will react to items may be inaccurate (Camilli & Shepard, 1994; Jensen, 1980; Sandoval & Mille, 1979; Scheuneman, 1984). Thus, we also used an empirical approach to help identify potentially biased items. For language tests, these are differential item functioning (DIF) studies, since criterion-related validities are essentially unobtainable for such tests. DIF studies include a systematic item analysis to determine if students with the same underlying level of ability have the same probability of getting the item correct. Items identified with DIF are then examined to determine if item performance differences between identifiable subgroups of the population are due to extraneous or construct-irrelevant information, making the items unfairly difficult. The inclusion of these items is minimized in the test development process. DIF studies have been routinely done for all major test batteries published by CTB after 1970. Differential item functioning of the Acuity assessment operational/field-test items was assessed for students identified as males and females and ethnicity (Hispanic, African American, Asian/Pacific Islander, Native American, and White) at each course level and form in which the items were administered.

We use the Mantel-Haenszel procedure for estimating DIF. To avoid flagging items for DIF that are statistically significant but not of practical significance, interpretation of the DIF flag is based on both effect size and statistical significance. The Mantel-Haenszel delta (ΔMH) is a measure of effect size. A delta value greater than one and statistically significant is flagged for DIF based on a combination the two conditions. An example in the current practice is the three-level classification (Zieky 1993; Zwick & Ercikan, 1989). Items classified in the first level (A), have a ΔMH with an absolute value of less than 1 or have a value that is not significantly different than zero ($p<0.05$). Items in the third level (C) have a ΔMH

with absolute value greater than 1.5. Items in level B are those that do not meet condition A or C and have a delta value between 1 and 1.5 and are statistically significant. Items classified as A are considered to display little or no DIF. Item classified as B have moderate DIF. Items classified as C have large DIF. As soon as enough data has been collected for a given assessment, DIF is run and items are reviewed by content exports if flagged for C-level DIF and are to be used only if content experts consider them essential; otherwise they are removed from the item pool.

High type I error rates increases the cost of constructing and revising items and can also result in good items being flagged and discarded at a higher rate than necessary. To control for type I error, the overall nominal alpha is computed using the Bonferonni adjustment method. For example, nominal alpha of 0.05 can be divided by the number of items in the test for the critical value for the Bonferonni adjustment. The nominal alpha and the resulting critical value from the Bonferonni can be set in the SAS or SPSS program used in the computation of DIF. Using the combination of effect size and statistical significance, items with DIF will then be correctly identified. A positive indicates the item favors the focal group (i.e., females, Hispanic, African American, Asian/Pacific Islander, and Native American), and a negative value indicates the item favors the reference group (male and white).

CTB has provided summary statistics for Grade 5 and 6 ELA diagnostic assessments in Table XX. The reliability of these tests, as reported, is appropriate for tests of these lengths.

Content	Grade	Form	No. of Students	No. of Items	Total Score Points	Mean Number Correct	Number Correct SD	Average Difficulty	Form Reliability
LA	05	Form1	915	22	26	12.04	4.20	0.56	0.64
LA	05	Form2	521	22	25	13.63	4.48	0.59	0.76
LA	05	Form3	3808	22	25	11.99	4.65	0.53	0.76
LA	05	Form4	1782	22	25	10.53	4.41	0.47	0.72
LA	06	Form1	701	22	25	10.27	4.05	0.48	0.65
LA	06	Form2	179	22	25	12.62	4.03	0.56	0.68
LA	06	Form3	3954	22	25	11.19	4.68	0.50	0.74
LA	06	Form4	1688	22	25	9.31	4.02	0.42	0.63