The Relationship Between the DIBELS Math Program and Changes in NWEA MAP Mathematics Assessment Scores For Fourth Grade Students

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Abstract

Improving student proficiency and growth in mathematics education is important for the future success of our nation, schools, and students. The purpose of this study was to examine if there was a change in Northwest Evaluation Associate Measures of Academic Progress (NWEA MAP) mathematics assessment scores for fourth grade students after the adoption of the DIBELS Math program. This study was also conducted to determine if the change in mathematics test scores differed between male and female students, minority versus non-minority students, and students who did not receive free and reduced lunch compared to those who did receive free lunch. Additionally, this study was conducted to examine the change in mathematics test scores for students who received consistent progress monitoring utilizing the DIBELS Math program, and those who did not. The results of an independent-samples *t* test showed no statistically significant, positive impact from the DIBELS Math program on the average change in mathematics proficiency scores for fourth grade students. The results of multiple independent-samples *t* tests also show no statistically significant, positive impact from the DIBELS Math program on the average change in mathematics proficiency scores for fourth grade students based on gender, ethnicity, or socioeconomic status. The results of this study have implications for classroom teachers, building leaders, and district leaders who are working to ensure mathematics proficiency for all students. Recommendations for future research are also included in the study.

Dedication

This work is dedicated to my entire family, immediate and extended, who have always encouraged me to relentlessly pursue the things I hope to achieve in life. You taught me to strive for things even though they might be difficult, and to approach the improbable with enthusiasm. The task of completing a doctoral degree has seemed daunting at many points along the way, but the values and determination you shared with me have helped me to persevere. I am grateful for your guidance, sacrifices, and support.

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Finally, to the students I have had the pleasure to know and serve, and those I have not met, I dedicate this work. Your promise and potential are my motivation and the reason I believe we must continue to grow as educators.

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Chapter 1

Introduction

Mathematics skills are crucial for the future success of students. However, mathematics performance for American students has steadily declined for the past 30 years. Researchers have maintained that children in the United States are no longer competing with students from other westernized countries (Schmidt & Burroughs, 2015), which creates consequences for the American workforce, economy, and families (Lehman, 2013). Corporations have expressed the need to hire employees with a background in mathematics and engineering; however, they do not have a workforce of well-trained candidates from which to choose (Goodwin & Hein, 2017). It is imperative that we address the mathematical crisis that is growing as a result of deficiencies in mathematics education.

The struggle to improve mathematics education in America is not a new concern. There is evidence of this endeavor dating back to the inception of our country, through World War II, and into the twenty first century. Expectations and rigor have increased as a result of the work of instructional leaders such as DuFour and Marzano (2011). The Common Core State Standards have also been implemented to promote instructional equality for all students (Jochim & McGuinn, 2016). The Response to Intervention (RTI) model became prevalent in schools to meet the needs of all students regardless of differences in mathematical ability (Turse & Albrecht, 2015). Education leaders and policymakers have known that mathematics education in America has been inadequate for nearly a century (Woodward, 2004); however, an answer to the problem remains elusive.

Although individualized, targeted mathematics support is needed across communities and school districts in America, the need is even greater in educational communities with higher percentages of diverse students and students with a low socioeconomic status (SES) (Spencer, 2012). A student from a family with low income in the United States is less likely to perform well in mathematics than a student from a family with a median income, and students from ethnicities labeled "nonwhite" are typically two to three years behind learners of the same age (McKinsey & Company, 2009). Additionally, minority students enroll in remedial college mathematics courses as a result of gaps in their mathematics education at a greater rate than their peers (Howell, 2011).

An emerging program for mathematics assessment and monitoring aims to address many of these long-standing problems with mathematics education. The publishers of the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) have been supporting literacy interventions across America since the late 1980s (Kaminski, Cummings, Powell-Smith, & Good, 2007), and have developed a similar program targeting mathematics proficiency for all students. DIBELS Math employs similar strategies that have contributed to the success of the DIBELS literacy program, including progress monitoring, measures of adequate student growth, and instructional support based on individual student needs (Wheeler, 2016). This study explored the extent of the impact this new program had on changes in student test scores in mathematics for all students, as well as low SES students, minority students, and female students compared to male students.

Background

The XYZ School District (XYZSD) was founded in 1969 when thirteen individual school districts in a Midwestern suburb unified. At the time of this study, the XYZ School District was the 3rd largest school district in the state with over 27,000 students enrolled, and it encompassed over 72 square miles. The district included 33 elementary schools, 5 middle schools, and 5 high schools to serve a diverse student population.

XYZSD leaders noticed that students' mathematics scores on standardized tests remained stagnant or declined for several years across grade levels ranging from kindergarten to sixth grade (XYZSD, 2015). Therefore, XYZSD began examining educational tools that could assist teachers and instructional leaders with determining individual student intervention needs and monitoring students' progress toward goals throughout the school year. DIBELS Math is a set of measures that helps teachers identify students at risk of struggling with current and future mathematics content and assists teachers in identifying areas of individualized, targeted support (Wheeler, 2016). The DIBELS Math program also enables teachers to evaluate the effectiveness of instructional support and monitors student progress throughout the elementary grades (Wheeler, 2016). DIBELS Math was the sole mathematics program known to district leaders that offered these features in addition to benchmark assessments and individualized suggestions for intervention.

Additionally, XYZSD already utilized the DIBELS literacy program. Therefore teachers, patrons, and students were familiar with the format of the program, reports, and data collection software. The DIBELS Math program integrated with the district's RTI model and had the potential to increase student performance in mathematics on standardized tests.

Statement of the Problem

The XYZSD was searching for a mathematics tool that aligned with an RTI framework to help students increase mathematics scores and close the achievement gap for at risk students. From 2009 to 2014, across all seven elementary grade levels, there was no increase in student NWEA MAP Math scores (XYZSD, 2015). Additionally, student Rasch Unit (RIT) scores in the seven grade levels decreased consistently following the fall of 2011 (XYZSD, 2015). Without a system level change, this trend was expected to continue and student growth would remain stagnant. This study focused on examining changes in students' NWEA MAP mathematics assessment scores after the implementation of the DIBELS Math program. This study specifically examined changes in scores for male and femle students, minority students, and low SES students after the implementation of the DIBELS Math program.

Purpose of the Study

The first purpose of this study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students. The second purpose of the study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade male and female students. The third purpose of the study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade minority students. The fifth purpose was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS

Math program for fourth grade students categorized as low SES, and those not categorized as low SES. The final purpose of this study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students who received consistent progress monitoring utilizing the DIBELS Math program and students who did not receive consistent progress monitoring.

Significance of the Study

Student progress in mathematics had been stagnant in recent years in the XYZ School District, and standardized test scores indicated that current methods and interventions were not producing the results district leaders desired. This study will examine the change in NWEA MAP Math scores after the implementation of the DIBELS Math program and compare the effects on female and male students, minority students, and low SES students to the overall population. There is limited research available on the program due to its recent release; therefore, the research conducted within this study can assist district leaders in examining the value and usefulness of the program for the students and communities they serve.

Delimitations

Delimitations are restrictions established to determine the scale and purpose of the study. This study included the following delimitations:

1. This study included fourth grade students from the XYZ School District and therefore may not directly apply to other districts.

2. Changes in NWEA MAP mathematics assessment scores were analyzed for students who attended the XYZ School District for the duration of the 2015- 2016

school year and completed beginning and end of the year NWEA MAP Mathematics exams.

3. This study was limited to examining the NWEA MAP mathematics scores of fourth graders who completed the NWEA MAP Mathematics exam and the DIBELS Math benchmark exams.

Assumptions

Assumptions are conditions, circumstances, and protocols that are acknowledged and accepted to conduct research. This study included the following assumptions:

1. Students put forth their best effort on the NWEA MAP Mathematics exam and DIBELS Math tests.
2. The sample included all fourth grade students in the XYSD during the 2015-2016 school year and was an accurate representation of the overall population.
3. Proctors correctly administered the NWEA MAP Mathematics exam and DIBELS Math tests.
4. All data were reported and entered correctly.
5. The DIBELS Math program was implemented with fidelity.

Research Questions

The following research questions were addressed to examine the effect of the DIBELS Math program on students' NWEA MAP mathematics assessment scores:

RQ1. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for fourth grade students after one year of implementation of the DIBELS Math program?

RQ2. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for male and female fourth grade students after one year of implementation of the DIBELS Math program?

RQ3. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for fourth grade students of four ethnicities (white, black, Hispanic, and other) after one year of implementation of the DIBELS Math program?

RQ4. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for low SES students and non low SES after one year of implementation of the DIBELS Math program?

RQ5. To what extent was there a difference in the change in scores on the NWEA MAP Mathematics assessment for fourth grade students who received consistent progress monitoring, and fourth grade students who did not receive consistent progress monitoring after one year of implementation of the DIBELS Math program?

Definition of Terms

DIBELS Math. The Dynamic Indicators of Basic Early Literacy Skills Math edition is a set of individually administered measures that evaluate the acquisition of early numeracy skills in students in kindergarten through sixth grade (Kaminski & Cummings, 2007).

NWEA MAP assessment. This assessment is an interim computer adaptive test that measures student achievement in kindergarten through twelfth grade. Scores are reported on a Rasch Unit (RIT) scale and range from 100 to 350 (Northwest Evaluation Association, 2016).

Programme for International Student Assessment (PISA). This is an international comparative student assessment administered to fifteen year olds in 65 countries every three years. The assessment was first administered by the Organization for Economic Cooperation and Development in 2000 and measures reading, mathematics, and problem solving (Taut & Palacios, 2016).

Rasch Unit Score (RIT Score). A RIT score is an equal interval scale that enables comparisons of student growth across grade levels, districts, and states. RIT scores indicate the level of question difficulty where students answer questions correctly fifty percent of the time.

Progress Monitoring. Progress monitoring is the measurement of a student's progression of achievement toward an individualized goal on a weekly or monthly basis in comparison to expected rates of learning. Teaching can be adjusted as needed based on these measurements (Good, 2015).

Low Socioeconomic Status (SES). Students whose families meet the minimum income requirement for free or reduced lunch rates will be defined as low SES.

Consistent Progress Monitoring. Students who completed at least ten progress monitoring assessments over the course of the school year will be defined as consistently progress monitored.

Organization of the Study

The first chapter of this study includes an introduction and background information about the school district where the study was completed. The goal of this study was to compare student growth in mathematics as measured by the NWEA MAP assessment after one year of the DIBELS Math program. The statement of the problem, purposes, significance of the study, and delimitations and assumptions of the study were identified. Additionally, the research questions that guided the study were presented.

Chapter 2 includes a review of the literature regarding student performance on international assessments, inadequacies in mathematical proficiency amongst demographic groups in the United States, a brief history of mathematical practices in the United States, current mathematical practices in the United States, and a synthesis of the DIBELS Math program and its components. In Chapter 3, the methodology of the study is described and includes the research design, selection of participants, measurement, data collection procedures, and hypothesis testing. Chapter 4 contains the results of the data analysis. A summary of the study, findings related to the current literature, and a conclusion that includes implications for action and recommendations for future research are included in Chapter 5.

Chapter 2

Review of the Literature

A Brief History of Mathematics Education in Twentieth Century America

Math in the early twentieth century: 1920s-1940s. In the earliest years of the twentieth century, mathematics education served as a social utility for most students (Waggener, 1996). All citizens were not required to take advanced mathematics courses, and they were considered vital only for the upper class. In 1920, The National Education Association, led by Will Kilpatrick, released a report titled *The Problem of Mathematics in Secondary Education*. This report suggested a decrease in not only the rigor of mathematics courses, but also the need for everyone to take mathematics courses. This rhetoric continued through the 1930s and was perpetuated by a historical document titled *The Reorganization of Mathematics in Secondary Education* written by the National Committee on Mathematical Requirements in association with the Mathematical Association of America (Department of the Interior, 1922). This report was written in response to *The Problem of Mathematics in Secondary Education*. It became more widely known as *The 1923 Report*, and the authors urged America to decrease focus on advanced mathematical courses and instead focus on practical, "lifestyle" mathematics for all (Bidwell & Clason, 1970). These mathematics courses were low rigor and high relevance. Although the two reports contained differing opinions, neither supported an increase in advanced mathematics courses for everyone, and both echoed the pervasive sentiment of the time that mathematics education was a luxury rather than a necessity (Brownell, 1935).

Opinions on mathematics education began to shift in the post-World War I era. During this time the National Council for Teachers of Mathematics (NCTM) was established and more school districts began offering additional high school courses to all students that covered the mathematical topics necessary for everyday life (Jones & Coxford, 1970). World War II accelerated this movement. The United States military reported that an inadequate number of soldiers were prepared to complete the duties needed in the military (Fey & Graeber, 2003). The military was one of the first organizations to recognize a lack of mathematics skills among recruits and questioned the American mathematics education curriculum (Klein, 2003). Top ranking officials recommended that all civilians should have at least “functional competence” (p. 57), in mathematics in order to be prosperous citizens (Willoughby, 1967). Although the number of students enrolled in advanced mathematical courses steadily declined over the first forty years of the twentieth century, these insights from the U.S. military and other leaders began a movement toward change in mathematics education (Klein, 2003).

New Math: 1950s-1960s. As the 1950s began, mathematics education in America was beginning to shift. The emphasis on practical skills and computation drills was fading, and there was a re-emphasis on mathematics theory and application (Fey & Graeber, 2003). Mathematics concepts became increasingly abstract and rigorous, even at the elementary level (Woodward, 2004). The purpose of mathematics education became preparing students for college, and most of the curriculum was being created by the School Mathematics Study Group, a branch of the National Science Foundation. During this time, calculus was added to the American high school curriculum (Klein, 2003).

One international event significantly impacted mathematics education for all students in America during the 1950s. In October of 1957, the Soviet Union launched Sputnik and caused all Americans to suddenly become intensely concerned with the quality of math and science education in the country (Barlage, 1982). As a result, the National Defense Education Act of 1958 was passed and funding was made available for mathematics education nationwide (Woodward, 2004).

Despite the increased interest and enthusiasm for mathematics and science education, the American education system was not prepared to make the rapid shift (Barlage, 1982). Elementary and high school teachers were not prepared to teach high level, abstract mathematical content. Demand for highly trained mathematics and science teachers was created, and a need for focused, rigorous professional development for American teachers was established (Eckstein, 1982). The newfound sense of urgency caused the educational community to respond quickly, but American students' test scores and ability levels did not increase as rapidly. Standardized test scores did not improve, and within a decade, the country returned to a back to basics mentality focused on drill, computation, and accountability rather than application (Waggener, 1996).

Opposing views: 1970s-1980s. Frustration and lack of teacher professional development led to the end of the New Math movement of the 1950s and 60s (Phillips, 2015). America reverted to a low rigor, high relevance mentality and prioritized practicality over abstract math (Eckstein, 1982). However, instead of focusing on memorization and drill, and narrowing the quantity of mathematics topics taught to American students as predecessors in the 1930s and 40s had suggested, the education system adopted a new pedagogy. A. S. Neill released *Summerhill: A Radical Approach* *to Child Rearing* in 1960 and introduced the United States' education system to a new form of progressive education (Neill, 1960). In his work, Neill stressed the importance of play for developing children and continually affirmed that when left to choose for themselves, children would eventually choose to prioritize their education (Cassebaum, 2003). He claimed students should have the freedom to choose what they want to learn and if they want to learn advanced mathematics, they will because they want to, not because of teaching methods or curricular approaches (Darling, 1992).

Neill's message resonated with American educators in the 1970s. In the decade following the release of his book, and in contrast to the New Math era before, educators began to shy away from a focus on basic skills and drills at the elementary level (McLeod, 2003). Simultaneously, the demand for rigor decreased and led to the Open Education Movement. This movement was defined by student choice in curriculum, activity centers, dramatic play, and learning in social situations (McEvers, 2017). *Summerhill* was considered mandatory reading in over 600 university courses and was a best seller at the time (Klein, 2003).

Not everyone agreed that progressive education was the right choice for American schools. Educators in low SES and high minority, urban communities argued that neglecting to teach basic mathematics skills was inadequate for their students (Brodinsky, 1977). Educators pointed out that their students did not arrive at school with a strong foundation of basic mathematical skills and that schools needed to focus on closing the educational gap that was evident in early elementary school (Klein, 2003). Students were not performing well in mathematics, and the need for teaching basic skills became evident.

By the 1980s, educators were seeing low enrollment rates in advanced mathematics courses and low college entry requirements (National Commission on Excellence in Education, 1983). Competency tests were established and became a requirement for graduation, and schools began using standardized tests to measure the quality of education. Standardized tests, competency tests, and enrollment in advanced mathematics courses gained political importance during this decade as well. In 1980 *An Agenda for Action* was released by NCTM. Authors of this influential document urged educators to prioritize problem-solving when teaching mathematics (Fey & Graeber, 2003). They also encouraged the use of manipulatives and de-emphasized paper and pencil computation in response to technological advancements, particularly the availability of advanced calculators for all students (Eckstein, 1982). This report was soon followed by another landmark document. *A Nation at Risk* was published in 1983 by the National Commission on Excellence in Education and generated public interest in mathematics and science education.

A Nation at Risk painted a dismal picture of mathematics education in the United States. The authors claimed the country's global and economic success were at risk as a direct result of the mathematics education available for students (Mehta, 2015). According to the report, mathematics remediation needs in colleges, universities, and businesses were far too high and costing the country money (Thomas B. Fordham Foundation, 1999). This was a direct result of a lack of attention on basic mathematics skills and accountability at the elementary and secondary levels (Smith & Lincoln, 1988). Teacher preparation was questioned, and higher education was accused of offering too many courses on instructional pedagogy, and not enough on mathematics and science content (National Commission on Excellence in Education, 1983). There was also a call for reform to textbooks and standardized tests (Jones, 2009). The release of these documents established an urgency to address mathematics education in America and put to rest many progressive ideas of the prior decade. In 1989, NCTM released the new standards for mathematics education as a result of this new-found urgency and set a precedent for mathematics and science education in the new century (Cauley, 1993).

Excellence in education: 1990s and 2000s. The standards released by NCTM in 1989 were widely accepted by the 1990s, and curriculum was being created and adopted across the nation (Cauley, Walle, & Hoyt, 1993). Americans inside and outside of public education agreed that mathematics and science skills were needed for America to move from an industrial economy to an information economy. Rigor was prioritized, and more attention was given to standardized testing. International tests were subjected to increased scrutiny, and United States mathematics and science curricula came to be known as a mile wide and an inch deep (Schmidt, 2003). The consensus was America was falling behind the rest of the world and we needed to increase our expectations to continue as a world superpower and economic leader. Simultaneously, a call to teach all students, including those with disabilities increased in comparison to previous decades (Woodward, 2004).

One particular piece of legislation during this period became a landmark in the history of mathematics education in America. The No Child Left Behind Act (NCLB) was signed into law by President George Bush in 2002 with bipartisan support (Klein, 2015). NCLB dramatically increased federal involvement in public education and increased the emphasis on standardized testing for accountability purposes (American

Enterprise Institute for Public Policy Research [AEI], 2015). NCLB also emphasized the education of students of specific demographics. English Language Learners (ELL), students in special education, minority students, and low SES students were performing below the level of their peers, and NCLB placed a spotlight on the issue (Blank, 2011). States were not required to conform to this historic piece of legislation, but they were at risk of losing federal funding if they did not (Klein, 2015).

Mathematics education in the United States in the twentieth century was a constant tug of war between rigor and relevance. In the earliest decades, the need for advanced mathematics was not relevant in the daily lives of most civilians, which was reflected in the content of mathematics education at the time. In times when innovation was needed, such as the 1950s, the American education system responded and provided the rigorous mathematics content students would need to transform industries and the economy. As political focuses shifted in the late twentieth century, so did the educational focus. As the War on Poverty and battles for equality were fought in the political arena, the fight to close the achievement gap and provide an education for all was undertaken in public education. Mathematics education in America seemed to adjust based on the needs of the nation over time.

Mathematics Performance In America

Mathematical proficiency amongst American students has been a national concern for many decades. Since 1978, there has been data documentation that students from the United States were underperforming in the area of mathematics (U.S. Department of Education, 2008). In comparison to the other 33 countries that comprised the Organisation for Economic Cooperation and Development (OECD), the United States ranked 28th based on the percentage of students scoring in the top two categories of mathematics proficiency on the 2012 Program for International Student Assessment (PISA) (Kelly, Nord, Jenkins, Chan, & Katsberg, 2013). For comparison, 55% of students from China scored in the top two levels of proficiency on the PISA, whereas 9% of students from the United States performed at the same levels. In contrast, the percentage of students scoring in the lower two categories of the six proficiency categories was significantly higher in the United States than other OECD members. The OECD considered level two to be the lowest standard of proficiency. Twenty six percent of United States students tested scored at level two or lower. This percentage was greater than the OECD average of 23% of students scoring at level two or below (Kelly, et al., 2013). Furthermore, the average score of American students on the PISA Mathematics exam in 2012 was 481. This was lower than the OECD average, below the average of other financially stable nations within the OECD, and significantly lower than South Korea, the top performing country, with an average score of 554 (Schmidt & Burroughs, 2015).

The conclusion that American students have been consistently underperforming compared to their peers from other nations was also reached based on the results of other standardized tests in addition to the PISA assessment. (President's Council of Advisors on Science and Technology, 2010). Results from the 2007 National Assessment of Educational Progress (NAEP), indicated that 32 percent of eighth grade students in the United States met the minimum levels of proficiency (Peterson, Woessman, Hanushek, & Lastra-Anandon, 2011). Proficiency on the NAEP assessment was based on students' ability to make connections between mathematical concepts. For example, students must demonstrate their understanding of the relationship between fractions, percentages, and decimals. The NAEP exam also required students to provide reasoning and support for their answers and emphasized algebraic understanding (Peterson et al., 2011). The Trends in International Mathematics and Science Study (TIMSS), is another international assessment that is administered in fourth, eighth, and twelfth grades. Twelfth grade American students scored last out of the twenty industrialized countries that participated in 1995, 1999, and 2003 (Ornstein, 2010). Proficiency levels were comparable across these various international assessments, and resulted in educators, politicians, and researchers reaching the same conclusion: American students are underperforming in mathematics compared to their international peers (Peterson et al., 2011).

Impact on the United States economy and workforce. Substandard performance of American students in comparison to international students is not merely an issue of national pride. Poor scores on international tests, specifically in the subject of mathematics, impacts the economy, workforce, and standard of living in the United States. Hanushek and Woessman (2010), determined that education impacted economies around the world in three ways: increased human capital, increased capacity for innovation, and the ability to adopt and implement new technologies. In 2000, Hanushek and Kimko found a statistically significant correlation between proficiency measured on international standardized tests and economic growth among all countries completing testing between the years 1960 and 1990. The study was replicated in 2009 to analyze the most recently available international test score data. Data from 50 countries from the years 1960- 2000 was compared, and it was concluded that proficiency on international exams had a statistically significant effect on GDP per capita (Hanushek & Woessman, 2010). Both studies suggested that scoring one standard deviation higher, which equates to approximately 47 test score points, resulted in an annual economic growth that was one percent higher (Hanushek & Woessman, 2010). Furthermore, it can be demonstrated statistically that education reform can impact an economy over time. Hanushek and Woessman calculated that quality reform would yield a 5% increase in GDP over a 20-or 30-year period, and our nation's GDP could be 36% higher 75 years following a 20-year reform (2010). The quality of education countries provide to students has a direct impact on their economies.

Proficiency in mathematics impacts financial performance on a large scale and at the individual level. As a country, if we had successfully increased our performance on standardized international assessments in mathematics to the level of nations such as South Korea and Finland after the release of *A Nation at Risk* in 1983, GDP in 2008 could have risen by 9-16 percent, which equates to approximately 1.3-2.3 trillion dollars (McKinsey & Company, 2009). Performance in mathematics and related content areas could also determine America's success in the future as the world searches for solutions to issues such as climate change, energy resources, and food supplies. Additionally, businesses and military leaders have reported spending billions of dollars annually to increase employees' remedial math skills needed in the workforce (Ornstein, 2010). Our ability to produce a workforce capable of solving problems will determine whether America remains a leader among industrialized nations (President's Council of Advisory on Science and Technology, 2010).

Individuals noticed the economic impact of a mathematics-rich education too. Studies have helped researchers demonstrate that the more mathematics classes students complete, the higher their earnings will be ten years after high school (Boaler, 2016). Completion of advanced mathematics courses is associated with a 19.5% higher salary ten years after high school graduation (Rose & Betts, 2004). Throughout their careers, employees who completed advanced mathematics courses were also promoted to higher paying positions than those who did not complete advanced mathematics courses (Rose & Betts, 2004). These trends remained true regardless of gender or ethnicity (Olitsky, 2013).

One way to increase student performance in mathematics and create a highly qualified workforce in America is to increase students' computation skills and conceptual understanding of mathematics (Boaler, 2016). Students who learn mathematics topics in a project-based, inquiry-driven manner were better prepared to meet the needs of the current workforce (Boaler, 2005). Engaging mathematics courses were also more likely to increase students' interest in the mathematical field, which also benefited America's workforce (DeJarnette, 2012). Negative performance at the national level could continue to have long term effects on our economoy if we do not foster early interest and proficiency in mathematics fields at the K-12 level of education (Epstein & Miller, 2011).

Internal inequalities in student performance. Although the statistics comparing American students' proficiency in mathematics to other countries demonstrated a need for educational reform, the difference in student performance within the country was also unsettling. Graduates of the class of 2011 in the United States ranked 32nd among the nations compared on the PISA assessment and had a 32% proficiency rate (Peterson, et al., 2011). However, when each state was ranked rather than the nation as a whole, the rankings in mathematics proficiency ranged from 9th to

101st out of 106 locations, with the nation as a whole ranking 60th (Peterson, et al., 2011). The highest-ranked state was Massachusetts with 51% of students scoring proficient in mathematics on the PISA assessment. The lowest-ranked state was Mississipi with 13% of students scoring proficient in mathematics on the PISA assessment. International exams allowed us to compare the United States performance in mathematics to other nations, but the inequities within our own education system remained a greater reason for reform (Spencer, 2012). Children residing in the same country, state, city, or even school district could have varying abilities (Spencer, 2012).

Student achievement in mathematics content in the United States is highly correlated to gender, ethnicity, and socioeconomic status (Ornstein, 2010). Socioeconomic data is a common factor among the highest and lowest ranking states on the PISA assessment. The District of Columbia, Mississippi, New Mexico, Alabama, and West Virginia are the five lowest ranking states in the nation on the PISA exam (Peterson, et al., 2011). These states are also some of the poorest in the United States (Satter, 2016). This is a critical comparison because Title I schools, which have higher numbers of students from low-income families, typically have less rigorous mathematics courses and lower proficiency in Science, Technology, Engineering and Mathematics (STEM) content areas (Spencer, 2012). Out of all the industrialized countries that completed the PISA assessment in 2006, the United States had the most students scoring below the proficiency level, and the highest poverty rate amongst all industrialized nations (Ornstein, 2010). Socioeconomic status impacts student achievement in mathematics, and is one reason mathematics education in America is in need of reform.

The impact of gender, ethnicity, and socioeconomic status on student proficiency in mathematics is evident in the fact that female, minority, and disadvantaged students are less likely to enroll in STEM courses at the collegiate level (President's Council of Advisory on Science and Technology, 2010). This was linked to the fact that students in these demographics do not build a strong foundation of mathematical skills at the elementary and secondary levels (Vidgor, 2013). The most at-risk students often received mathematics instruction based on computation, memorization, and repetition rather than a deep understanding of mathematical practices (Spencer, 2012). This mathematics instruction is due to inadvertently lowered expectations, and the focus is placed on building basic skills rather than advanced, abstract concepts (Ornstein, 2010). Education for at risk students in the United States has focused on computation and drill, and neglected the critical skills of application and conceptual understanding (Spencer, 2012).

Students' limited understanding of advanced mathematical concepts has led to a greater problem for the United States. Approximately twenty five percent of the freshmen enrolled in four-year colleges, and half of the freshmen beginning in community colleges required a remedial math course (Mangan, 2013). The percentage of female, minority, and low-income students requiring mathematics remediation in college was even greater (Howell, 2011). Additionally, students who enrolled in remedial mathematics courses as freshmen were less likely to move on to advanced STEM courses or even complete their college degrees (Mangan, 2013). A weak foundation of mathematical understanding at the K-12 level leaves students unprepared for higher-level mathematics in college, and limits career options and earnings potential for

American students. This is especially true for female, minority, and low- income students (Boaler, 2016). Preventing and closing the gap in mathematics education for at risk students is critical to our national economic future, the workforce, and the opportunities available for individual students and families.

Current Mathematics Education Practices

Common Core and Mathematics. Mathematics education in the twentieth century was constantly fluctuating in reponse to the needs of the nation. While some educators encouraged procedural mathematics and memorization, others sought application and conceptual understanding for all students. In the early years of the twenty first century, mathematics educators throughout the United States realized that their colleagues before them were correct on both sides of the debate; American students should have a deep conceptual understanding of mathematical practices, as well as the ability to perform procedural mathematics and algorithms (Larson & Kanold, 2016). The shared realization that both are important led to the creation of the Common Core State Standards. Educators from all parts of the country came together to create these standards in an effort to overcome the failed teaching practices of the twentieth century and to ensure rigorous and relevant mathematics education for all American students (National Governors Association Center for Best Practices [NGA], 2009). Despite their shared purpose and progress, this change has encountered tough criticism and rhetoric similar to change initiatives of the past.

Mathematics education in America has been driven by standards-based curriculum since NCTM issued the first mathematical standards in 1989 (NCTM, 1989). Since that time, individual states have determined the required curriculum for their schools (Bandeira de Mello, Bohrnsted, Blankenship, & Sherman, 2015). Throughout the 1990s and early 2000s this common practice concentrated on improving and focusing mathematics education. Since the inception of standards based reform, student achievement in mathematics has increased in the United States (Chingos, 2015). Since 1990, NAEP scores for mathematics in the elementary and middle school grades have steadily increased (National Center for Education Statistics [NCES], 2015). Long-term trend data from the NAEP assessment is also trending upward, and researchers suggest that American fourth graders and eighth graders are performing at a significantly higher level than their parents and grandparents in mathematics based on this data (Dossey, Halvorsen, & McCrone, 2016). Similarly, mean scores on the ACT and SAT mathematics exams are increasing across the United States (Larson & Kanold, 2016).

Despite these improvements, factors persisted that led to the inception of the Common Core State Standards. First, students from the United States were still being outperformed in mathematics by students from other developed countries. Specifically, American students scored below the international mean, and were steadily declining in the area of applied mathematics and problem solving (Organisation for Economic C0-operation and Development [OECD], 2014). While fourth and eighth grade students' performance in mathematics was increasing, only half were considered proficient (NCES, 2015). Although 50% proficiency is triple the rate of students of previous generations, that cannot become the standard the nation accepts. Similarly, only 50% of high school graduates are prepared for college level mathematics coursework (ACT, 2015). Additionally, the achievement gap between white and black students and white and

Latino students in mathematics persists (NCES, 2015). Standards-based reform led to early successes that suggested its validity; however there was still room for growth.

These shortcomings have led to an in depth analysis of mathetmatics proficiency data across the United States. Researchers and educators have cited a significant discrepancy in the number of students in states considered proficient based on their own state level standards compared to the NAEP international standards of proficiency (Achieve, 2015). This means that proficiency standards across the United States varied and were not on par with global expectations. In fact, only two states set their levels of proficiency higher than NAEP standards in 2013. In that same year, only five states set their levels of proficiency equal to NAEP for fourth graders, and only three for eighth graders (Bandeira de Mello et al., 2015). State proficiency comparisons utilizing the TIMSS assessment were similar. In 2007, if states had written individual state assessments to international levels of proficiency, the mean national proficiency rate would have dropped from 62% to 29% for eighth graders, and it would have decreased in all states except two. Similarly, at the elementary level, the national mean for proficiency rate would have dropped from 72% to 39% and would have decreased in all states except one (Larson & Leinwald, 2013). Individual states were lowering expectations for mathematical proficiency among students compared to international standards (Phillips, 2010).

Proficiency assessments were not accurately measuring the mathematics skills students must know in order to compete in a global economy. This was unacceptable in a time when the economy and the job market were becoming increasingly international (Phillips, 2010). Furthermore, inconsistent levels of proficiency from state to state did not allow policy makers and educators to make evidence-based comparisons about student preparedness amongst states within the United States. This inconsistency prompted the 2009 creation of a set of common mathematics standards for students in K-12 education (Schmidt, Cogan, Houang, & McKnight, 2011). The goal of these standards was to ensure that all students are exposed to the same mathematics content before completing high school. Initially these standards had bipartisan support from govenors and education policy makers across America (Akkus, 2016). The “patchwork quilt” of mathematics standards (Larson & Kanold, 2016, pg. 45) and the seemingly un-American idea of unequal opportunities based on zip codes appeared to be ending.

After only a few years of seemingly universal support for the Common Core State Standards, attitudes shifted (Larson & Kanold, 2016). Currently it is too early to determine why this shift occurred and continues, however a few theories and misconceptions have become prevalent. The first is that the Common Core Standards were a federal initiative (Larson & Kanold, 2016). Historically, education in the United States has been under the control of state and local leaders. The CCSS were developed and encouraged by governors and state level education leaders since their origination in 2009. This may have become unclear when the federal government associated Race to the Top funds with college and career ready standards implementation at the district and state level (Jochim & McGuinn, 2016). In order to receive Race to the Top funds, it was necessary for states and districts to adopt college and career ready standards. The federal government did not explicitly state that these standards had to be the CCSS, but adopting the CCSS was the easiest way to ensure standards were college and career aligned (Lavenia, Cohen-Vogel, & Lang, 2015). This created a perception that the federal government was trying to force the CCSS on districts and states. The CCSS were not designed as an intrusion on states' rights, and were coincidentally initiated at the state level (Larson & Kanold, 2016).

Another common misconception was that confusing instructional strategies and curriculum were a result of the CCSS. The writers of the CCSS specifically stated, "These standards do not dictate curriculum or teaching methods" (NGA & CCSSO, 2010, p.5). Often, complicated homework or coursework is attributed to the CCSS. However, these are incorrect examples of Common Core implementation and often a result of ineffective instructional practices (Pense, Freeburg, & Clemons, 2015). The CCSS became a scapegoat for the frustration of parents and educators and a negative narrative was established. This is evident in the viral examples of parent complaints about students' homework. There are many examples of parents sharing unnecessarily complicated or confusing student work and their inability to complete the work themselves (Castillo, Mendoza, & Poblete, 2011). These stories become increasingly powerful when they are shared by parents with advanced degrees in the fields of mathematics or science. One instance of this occurred in 2014 when concerned dad Jeff Severt made a Facebook post that went viral (Atler, 2014). Severt held a bachelor's degree in engineering and was unable to solve his son's homework computation problems utilizing the methods required by the school curriculum (Atler, 2014). The issue gained national attention and resulted in Severt's appearance on multiple talk shows, which further publicized the rhetoric that the CCSS were overly complicated and unnecessary.

This instance is comparable to a response to the New Math initiative in 1972. James Shackleford, the parent of an elementary student, submitted an editorial to the

Washington Post. He shared that he was a chemist and unable to complete his daughter's overly complicated math coursework as a result of the New Math curriculum (Mathews, 1972). Frustration and confusion have been incorrectly associated with the CCSS rather than poor teaching practices and curriculum resources.

Similarly, frustration with testing the standards has been confused for frustration with the standards themselves. Since NCLB was implemented in 2001, states have been required to test students in the third through eighth grades and once in high school (Larson & Kanold, 2016). NCLB was passed by both houses of Congress and supported the use of standards, which would be measured by assessments, and used to make measureable goals for adequate progress. Assessments were created by each state, and each state determined its own level of proficiency (Fuller, Wright, Gesicki, & Kang, 2007). This made it nearly impossible to compare proficiency levels as a nation; a student could be considered proficient in one state, but not in another. When the CCSS were adopted, the next logical step for policymakers was to develop new, common, summative assessments to measure proficiency levels throughout the country. Two education consortia represented more than thirty states at that time, and the federal government awarded a combined total greater than $336 million in Race to the Top funds to the two consortia to develop the needed common assessments (Porter, McMaken, Hwang, & Yang, 2011). These new assessments were first given in the spring of 2015 and looked vastly different than their state-created predecessors. The new common assessments were digitized, required constructive responses, and included performance based tasks. This was a sharp comparison to the multiple choice structures and low level thinking requirements of the previous state assessments (Herman & Linn, 2013).

Frustrations with the new assessments lead to the opt-out movement organized by a small but influential group of parents who refused to require their students' participation in the new assessments (DeNisco, 2015). Parent and educator frustration with the assessments that measured the CCSS should not have been confused with the content of the CCSS.

These misconceptions, as well as others, were perpetuated in an era of social media and resulted in strong opinions regarding the CCSS and mathematics instruction. Social media had an impact on citizens' perspectives and informed many of their beliefs despite the fact that much of the content shared on social media did not rely on research or expert opinion (Henig, 2008). Additionally, the personalized nature of social media inadvertently allowed people to only filter the content they already agreed with, and limited other perspectives (Achenbach, 2015). Supovitz, Daly, and Miguel de Fresno (2004), completed a study in 2014 that analyzed 190,000 tweets using the hashtag #commoncore. They found that the majority of messages being posted about the CCSS were negative, and in fact outnumbered positive messages by four to one. The topics most commonly mentioned in association with the CCSS were testing and mathematics. The wide spread negativity about the CCSS and mathematics on social media contributed to a negative public perception of the standards (Supovitz, Daly, & Miguel de Fresno, 2014).

What is rarely criticized or questioned is the content of the standards themselves. The skills that students are expected to master and the developmental appropriateness of the standards is typically agreed upon by educators, scholars, and parents (Munter, Stein, & Smith, 2015). Some experts do disagree on the order and alignment of the standards, but few argue about the level of rigor in the new standards, and they are nearly universally considered to be superior than the former state standards (Schmidt & Houang, 2012). The CCSS are more likely to produce students who are prepared for college and careers than the standards of previous generations (Peterson, Barrows, & Gift, 2016).

Response To Intervention. Implementing the Response to Intervention (RTI) framework begins with a solid foundation in the Common Core State Standards. The Common Core State Standards are the content that should be included in instruction, and Response to Intervention is the framework utilized to deliver the content (Burton & Kappenberg, 2012). The two systems are most effective when implemented together. RTI is a systematic approach to teaching and learning that includes intervention, monitoring student progress, and using data to make instructional decisions (Johnson, Mellard, Fuchs, & McKnight, 2006). There are many explanations of RTI available, however all definitions consistently include the critical elements of screening, intervention, and progress monitoring (Gersten & Newman-Gonchar, 2011).

RTI originated in the special education field. Prior to the reauthorization of IDEA in 2004, learning disabilities were primarily identified utilizing IQ testing (Gersten & Newman-Gonchar, 2011). This approach became increasingly criticized due to overidentification or misidentification of students with disabilities, an absence of instructional relevancy for teachers, a lack of preventative efforts, and lack of consistency (Berkeley, Bender, Peaster, & Saunders, 2009). The reauthorization of IDEA encouraged the implementation of RTI, and states began exploring the RTI framework (PL 108-446). From the earliest period of implementation, educators realized that RTI not only benefited students with potential learning disabilities, but it also helped to ensure appropriate, differentiated instruction for all students (Berkeley, Bender, Peaster, &

Saunders, 2009). This expanded the responsibility for student growth to a broader education team including not only the special education teacher, but also the general education teacher, school psychologists, interventionists, administrators, and instructional coaches (Gersten & Newman-Gonchar, 2011). The shared responsibility of the RTI framework and the intentionally broad definition are two critical elements that have led to the widespread adoption of RTI.

The RTI framework is based on three tiers of instruction. Each tier of instruction increases in intensity and intentionality, and applies to a smaller percentage of students (Buffum, Mattos, & Weber, 2010). For example, the first tier of the RTI model includes the grade level standards, a universal screening assessment, and differentiation (Burns & Gibbons, 2008). All students receive tier one instruction. The grade level curriculum is utilized to deliver instruction and the majority of tier one instruction occurs in the general education classroom. The needs of approximately 80% of students can be met in the first tier of RTI instruction (Burns, Deno, & Jimerson, 2007). In the event that these numbers are skewed and a significantly smaller percentage of students' needs are met in tier one, a change to the general curriculum for all students should be considered (Burns, Deno, & Jimerson, 2007).

Tier two instruction increases in intensity. In addition to the general grade level curriculum, small group instruction is included based on individual student needs (Johnson, Mellard, Fuchs, & McKnight, 2006). Students receiving tier two instruction might be considered at risk for academic achievement. The second tier of RTI also includes monitoring student progress toward individual goals utilizing frequent assessments (Burton & Kappenberg, 2012). One example of a tier two intervention is a small group of students who meet consistently to work on mathematics fact fluency. The needs of approximately 15% of students should be met employing tier two instruction (Bender & Shores, 2007). The remaining 5% of students whose needs are not met with tier one or two instruction might require tier three instruction.

Tier three instruction is the most intensive instruction in the general education setting (Samuels, 2011). Students receiving tier three academic supports require one-on-one instruction focused on individual goals, and are typically performing significantly below the grade level expectation (Gersten & Newman-Gonchar, 2011). Tier three instruction might be provided by a specialist or interventionist and could take place outside of the general education classroom. Students receiving tier three instruction should be monitored for academic progress even more frequently than students receiving tier two instruction (Deno, 2014). One example of a tier three intervention is a math intervention specialist meeting with a student individually and consistently to fill in missing mathematics skills from previous grade levels. The progression through the three tiers of intervention and instruction is intended to provide increasingly intensive and targeted instruction for a decreasing percentage of students.

In order to determine the level of tiered instruction students need, educators working within an RTI framework rely on two main types of assessments: universal screening assessments and progress monitoring assessments (Burton & Kappenberg, 2012). Universal screening assessments are administered to all students three to four times each year (Bender & Shores, 2007). Because these assessments are given to all students, they are brief and do not go into great detail or provide large quantities of diagnostic data. Universal screening assessments are also easily replicated and scripted to ensure consistency for all students assessed (Burns & Gibbons, 2008). Additionally, the technical adequacy and validity of universal screening assessments was critical to their effectiveness (Jimerson, Burns, & VanDerHeyden, 2016). Universal screening assessments are the first instrument utilized in an RTI framework to determine which students are at risk learners and should receive additional support in the form of academic interventions.

In addition to the universal screening assessments, all students who receive additional academic supports should participate in progress monitoring assessments. Progress monitoring assessments are continuously administered, brief assessments that resemble the universal screener (Foegen, 2008). They are employed to track student growth in a particular skill or area between summative assessment periods (National Association of State Directors of Special Education, 2005). Progress monitoring assessments should match the academic supports students are receiving (Fisher & Frey, 2010).

The Iowa Department of Education (2006), recommended six key steps to progress monitoring. The first step was identifying specific skills that required additional instruction in order to master. The universal screening tool and diagnostic assessments can help educators determine which skill to target for individual students. The second step was to choose a measurement tool that would monitor progress on the specifically identified skill. These tools may be predetermined by school districts, or they might be selected by teachers and administrators (Burton & Kappenberg, 2012). Regardless of who selects the assessment, the key is that the chosen tool provides teachers with data to help them determine whether targeted instruction is leading to student growth, or if an instructional change needs to be made (Mellard & Johnson, 2008).

Third, teachers and instructional leaders need to determine a baseline for each student that will be progress monitored. A baseline is an initial score before interventions begin that indicates students' beginning levels of proficiency (Hutton, Dubes, & Muir, 1992). A baseline score typically requires 3-5 data points that are plotted on a graph (Wright, 2007). These data points are used to determine students' rate of growth over time and determine what levels of growth can be expected. Once baseline data have been collected, teachers, leaders, and students can work together to establish attainable goals for students. The goal for all students might not be to reach the grade level expectation within one school year depending upon their intial universal screening data. Goals can also be altered for students as a school year progresses. This might be appropriate if a student's rate of improvement exceeds or does not meet the original prediction. The fifth step to progress monitoring is creating a chart or graph that students and adults can use to determine whether adequate growth is being obtained. Visually tracking growth on a chart or table helps the educational team make adjustments as needed, and provides the learner with timely, easy to understand feedback (Wright, 2007). Feedback and visual progression toward a goal can increase student motivation and the likelihood of student goals being met (Harks, Rakoczy, Hattie, Besser, & Klieme, 2014).

The sixth and final step in the progress monitoring process is for educators to frequently review student progress monitoring data and use that data to make instructional decisions for individual students (Burton & Kappenberg, 2012). If the progress monitoring data does not reflect the desired growth outcomes, rather than waiting until the next summative testing opportunity, educators should be proactive and make an instructional change to the specific student's individualized instruction (Shinn, Shinn, Hamilton, & Clarke, 2002). It is important to remember that this process of progress monitoring will not be appropriate for all students. It is only necessary for those students who are at risk as determined by initial universal screening data (Gersten, Beckmann, Clarke, Foegen, March, Star, et al., 2009).

Progress monitoring is utilized to track the effectiveness of intentional academic supports for individual students. These academic supports are known as interventions in an RTI framework (Fuchs & Fuchs, 2006). Interventions are determined using the information gained from universal screening and diagnostic assessments. Interventions target specific skills for different students and are taught in addition to the grade level curriculum (Samuels, 2006). Interventions typically occur in small group or one to one settings. Research based programs might be utilized to ensure the quality of interventions, or standards-based interventions can be designed by a teacher or intervention specialist (Fuchs & Fuchs, 2006). The rate of interventions should vary depending on the level of need for each student. Students in the second tier of the RTI framework should receive less frequent or intense interventions than students in the third tier of the RTI framework (Berkeley, Bender, Peaster, & Saunders, 2009). It is important for educators to distinguish between instructional strategies and interventions. Instructional strategies are methods for delivering content that assist with understanding, engagement, or activating schema. Interventions are specially designed curricula or lessons that focus on missing skills; interventions are the content being delivered (Conderman, Liberty, & DeSpain, 2017).

The RTI approach to education that meets the needs of all learners has been recommended since the reauthorization of IDEA in 2004. However, it is only recently becoming more widely adopted and utilized by educators in mathematics classrooms across the United States. A disproportionate amount of time and research in RTI has been allocated to reading rather than mathematics since 2004 (Gersten & Newman-Gonchar, 2011). Transferring these practices to mathematics education has the potential to close the achievement gap in mathematics for all learners, including learners of different genders, ethinicities, and socio-economic backgrounds (Clarke, et al., 2016).

The DIBELS System for Assessment and Intervention

The Dynamic Indicators of Basic Early Literacy Skills (DIBELS), are combinations of measures designed to indicate how well a student is progressing in a particular content area (Dynamic Measurement Group [DMG], n.d.). DIBELS Math is the portion of those measures that specifically indicates student readiness and progress in mathematics. DIBELS Math measures early numeracy skills, computation skills, and application skills from kindergarten through sixth grade (DMG, 2015). Within the domain of early numeracy skills, DIBELS Math specifically examines the skills of beginning quantity discrimination, number identification fluency, next number fluency, advanced quantity discrimination, and missing number fluency in kindergarten and first grade (Wheeler, 2016). The DIBELS Math program includes the critical RTI components of universal screening and progress monitoring (Wheeler, 2016). It is also aligned to the Common Core State Standards (DMG, 2014).

An integral component of the RTI framework is the usage and interpretation of universal screening data. Universal screening assessments are administered to help educators determine which students might be at risk and need additional academic supports. DIBELS Math includes universal screening tools called benchmark assessments (DMG, 2015). These benchmark assessments include composite scores indicating overall student skills, as well as scores in individualized domains such as computation or quantity discrimination (Wheeler, 2016).

Educators use DIBELS Math assessments to identify which students are on track to make adequate yearly growth with the implementation of adequate instruction, which students are less likely to make typical yearly progress with adequate instruction, and which students are highly unlikely to make yearly progress and meet grade level expectations with adequate instruction (Wheeler, 2016). These student categories are labeled benchmark, strategic, and intensive. By identifying which students are unlikely to make sufficient growth with only typical, adequate instruction, DIBELS benchmark assessments are used to help teachers determine which students will need additional, specialized instruction in order to make progress and meet grade level expectations (Kaminski & Cummings, 2007).

The results of DIBELS Math benchmark assessments can be used to create instructional groups, design instructional interventions, and establish individual student goals (Wheeler, 2016). After administering these universal screening assessments, educators will have a data set that includes a detailed report for every student. Determining which students have similar needs can assist teachers in creating instructional groups. This information also helps teachers know what specific skills should be addressed with each group (DMG, 2015). Additionally, educators can share current readiness levels with students and families, and set appropriate goals that will help ensure students meet expected growth during the school year. Despite the many uses for DIBELS Math benchmark assessments, they do not measure student progress toward these goals in consistent intervals. Another component of the DIBELS Math program is utilized for this purpose.

Progress monitoring is the additional component of the DIBELS Math program that educators use to track student progress. Progress monitoring assessments are similar to the benchmark universal screening assessments included in the DIBELS Math program, however they are shorter assessments and administered on a weekly or biweekly basis (Good, 2015). Students only complete progress monitoring assessments in the areas indicated based on the benchmark assessments. For example, if a student scores at the benchmark level on the computation portion of the universal screening assessment, but is categorized as strategic or intensive on the concepts and applications portion of the assessment, they would only be progress monitored for growth in the area of concepts and applications (Good, 2015).

Administering these frequent assessments helps educators make informed instructional decisions for all students. If an intervention has been put in place for a student, but they are not making adequate growth as determined by progress monitoring assessments, educators should make an instructional change (Shinn, Shinn, Hamilton, & Clarke, 2002). Evidence that an instructional change is necessary would not be available without progress monitoring assessments. Instead, educators would not have growth data until the next summative evaluation period. This might be several weeks or even a full semester from the time an intervention is first implemented. Progress monitoring assessments allow educators to oversee student improvement and use instructional time efficiently and effectively (Gersten et al., 2009).

The DIBELS Math program aligns with the RTI framework by incorporating the critical components of universal screening and progress monitoring (DMG, 2015). These two types of assessments help educators identify at risk students, design instructional groups and interventions, set individual goals, and monitor progress toward goals (Gersten & Newman-Gonchar, 2011). The RTI framework is intended to help close academic gaps for students and ensure the same outcomes for all students. Therefore, the DIBELS Math program may help educators achieve mathematics proficiency and growth for all students.

In addition to aligning with the RTI framework, the DIBELS Math program also aligns with the Common Core State Standards. The DIBELS Math measures of Beginning Quantity Discrimination and Number Identificiation address kindergarten standards (DMG, 2014). The Next Number Fluency portion of the assessment addresses both kindergarten and first grade standards (DMG, 2014). Additional first grade standards are evaluated using the measures of Advanced Quantity Discrimination, Missing Number Fluency, and Computation (DMG, 2014). In second through sixth grades, the measures of Computation and Concepts and Applications are aligned with the Common Core State Standards for Mathematics at each level (DMG, 2014). The Computation portion of the assessment varies by grade level based on the Common Core State Standards. For example, the Second Grade Computation measure includes the skills of adding and subtracting numbers up to 20 and using place value to add and subtract (DMG, 2014). For comparison, the Fifth Grade Computation measure includes the skills of solving operations with multi-digit whole numbers and decimals to the hundredths place, and using equivalent fractions to add and subtract fractions (DMG, 2014). Both measures assess computation skills, but the skills assessed are driven by the Common Core State Standards.

Similarly, all students in grades two through six complete the Concepts and Applications portion of the DIBELS screening assessment, however the contents of the assessment varies by grade level. Sixth grade students are asked to solve real world problems that involve area, surface area, and volume, whereas third grade students are asked to apply their knowledge of multiplication and division to solve problems (DMG, 2014). For all grade levels, the Concepts and Applications measure requires students to apply their understanding of a concept to a problem or situation (Wheeler, 2016). This differs from the Computation measure which includes solely algorithms. Utilizing both the Computation and Concepts and Applications assessments allows teachers to evaluate students' procedural fluency and conceptual understanding.

Summary

Mathematics proficiency in the United States has been stagnant in recent decades. This is especially true for female, minority, and low SES students (Lee, 2002). This fact becomes more concerning as mathematics proficiency and the ability to apply mathematics content to twenty first century problems becomes increasingly important for American students in a growing global economy (Rose & Betts, 2004). The practices, quarrels, and misguided interpretations of mathematics instruction from our past have led to our current struggles and status in mathematics as a country. Recent changes and additions to the field of mathematics education have the potential to remedy some of these concerns and provide improved opportunities in mathematics education for all American students. The Common Core State Standards and Response to Intervention framework are becoming widely adopted to help ensure adequate mathematics education for all American students. The DIBELS Math program has the potential to be a powerful tool in the evolving field of mathematics education. In chapter three, the research design and sampling procedures of the study are presented. Instrumentation, data collection procdures, data analysis and hypotheses testing, and limitations, are also examined.

Chapter 3

Methods

Research Design

A quasi-experimental quantitative research design guided this study. This approach was appropriate for examining the extent of change to students' NWEA MAP Mathematics scores after one year of implementation of the DIBELS Math program (Lunenburg & Irby, 2008). NWEA MAP mathematics assessment data from the year prior to the implementation of the DIBELS Math program was compared to data after one year of implementation.

Specifically, the study was conducted to examine the extent of the change in test scores on the NWEA MAP Math assessment between specific groups of fourth grade students after one year of implementation of the DIBELS Math program in the XYZ School District. The results were compared across categorical variables to explore differences amongst student demographic groups. These variables included gender, ethnicity, and socioeconomic status.

Selection of Participants

The sample included all fourth grade students enrolled in the XYZ School District during the 2014- 2015 school year and the 2015-2016 school year with fall and spring DIBELS Math and NWEA MAP Mathematics Assessment scores. Fourth grade students were selected as a result of the consistency of data collected over time. For the 2015-2016 school year, prelimnary benchmark scores were not available for all components or all measures of the DIBELS Math assessment in other grade levels. Preliminary benchmark scores were available for all components of the fourth grade DIBELS Math assessment during the 2015- 2016 school year. In the Fall and Spring of of the 2015-2016 school year, 2,135 fourth grade students completed the DIBELS Math and NWEA MAP Mathematics Assessments. Table 1 displays the number of participants included in the study based on gender, ethnicity, and socioeconomic status from the 2014-2015 school year. Table 2 displays the number of participants included in the study based on gender, ethnicity, and socioeconomic status from the 2015-2016 school year. Purposive sampling was utilized in this study. This technique is used to select the sample population based on the proficiency and familiarity of the researcher with the sample (Lunenburg & Irby, 2008).

Table 1

Participants Based on Independent Variables 2014-2015

Variables	Categories	Numbers of participants	Percentage
Gender	Male	1,029	52
	Female	937	48
Ethnicity	White	1,252	64
	Black	176	9
	Hispanic	381	19
	Other	157	8
Socioeconomic Status	Free or reduced lunch	741	38
	Non free or reduced lunch	1,225	62

Table 2

Participants Based on Independent Variables 2015-2016

Variables	Categories	Numbers of participants	Percentage
Gender	Male	987	50
	Female	1,005	50
Ethnicity	White	1,244	62
	Black	175	9
	Hispanic	393	20
	Other	180	9
Socioeconomic Status	Free or reduced lunch	752	38
	Non free or reduced lunch	1,040	52

Measurement

The NWEA MAP mathematics assessment reports students' instructional levels based on RIT scores. RIT scores are based on Item Response Theory (Lord & Novick, 1968), which provides the foundation for a measurement scale based on the relationship between student achievement levels and test item difficulty. The MAP mathematics assessment utilizes an equal-interval, one parameter model known as the Rasch Model. Scores are computed using the Rasch Model, and then transformed into a linear, positive score called a RIT score. RIT scores are unique to NWEA MAP assessments. Student scores range between 100 and 350 and are distributed among five categories: (a) academic warning, (b) approaches standard, (c) meets standards, (d) exceeds standard, and (e) exemplary (Northwest Evaluation Association [NWEA], 2013).

Validity and reliability are critical to the usefulness and credibility of an instrument of measurement. Validity refers to an instrument's ability to measure what it is created to measure, and reliability is how consistently an instrument measures what it intends to measure (Lunenburg & Irby, 2008). The NWEA MAP mathematics assessments yields content validity by incorporating content standards employed by the educational entity commissioning the assessment, and using software that combines artificial intelligence and key word matching to ensure all the necessary standards and skills are incorporated in the assessment (NWEA, 2011). Concurrent validity for the NWEA MAP mathematics assessment has also been established in the form of a Pearson correlation coefficient comparing RIT scores to scaled scores on other established tests (NWEA, 2011). A correlation coefficient is not available for the state where the XYZ School District is located, but correlation coefficients with other state assessments range between .729 and .821 (NWEA, 2011). Concurrent validity correlations are considered to be strong if the correlations are in the mid .800s. The NWEA MAP mathematics assessment also demonstrates predictive validity based on its ability to predict student scores on other established achievement assessments (NWEA, 2011). Strong predictive validity is also indicated by a correlation in the mid .800s. Both the predictive validity and concurrent validity of the NWEA MAP mathematics assessment can be influenced by the quantity of subjective or constructed response questions contained in comparative tests (NWEA, 2011).

The reliability of the NWEA MAP Mathematics Assessment is based on a combination of test-retest reliability and equivalent forms reliability over the course of several months (NWEA, 2011). It is a correlation of two tests administered from similar item pools and produces a collective reliability representative of an entire pool of test items (NWEA, 2011). The reliability coefficient of the NWEA MAP Mathematics Assessment is .867 (NWEA, 2011).

Data Collection Procedures

Prior to collecting data, a request was submitted to the XYZ School District for the data needed to complete the study (D. Gruman, personal communication, January 31, 2018) (see Appendix A). The request was granted in writing, and permission was given from the XYZ School District on February 9, 2018 (see Appendix B). In addition, a proposal for conducting research was submitted to the Baker University Institutional Review Board (IRB) (see Appendix C). The IRB granted permission to the researcher in writing on May 15, 2017 (see Appendix D), and data collection began.

All data in this study was obtained from the XYZ School District's Data and Assessment Department. Student mathematics achievement data in the form of DIBELS Math and NWEA MAP mathematics scores were downloaded for each student from the NWEA website and the Dynamic Measurement Group (DMG) website. Baseline data was taken from the 2014-2015 school year, and scores from the 2015- 2016 school year were used for comparison throughout the study. The data was then imported into an Excel spreadsheet. The names of students were coded for the purpose of student confidentiality. The spreadsheet also contained categorical information indicating students' gender, ethnicity, and socioeconomic status.

Data Analysis and Hypothesis Testing

The following hypotheses were proposed and the level of significance was set at .05 for all of the following statistical analyses.

RQ1. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for fourth grade students after one year of implementation of the DIBELS Math program?

H1. There was a change in scores on the NWEA MAP Mathetmatics assessment for fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H1. The mean change in NWEA MAP Mathematics scores for all fourth grade students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for all fourth graes students from the 2015-2016 school year were compared.

RQ2. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for male and female fourth grade students after one year of implementation of the DIBELS Math program?

H2. There was a change in scores on the NWEA MAP Mathetmatics assessment for male fourth grade students after one year of implementation of the DIBELS Math program.

H3. There was a change in scores on the NWEA MAP Mathetmatics assessment for female fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H2. The mean change in NWEA MAP Mathematics scores for fourth grade male students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade male students from the 2015-2016 school year were compared. An independent-samples *t* test was also conducted to test H3. The mean change in NWEA MAP Mathematics scores for fourth grade female students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade female students from the 2015-2016 school year were compared.

RQ3. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for fourth grade students based on ethnicity (white, black, Hispanic, and other) after one year of implementation of the DIBELS Math program?

***H4*.** There was a change in scores on the NWEA MAP Mathetmatics assessment for white fourth grade students after one year of implementation of the DIBELS Math program.

***H5*.** There was a change in scores on the NWEA MAP Mathetmatics assessment for black fourth grade students after one year of implementation of the DIBELS Math program.

***H6*.** There was a change in scores on the NWEA MAP Mathetmatics assessment for Hispanic fourth grade students after one year of implementation of the DIBELS Math program.

***H7*.** There was a change in scores on the NWEA MAP Mathetmatics assessment for fourth grade students categorized as other after one year of implementation of the DIBELS Math program.

***H8*.** There was a difference in the change in scores on the NWEA MAP Mathetmatics assessment for fourth grade students from four ethnic groups after one year of implementation of the DIBELS Math program.

Four independent-samples *t* tests were conducted to test H4, H5, H6, and H7. In H4, the mean change in NWEA MAP Mathematics scores for fourth grade white students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade white students from the 2015-2016 school year were compared. In H5, the mean change in NWEA MAP Mathematics scores for fourth grade black students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade black students from the 2015-2016 school year were compared. In H6, the mean change in NWEA MAP Mathematics scores for fourth grade Hispanic students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade Hispanic students from the 2015-2016 school year were compared. In H7, the mean change in NWEA MAP Mathematics scores for fourth grade students categorized as other from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade students categorized as other from the 2015-2016 school year were compared.

A one-way ANOVA was conducted to test H8. The mean change in NWEA MAP Mathematics scores for white, black, Hispanic, and other fourth grade students from the 2015-2016 school year were compared.

RQ4. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for low SES students and non low SES after one year of implementation of the DIBELS Math program?

***H9*.** There was a change in scores on the NWEA MAP Mathetmatics assessment for low SES fourth grade students after one year of implementation of the DIBELS Math program.

H10. There was a change in scores on the NWEA MAP Mathetmatics assessment for non low SES fourth grade students after one year of implementation of the DIBELS Math program.

H11. There was a difference in the change of scores for low SES and non low SES fourth graders after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H9. The mean change in NWEA MAP Mathematics scores for fourth grade low SES students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade low SES students from the 2015-2016 school year were compared. An independent-samples *t* test was also conducted to test H10. The mean change in NWEA MAP Mathematics scores for fourth grade non low SES students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade non low SES students from the 2015-2016 school year were compared. An additional independent-samples *t* test was conducted to test H11. The mean change in NWEA MAP Mathematics scores for low SES and non low SES fourth grade students from the 2015-2016 school year were compared.

RQ5. To what extent was there a difference in the change in scores on the NWEA MAP Mathematics assessment for fourth grade students who received consistent progress monitoring, and fourth grade students who did not receive consistent progress monitoring after one year of implementation of the DIBELS Math program?

H12. There was a difference in the change of scores on the NWEA MAP Mathematics assessment for fourth grade students who received consistent progress monitoring, and fourth grade students who did not receive consistent progress monitoring after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H12. The mean change in NWEA MAP Mathematics scores for fourth grade students who received consistent progress monitoring during the 2015-2016 school year was compared to the mean change in NWEA MAP Mathematics scores for fourth grade students who did not receive consistent progress monitoring during the 2015-2016 school year.

Limitations

Limitations are factors that could impact research findings or limit the ability to make generalizations based on the conclusions of a single study. Limitations are not within the control of the researcher; however stating limitations in a study can reduce misinterpretations of findings (Lunenburg & Irby, 2008). This study has the following limitations:

1. The pre- and post-test NWEA MAP data analyzed were limited to students enrolled in the XYZ School District, therefore the results may not be generalized to other school districts or states.

2. The pre- and post-test data analyzed was limited to fourth graders in the XYZ School District, therefore the results may not be generalized to other grade levels.

3. Variables outside of the control of the researcher could impact student achievement. These variables could include: available teacher resources, teacher training, student absences, and motivation.

Summary

The extent of the impact the DIBELS Math program had on students' mathematics growth in the XYZ School District was evaluated in this quasi-experimental study. This chapter outlined the research design and the selection of participants. Data measurement, collection procedures, and hypothesis testing were discussed in detail. Finally, the limitations of the study were stated. The results of the study are presented in the following chapter.

Chapter 4

Results

The first purpose of this study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students. The second purpose of the study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade male and female students. The third purpose of the study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade minority students. The fourth purpose was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students categorized as low SES, and those not categorized as low SES. The final purpose of this study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students who received consistent progress monitoring utilizing the the DIBELS Math program and students who did not receive frequent progress monitoring. This chapter presents the descriptive statistics, hypothesis testing, and results of the additional analysis from the study.

Descriptive Statistics

During the 2014- 2015 school year, 1,888 fourth grade students completed the fall and spring NWEA MAP Mathematics assessment. This study includes 1,086 male students and 998 female students from the 2014-2015 school year. This study also includes data for 1320 white students, 191 black students, 402 Hispanic students, and 171 other students from the 2014- 2015 school year. Additionally, 831 low SES students and 1281 non-low SES students from the 2014- 2015 school year were included. During the 2015- 2016 school year, 1,935 fourth grade students completed the fall and spring NWEA MAP Mathematics assessment. This study includes 1,056 male students and 1079 female students from the 2015-2016 school year. This study also includes data for 1311 white students, 203 black students, 424 Hispanic students, and 197 other students from the 2015- 2016 school year. Additionally, 831 low SES students and 1304 non-low SES students from the 2015- 2016 school year were included.

Hypothesis Testing

The results of the hypothesis testing completed for each research question are described in this section. Each of the five research questions is listed with a corresponding hypothesis statement. Two independent-samples *t* tests were conducted to examine the potential impact of the DIBELS Math program on the mean change of scores on the NWEA MAP mathematic assessment for fourth grade students based on gender. Four independent-samples *t* tests were conducted to examine the potential impact of the DIBELS Math program on white, black, Hispanic, and other students' mean change in scores on the NWEA MAP mathematics assessment. A one-way ANOVA was also conducted to compare the potential impact of the DIBELS Math program on the mean change in scores for white, black, Hispanic, and other students. Independent-samples*t* tests were also utilized to explore the potential impact of the DIBELS Math program on the mean change of scores for low SES and non-low SES students, as well as students who received consistent progress monitoring and those who did not. In addition to the testing results, a description of the analyses used to test each hypothesis is also included.

RQ1. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for fourth grade students after one year of implementation of the DIBELS Math program?

H1. There was a change in scores on the NWEA MAP Mathetmatics assessment for fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H1. The mean change in NWEA MAP Mathematics scores for all fourth grade students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for all fourth grades students from the 2015-2016 school year were compared.

Table 3 includes a summary of the mean change in RIT scores, standard deviation, and number of fourth grade students included in the statistical analysis for H1. For H1, 135 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated a statistically significant difference between the two means, $t = 3.378$, $df = 3797.161$, $p = .001$. The mean change for fourth grade students during the 2014- 2015 school year ($M = 12.14$, $SD = 6.71$) was significantly higher than the mean change for fourth grade students during the 2015- 2016 school year ($M = 11.42$, $SD = 6.36$). The mean change in RIT scores was greater for fourth grade students during the 2014- 2015 school year compared to fourth grade students during the 2015- 2016 school year. Therefore, H1 was supported.

Table 3

Descriptive Statistics for the Results of the Test for H1

Fourth Grade Students	*M*	*SD*	*N*
2014-2015	12.14	6.71	1888
2015-2016	11.42	6.36	1935

RQ2. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for male and female fourth grade students after one year of implementation of the DIBELS Math program?

***H2*.** There was a change in scores on the NWEA MAP Mathetmatics assessment for male fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H2. The mean change in NWEA MAP Mathematics scores for fourth grade male students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade male students from the 2015-2016 school year were compared.

Table 4 includes a summary of the mean change in RIT scores, standard deviation, and number of fourth grade, male students included in the statistical analysis for H2. For H2, 127 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated a statistically significant difference between the two means, $t = 1.957$, $df = 1885.139$, $p = .051$. The mean change for fourth grade, male students during the 2014- 2015 school year ($M = 11.82$, $SD = 6.57$) was significantly higher than the mean change for fourth grade, male students during the 2015- 2016 school year ($M = 11.25$, $SD = 6.215$). The mean change in RIT scores was greater for fourth grade, male students during the 2014- 2015 school year compared to fourth grade, male students during the 2015- 2016 school year. Therefore, H2 was supported.

Table 4

Descriptive Statistics for the Results of the Test for H2

Fourth Grade Male Students	*M*	*SD*	*N*
2014-2015	11.82	6.571	956
2015-2016	11.25	6.215	933

H3. There was a change in scores on the NWEA MAP Mathetmatics assessment for female fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was also conducted to test H3. The mean change in NWEA MAP Mathematics scores for fourth grade female students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade female students from the 2015-2016 school year were compared.

Table 5 includes a summary of the mean change in RIT scores, standard deviation, and number of fourth grade, female students included in the statistical analysis for H3. For H3, 45 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated a statistically significant difference between the two means, $t = 2.583$, $df = 1861.810$, $p = .010$. The mean change for fourth grade, female students during the 2014- 2015 school year ($M = 12.23$, $SD = 6.635$) was significantly higher than the mean change for fourth grade, female students during the 2015- 2016 school year ($M = 11.47$, $SD = 6.216$). The mean change in RIT scores was greater for fourth grade, female students during the 2014- 2015 school year compared to fourth grade, female students during the 2015- 2016 school year. Therefore, H3 was supported.

Table 5

Descriptive Statistics for the Results of the Test for H3

Fourth Grade Female Students	*M*	*SD*	*N*
2014-2015	12.23	6.635	916
2015-2016	11.47	6.216	981

RQ3. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for fourth grade students based on ethnicity (white, black, Hispanic, and other) after one year of implementation of the DIBELS Math program?

***H4*.** There was a change in scores on the NWEA MAP Mathetmatics assessment for white fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* tests was conducted to test H4. The mean change in NWEA MAP Mathematics scores for fourth grade white students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade white students from the 2015-2016 school year were compared.

Table 6 includes a summary of the mean change in RIT scores, standard deviation, and number of white fourth grade students included in the statistical analysis to investigate H4. For H4, 79 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated a statistically significant difference between the two means, $t = 3.508$, $df = 2388.195$, $p < .001$. The mean change for white fourth grade students during the 2014- 2015 school year ($M = 12.41$, $SD = 6.820$) was significantly higher than the mean change for white fourth grade students during the 2015- 2016 school year (*M* = 11.48, *SD* = 6.240). The mean change in RIT scores was greater for white fourth grade students during the 2014- 2015 school year compared to white fourth grade students during the 2015-2016 school year. Therefore, H4 was supported.

Table 6

Descriptive Statistics for the Results of the Test for H4

Fourth Grade White Students	*M*	*SD*	*N*
2014-2015	12.41	6.820	1198
2015-2016	11.48	6.240	1219

H5. There was a change in scores on the NWEA MAP Mathetmatics assessment for black fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H5. The mean change in NWEA MAP Mathematics scores for fourth grade black students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade black students from the 2015-2016 school year were compared.

Table 7 includes a summary of the mean change in RIT scores, standard deviation, and number of black fourth grade students included in the statistical analysis to investigate H5. For H5, 31 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated a statistically significant difference between the two means, $t = 2.138$, $df = 318$, $p = .033$. The mean change for black fourth grade students during the 2014-2015 school year (*M* = 11.02, *SD* = 5.958) was significantly higher than the mean change for black fourth grade students during the 2015- 2016 school year (*M* = 9.65, *SD* = 5.571). The mean change in RIT scores was greater for black fourth grade students during the 2014- 2015 school year compared to black fourth grade students during the 2015- 2016 school year. Therefore, H5 was supported.

Table 7

Descriptive Statistics for the Results of the Test for H5

Fourth Grade Black Students	*M*	*SD*	*N*
2014-2015	11.02	5.958	162
2015-2016	9.65	5.571	158

H6. There was a change in scores on the NWEA MAP Mathetmatics assessment for Hispanic fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H6. The mean change in NWEA MAP Mathematics scores for fourth grade Hispanic students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade Hispanic students from the 2015-2016 school year were compared.

For H6, 44 outliers were found and excluded from the analysis. The results of the independent-samples *t* test for H6 indicated no statistically significant difference between the two values, $t = -1.225$, $df = 728$, $p = .221$. The sample mean for Hispanic fourth grade students during the 2014- 2015 school year (*M* = 11.16, *SD* = 6.310) was lower than the sample mean for Hispanic fourth grade students during the 2015- 2016 school year (*M* = 11.72, *SD* = 6.144). The mean change in RIT scores was greater for Hispanic fourth grade students during the 2015-2016 school year compared to Hispanic fourth grade students during the 2014-2015 school year. Therefore, H6 was not supported.

H7. There was a change in scores on the NWEA MAP Mathetmatics assessment for fourth grade students categorized as other after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H7. The mean change in NWEA MAP Mathematics scores for fourth grade students categorized as other from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade students categorized as other from the 2015-2016 school year were compared.

For H7, 8 outliers were found and excluded from the analysis. The results of the independent-samples *t* test for H7 indicated no statistically significant difference between the two values, $t = -1.444$, $df = 327$, $p = .150$. The sample mean for fourth grade students classified as other during the 2014- 2015 school year ($M = 12.97$, $SD = 6.396$) was higher than the sample mean for fourth grade students classified as other during the 2015- 2016 school year ($M = 11.94$, $SD = 6.523$). The mean change in RIT scores was greater for fourth grade students classified as other during the 2014-2015 school year compared to fourth grade students classified as other during the 2015-2016 school year. Therefore, H7 was not supported.

H8. There was a difference in the change in scores on the NWEA MAP Mathematics assessment for fourth grade students from four ethnic groups after one year of implementation of the DIBELS Math program.

A one-way ANOVA was conducted to test H8. The mean change in NWEA MAP Mathematics scores for white, black, Hispanic, and other fourth grade students from the 2015-2016 school year were compared.

For H8, 128 outliers were found and excluded from the analysis. The results of the one-way ANOVA indicated there was a statistically significant difference between at least two of the means, $F = 3.439$, $df = 3, 1860$, $p = .016$. See Table 8 for the means and standard deviations for this analysis based on ethnicity. A follow-up post hoc was conducted to determine which pairs of means were different. The Tukey's Honestly Significant Difference (HSD) post hoc was conducted at $a = .05$. A total of three differences were statistically significant. The mean change for black students ($M = 9.89$) was significantly lower than the mean change for Hispanic students (M = 11.53). The mean change for black students ($M = 9.89$) was significantly lower than the mean change for white students ($M = 11.30$). The mean change for black students ($M = 9.89$) was statistically lower than the mean change for students classified as other ($M = 11.63$). The mean change in RIT scores for black students on the NWEA MAP Mathematics assessment during the 2015-2016 school year was significantly lower than the mean change in scores for white, Hispanic, and other fourth grade students. Therefore, H8 was supported.

Table 8

Descriptive Statistics for the result of H8

Fourth Grade Students 2015-2016		*M*	*SD*	*N*
Ethinicity	white	11.30	5.739	1181
	black	9.89	5.335	155
	Hispanic	11.53	5.887	359
	other	11.63	6.060	169

RQ4. To what extent was there a change in scores on the NWEA MAP Mathematics assessment for low SES students and non low SES after one year of implementation of the DIBELS Math program?

H9. There was a change in scores on the NWEA MAP Mathetmatics assessment for low SES fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H9. The mean change in NWEA MAP Mathematics scores for fourth grade low SES students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade low SES students from the 2015-2016 school year were compared.

For H9, 64 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated there was not a statistically significant difference between the two means, t = 1.102, df = 1427, p = .270. The mean change for low SES fourth grade students during the 2014- 2015 school year was higher than the mean change for low SES fourth grade students during the 2015- 2016 school year. The mean change in RIT scores was greater for low SES fourth grade students during the 2014-2015 school year compared to low SES fourth grade students during the 2015-2016 school year. Therefore, H9 was not supported.

H10. There was a change in scores on the NWEA MAP Mathetmatics assessment for non low SES fourth grade students after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H10. The mean change in NWEA MAP Mathematics scores for fourth grade non-low SES students from the 2014-2015 school year and the mean change in NWEA MAP Mathematics scores for fourth grade non low SES students from the 2015-2016 school year were compared.

Table 9 includes a summary of the mean change in RIT scores, standard deviation, and number of non-low SES fourth grade students included in the statistical analysis to investigate H10. For H10, 70 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated a statistically significant difference between the two means, t = 3.486, df = 2367.377, p< .001. The mean change for non-low SES fourth grade students during the 2014- 2015 school year (M = 12.53, SD = 6.670) was significantly higher than the mean change for non-low SES fourth grade students during the 2015- 2016 school year (M = 11.61, SD = 6.136). The mean change in RIT scores was greater for non-low SES fourth grade students during the 2014-2015 school year compared to non-low SES fourth grade students during the 2015-2016 school year. Therefore, H10 was supported.

Table 9

Descriptive Statistics for the Results of the Test for H10

Non Low SES Fourth Grade Students	*M*	*SD*	*N*
2014-2015	12.53	6.670	1185
2015-2016	11.61	6.136	1210

H11. There was a difference in the change of scores for low SES and non low SES fourth graders after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H11. The mean change in NWEA MAP Mathematics scores for low SES and non low SES fourth grade students from the 2015-2016 school year were compared.

For H11, 128 outliers were found and excluded from the analysis. The results of the independent-samples *t* test for H11 indicated there was not a statistically significant difference between the two values, t = 1.560, df = 1862, p= .119. The sample mean for non low SES fourth grade students during the 2015- 2016 school year (M = 11.42, SD = 5.687) was higher than the sample mean for low SES fourth grade students during the 2015- 2016 school year (M = 10.99, SD = 5.921). The mean change in RIT scores was greater for non low SES fourth grade students during the 2014-2015 school year compared to low SES fourth grade students during the 2015-2016 school year. Therefore, H11 was not supported.

RQ5. To what extent was there a difference in the change in scores on the NWEA MAP Mathematics assessment for fourth grade students who received consistent progress monitoring, and fourth grade students who did not receive consistent progress monitoring after one year of implementation of the DIBELS Math program?

H12. There was a difference in the change of scores on the NWEA MAP Mathematics assessment for fourth grade students who received consistent progress monitoring, and fourth grade students who did not receive consistent progress monitoring after one year of implementation of the DIBELS Math program.

An independent-samples *t* test was conducted to test H12. The mean change in NWEA MAP Mathematics scores for fourth grade students who received consistent progress monitoring during the 2015-2016 school year was compared to the mean change in NWEA MAP Mathematics scores for fourth grade students who did not receive consistent progress monitoring during the 2015-2016 school year.

For H12, 128 outliers were found and excluded from the analysis. The results of the independent-samples *t* test indicated there was not a statistically significant difference between the two values, $t = .789$, $df = 1862$, $p = .430$. The sample mean for fourth grade students without consistent progress monitoring during the 2015- 2016 school year (M = 11.30, SD = 5.747) was higher than the sample mean for fourth grade students with consistent progress monitoring during the 2015- 2016 school year (M = 10.97, SD = 5.995). The mean change in RIT scores was greater for fourth grade students without progress monitoring during the 2015-2016 school year compared to fourth grade students with consistent progress monitoring during the 2015-2016 school year. Therefore, H12 was not supported.

Summary

The descriptive statistics and results of each hypothesis test were described in this chapter. The implementation of the DIBELS Math Program had a statistically significant difference on the mean change in NWEA MAP Mathematics scores after one year of implementation in seven out of the twelve hypothesis presented. For hypotheses 1, 2, 3, 4, 5, 8, and 10 there was a statistically significant difference in the mean change on the NWEA MAP Mathematics assessment between the groups compared. However, in each case the mean change in RIT scores decreased from the 2014-2015 school year to the 2015- 2016 school year. The subsequent chapter provides a summary of the research as well as major findings from the literature, implications for further action, recommendations moving forward, and a conclusion.

Chapter 5

Interpretation and Recommendations

The purpose of this study was to examine the impact of the DIBELS Math program on the NWEA MAP mathematics scores of fourth grade students. Male and female student scores were analyzed, as well as fourth grade students from four demographic categories. Scores were also analyzed based on socioeconomic status and frequency of progress monitoring. The impact of the DIBELS Math program was examined based on the mean change in NWEA MAP mathematics scores from the 2014-2015 school year and the 2015-2016 school year. This chapter includes the findings related to the literature, conclusions, and recommendations for further actions.

Study Summary

The current study is summarized in this section. An overview of the problem, purpose statement, and research questions are provided. A review of the methodology and major findings conclude this section.

Overview of the problem. Educators in the XYZ School District have been attempting to close the achievement gap for all students, including minority and low SES students. They have also worked to ensure that both male and female students are growing at comparable rates. Additionally, an RTI framework has been established in the XYZ School District. Despite the investments and progress in reading instruction, similar resources and systems have not been implemented in the subject of mathematics. Students in the XYZ School District are not demonstrating the desired rate of growth in mathematics, and are falling behind their international peers. District leaders were searching for a tool that would help increase the rate of growth in mathematics for all students and align with existing district goals and initiatives, such as the RTI framework.

Purpose statement and research questions. The first purpose of this study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students. The second purpose of the study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade male and female students. The third purpose of the study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade minority students. The fourth purpose was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students categorized as low SES, and those not categorized as low SES. The final purpose of this study was to examine the change in NWEA MAP Math scores after one year of implementation of the DIBELS Math program for fourth grade students who received consistent progress monitoring utilizing the the DIBELS Math program and students who did not receive frequent progress monitoring. Five research questions were written to address the purposes of this study.

Review of the methodology. In this quasi-experimental research study, the difference in the mean change in NWEA MAP Mathematics assessment scores for fourth grade students after one year of implementation of the DIBELS Math program were analyzed. Additionally, the difference in the mean change in NWEA MAP mathematics scores after one year of implementation of the DIBELS Math program were further compared for male and female fourth grade students, white, black, Hispanic, and other fourth grade students, and low SES and non low SES fourth grade students. Finally, the difference in the mean change in NWEA MAP mathematics assessment scores after one year of implementation of the DIBELS Math program were compared for fourth grade students who received consistent progress monitoring, and those who did not. Multiple independent-samples *t* tests and a one-way ANOVA were used to analyze the data in this study.

Major findings. There is evidence that the implementation of the DIBELS Math program had a significant impact on NWEA MAP mathematics scores after one school year. The mean change in RIT scores on the NWEA MAP Mathematics assessment for all fourth grade students decreased from the 2014-2015 to the 2015-2016 school year. The mean change in RIT scores on the NWEA MAP Mathematics assessment for male and female fourth grade students decreased from the 2014-2015 to the 2015-2016 school year. The mean change in RIT scores on the NWEA MAP Mathematics assessment for white and black fourth grade students decreased from the 2014-2015 to the 2015-2016 school year. When the mean change in RIT scores on the NWEA MAP Mathematics assessment was compared between white, black, Hispanic, and other fourth grade students from the 2015-2016 school year, the mean change in scores for black students was significantly lower compared to the mean change for all other groups. The mean change in RIT scores on the NWEA MAP mathematics assessment for non low SES fourth grade students significantly decreased from the 2014-2015 to the 2015-2016 school year. There was no statistically significant difference in the mean change in RIT scores on the NWEA MAP Mathematics assessment between low SES and non low SES students during the 2015- 2016 school year. The socioeconomic status of students may not impact the effectiveness of the DIBELS Math program after one year of implementation based on the average change in RIT scores on the NWEA MAP Mathematics assessment. The consistency of progress monitoring also may not impact the effectiveness of the DIBELS Math program after one year of implementation based on the change in RIT scores on the NWEA MAP mathematics assessment.

Findings Related to the Literature

Ornstein (2010) found that mathematics achievement was highly correlated to gender, ethnicity and socioeconomic status. Howell (2011) also reported a relationship between mathematics remediation at the postsecondary level and female, minority, and low socioeconomic status students. These demographic groups were specifically selected for this study based on the literature. The results of this study suggest that the DIBELS Math program had a statistically significant impact on the average change in NWEA MAP mathematics assessment scores for male, female, white, black, and non low socioeconomic status studets. Unfortunately, the average scores for male, female, white, black, and non low socioeconomic students significantly decreased from the 2014-2015 school year to the 2015-2016 school year. The average change in scores for students in each of these groups decreased after one year of implementation of the DIBELS Math program.

The results of this study also found that the DIBELS Math program may not have a statistically significant impact on the average change in NWEA MAP Mathematics assessment scores for Hispanic fourth grade students, other ethnically diverse fourth grade students, or low socioeconomic status fourth grade students. Hispanic fourth grade students were the only group analyzed whose scores increased from the 2014-2015 school year to the 2015-2016 school year, however the increase was not statistically significant.

The results of this study were unexpected based on the research on mathematics intervention and the RTI framework. Based on the results of this study, the DIBELS Math program would not initially appear to assist educators in closing the achievement gap for at risk students. However, the systemic introduction and execution of the DIBELS Math program could have affected the impact of the program in the first year of implementation. The manufacturers of DIBELS Math state that consistent, uniform implementation of the program is critical to ensure expected results (Wheeler, 2016). It is possible that the program was not adopted with fidelity or consistency across the 33 elementary schools in the XYZ School District during the first year of implementation.

Burton and Kappenberg (2012) agreed that universal screening and progress monitoring must be consistent. Furthermore, their work explains that progress monitoring data must be frequently analyzed to make instructional changes. DIBELS Math provides a progress monitoring tool, however the tool alone cannot ensure that educators are analyzing the data and using it to inform intervention decisions. It is possible that educators could utilize the universal screening and progress monitoring components of the DIBELS Math program, but not use the data from these assessments to make instructional changes.

Furthermore, the intervention that accompanies a universal screener and progress monitoring tool has a critical impact on student growth (Gersten & Newman-Gonchar, 2011). The DIBELS Math program is not an intervention (Wheeler, 2016). Results from these assessments can be used to select or design an intervention, but if given without an appropriate intervention, the assessments themselves cannot be expected to result in an increase in student proficiency. Furthermore, the intervention in place should align with the progress monitoring tool (Good, 2015). For example, if a student is receiving a computation intervention, the progress monitoring tool should measure growth in computation. If the DIBELS progress monitoring tool is not monitoring a skill delivered in an instructional intervention, the desired impact on student growth may not be realized.

Conclusions

This section includes conclusions drawn about the impact of the DIBELS Math program on student proficieny in mathematics as measured by the NWEA MAP mathematics assessment. Conclusions are related to the gender, ethinicity, and socioeconomic status of students. Implications for action and recommendations for future research are included. Concluding remarks are found at the end of this section.

Implications for action. The research-based best practices of universal screening, intervention, and progressmonitoring that make up the RTI framework should result in an increased mean of change in proficiency scores for fourth grade students (Gersten & Newman-Gonchar, 2011). Educators could assume that determining which students are at risk and monitoring their progress continuously would assist teachers in ensuring that all students make growth in the area of mathematics. However, an increase in the mean change in mathematics assessment scores after one year of implementation of the DIBELS Math program was not found in this study. This results in implications for classroom teachers as well as building and district leaders.

Classroom teachers need training in order to use universal screening tools effectively. This enables them to assign suitable interventions that will maximize student growth. Additionally, classroom teachers should know how to design an appropriate intervention based on the results of universal screening data. The data gained from universal screening assessments is not useful if it does not influence interventions. Classroom teachers should also be comfortable monitoring the progress of the interventions implemented. Progress monitoring provides data to help determine whether to continue or discontinue an intervention based on effectiveness. Classroom teachers could be required to document conclusions from universal screening data, and align them with appropriate interventions and progress monitoring measures for all at risk students.

Based on the results of this study, it is possible that the introduction of consistent tools for teachers to utilize for universal screening and progress monitoring did not improve the average change in student proficiency scores after one year of implementation. District and building level leaders should examine the thoroughness of initial training and implementation of these tools. It is possible that initial training was not consistent or comprehensive and resulted in improper use of the tools in their first year of implementation.

Additionally, district and building level leaders should develop a plan to increase teachers' capacity for determining and implementing effective mathematics interventions. The educators' ability to design interventions and make instructional decisions based on data is critical to the RTI framework (Burton & Kappenberg, 2013). If teacher capacity in this area is lacking, the tools themselves will not result in increased student proficiency in mathematics.

Recommendations for future research. The purpose of this study was to examine the effect of the DIBELS Math program on the mean change in NWEA MAP mathematics assessment scores for fourth grade students in the XYZ School District. This study contributes to the research in the field of mathematics education, however additional research is needed to ensure all students, especially those in at risk demographic groups, make optimal growth in mathematics.

One recommendation for further research is to examine the impact of the DIBELS Math program on NWEA MAP mathematics assessment scores over time utilizing a longitudinal study. Inconsistencies in administration may have decreased since the first year of implementation of the program. Other factors, such as changes in curriculum, staffing, or resources, occurring in the XYZ School District may have contributed to a negative impact on the mean change in mathematics assessments scores for students in the 2015- 2016 school year. In order to eliminate some of those factors, data from multiple years should be considered.

Another recommendation for further research is to examine the difference in the mean change in NWEA MAP mathematics assessment RIT scores after one year of implementation of the DIBELS Math program for students whose beginning of the year benchmark scores on the universal screener fell in the benchmark, strategic, and intensive categories using DIBELS Math. Students who initially score in the benchmark category might not receive interventions or progress monitoring. However, students with initial scores in the strategic and intensive categories should receive interventions with aligned progress monitoring. Performing an independent-samples *t* test to compare the mean change of scores on the NWEA MAP Mathematics assessment for intensive students from the 2014-2015 school year to intensive students from the 2015- 2016 school year could explore the extent of the impact of the program for at risk students.

An additional recommendation for further research is to analyze the reliability of DIBELS Math benchmark scores to accurately predict end of year NWEA MAP Mathematics assessment scores. A benchmark score on the DIBELS Math universal screener indicates that students have approximately an 80% chance of being at grade level in mathematics by the end of the school year. A strategic score on the DIBELS Math universal screener indicates that students have approximately a 50% chance of being at grade level in mathematics by the end of the school year. An intensive score on the DIBELS Math universal screener indicates that students have approximately a 20% chance of being at grade level in mathematics by the end of the school year. Students are assigned interventions based on these predictions; the likelihood of an intensive-level student reaching grade level proficiency increases with the addition of an intervention. If DIBELS Math results are not closely correlated with NWEA MAP performance, interventions may be incorrectly prescribed.

Concluding remarks. Universal screening, intervention, and progress monitoring are all known best practices for closing the gap for at risk students. The DIBELS Math program provides reliable, statistically valid tools for universal screening and progress monitoring that educators can use in an RTI framework to ensure growth for all students, especially female, minority, and low SES students. The DIBELS Math program does not provide intervention. Educators are required to make decisions about instructional interventions. The DIBELS Math program does not replace differentiated, high quality instruction or professional judgement. It is a tool that can be combined with quality instruction to close the gap for at risk learners and ensure mathematics growth for all students.

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Appendices

Appendix A: Request to Conduct Research

dissertation help

BG

Brittany Gonser

[redacted]

Wednesday, January 31, 2018 at 5:25 PM

Show Details

Hello Dr. [redacted]

I am preparing to run data for my dissertation soon. Is there a time we could talk over the phone or in person during the next week to discuss the data I need to collect?

Thank you,

Brittany Gonser

[redacted]

Administrative Intern

[redacted]

[redacted]

Appendix B: Permission to Conduct Research

[redacted]

[redacted] SCHOOLS

Project Screening Action – District Level

To: Brittany Gonser

From: [redacted]
Assessment & Research

Date: 02/09/2018

Project Title: Change in NWEA Math MAP with Implementation of DIBELS Math

Your research project has been reviewed and the project has [redacted]:

x approved

not approved

conditional approved [redacted]ed in changes to be made

Clarification/Comments:

All data is archival. [redacted] will prepare raw data files and de-identify all data before sending to Brittany.

This project has been assigned the following number for identification purposes:

Project Number: 2018_10_BG

Please submit a copy of the completed project to our office.

If further clarification is needed concerning this action, please contact:

[redacted]

[redacted]

Appendix C: IRB Request

BAKER UNIVERSITY

SCHOOL OF EDUCATION
GRADUATE DEPARTMENT

Date: June 5, 2017
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: Brittany Gonser Signature: Brittany E. Gonser

1. Dr. Sharon Zoellner, Sharon L Zoellner Major Advisor

2. Dr. Li Chen-Bouck, Li Chen-Bouck Research Analyst

3. Dr. Jim Robins University Committee Member

4. External Committee Member

Principal Investigator: Brittany Gonser
Phone: 913-488-2804
Email: brittanygonser@smsd.org
Mailing address: 7020 Meadowlark Lane Shawnee, KS 66226

Faculty sponsor: Dr. Sharon Zoellner
Phone: 913-344-1225
Email: Sharon.zoellner@bakeru.edu

Expected Category of Review: X Exempt ___ Expedited _ __Full

II: Protocol:

The Relationship Between the DIBELS Math Program and Mathematics Proficiency Amongst Fourth Grade Students

Summary

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

The school district for this study has a current enrollment of over 27,000 students and covers more than 72 square miles of northeast Johnson County Kansas. It is the third largest school district in Kansas and serves students in 33 elementary schools, 5 middle schools, and 5 high schools. At this time the school district prefers to remain anonymous and will therefore be referred to as the XYZSD throughout this study. Students' mathematics scores on standardized tests remained stagnant or declined in the XYZ School District (XYZSD) for several years across grade levels ranging from kindergarten to sixth grade (XYZSD, 2015). Therefore, XYZSD is searching for a tool that will assist teachers and instructional leaders in determining individual student intervention needs and monitoring students' progress toward goals over time.

The DIBELS Math program is the only mathematics program known to offer benchmark assessments, progress monitoring, and individualized suggestions for intervention in mathematics. The purpose of this study is to determine the extent of the impact the DIBELS Math program has on 4th grades students' performance as measured by student standardized test scores, and to look for differences in impact amongst students based on gender, race, and socioeconomic status.

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

One condition of this study is that only students with fall and spring benchmark assessment scores on the NWEA MAP Mathematics assessment and the DIBELS Math assessment will be utilized. There are no manipulations included in this study.

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 growth will be measured utilizing the NWEA MAP assessment. Fall and Spring scores will be evaluated to determine levels of students growth. No questionnaires will be used in this study. All data utilized in this study is archival.

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.

Subjects will not encounter the risk of psychological, social, physical, or legal risk as a result of this study.

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

No stress to subjects will be involved in this study.

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

Subjects will not be deceived or misled in any way during this study.

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

No personal or sensitive information will be requested from participants during this study.

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

Subjects will not be presented with any materials which might be considered to be offensive, threatening, or degrading.

Approximately how much time will be demanded of each subject?

All data used in this study is archival and does not require additional time on behalf of subjects.

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.

The subjects in this study are all fourth grade students enrolled in the XYZ School District during the 2015- 2016 school year with NWEA MAP Math and DIBELS Math assessment scores for the fall and spring assessment period. No scripts or information will be provided to subjects and there will be no oral or written solicitation as archived data will be used.

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

Subjects will be unaware of their participation in this study and there will be no reference or association to specific subjects. All data utilized will be archived data and no inducements will be offered.

How will you insure 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.

Consent is not needed for this study. Only archived data will be utilized.

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.

No aspect of the data will be made a part of any permanent record that can be identified with a subject.

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.

Participation in the study will not be documented or recorded because the study is limited to archived data.

What steps will be taken to insure the confidentiality of the data? Where will it be stored? How long will it be stored? What will be done with it after the study is completed?

The data will be provided without any identifying factors. It will be stored in a secure, web-based file that can only be accessed with permission from the researcher or the XYZ School District. Access to the data will be limited to the researcher, research analyst, and the XYZSD Research and Assessment Department. The data will be kept for five years after the completion of the study. At that time the data will be returned to XYZSD and the researcher will no longer have access to the files.

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

This study uses only archival data, therefore there are no risks involved for the subjects or society.

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

Yes, archival data from all fourth grade students will be compared utilizing a paired sample *t* test. NWEA MAP Mathematics and DIBELS Math scores will be examined for all fourth grade students with fall and spring scores for the 2015- 2016 school year.

Appendix D: IRB Approval

BAKER UNIVERSITY
Own Confidence

Baker University Institutional Review Board

June 6, 2017

Dear Brittany Gosner and Dr. Zoellner,

The Baker University IRB has reviewed your research project application and approved this project under Exempt Status 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.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.

Please inform this Committee or myself when this project is terminated or completed. As noted above, you must also provide IRB with an annual status report and receive approval for maintaining your status. If you have any questions, please contact me at EMorris@BakerU.edu or 785.594.7881.

Sincerely,

Erin R. Morris

Erin Morris PhD
Chair, Baker University IRB

Baker University IRB Committee
Joe Watson PhD
Nate Poell MA
Susan Rogers PhD
Scott Crenshaw