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# Impact of a Tier 2 Intervention on Freshman Students with Math Disabilities

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This is to certify that the doctoral study by

Rena Whitten

has been found to be complete and satisfactory in all respects,
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Walden University
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Abstract

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by

Rena Cureton

MA, Governors State University, 2005

BS, Governors State University, 2003

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

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December 2017

Abstract

Math achievement for U.S. high school students identified with math disabilities continues to fall below expected norms. Longitudinal national and state-level assessment data showed a flat or negative trend in math performance of students with disabilities, which may negatively affect their postsecondary outcomes. The purpose of this embedded mixed-methods study was to determine the impact of an extended time algebra course on increasing the math performance of freshman students with math disabilities. The conceptual framework included Vygotsky's sociocultural theory and zone of proximal development, Bloom's theory of master learning, and Carroll's theory of degree of learning. Data collection included archived test scores from the previous school year of 21 students and a survey administered to 4 current teachers of the Tier 2 course. Statistical analysis of the archived scores using an *independent samples t- test* measured the differences between the means test scores of students from the Extended Time course and the Special Education Algebra course. Additionally, the study used a *paired samples t-test* to measure pretest and posttest differences in math scores of students enrolled in the intervention course. Results from the *t-tests* along with coding of the qualitative data indicated that the Tier 2 intervention did not allow students to make statistically significant gains in math performance. Suggestions for improving the Tier 2 course were created based on study findings. The study is significant to high school educators inclusive of classroom teachers, school and district administrators, and curriculum developers because it examined an intervention used for students with disabilities who received educational support in the mainstream classroom. Results can inform best practices for meeting the needs of high school freshman and assist in the development of programming options that positively affect the academic achievement of students with disabilities. Implications for social change include improving math outcomes of students with disabilities as a means of increasing their success in postsecondary endeavors.

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# Dedication

This dissertation and the commitment it took to complete it is dedicated to my dad, Johnny Cureton, who passed away June 15, 2017, and my mommy, Clara Cureton. One of the most significant lessons I learned from Daddy was to persevere no matter what it looked like or how it felt. The lessons he taught me helped me find my inner strength, which propelled me through the sometimes hectic, always frustrating process of completing this dissertation. I am forever changed, forever humbled, and forever grateful for everything my dad imparted to my life and now know that my Heavenly Father used it all for my good. To Mommy, you continue to be a shining beacon of strength and self-sacrifice, and for that you are one of the most amazing women I know. Thanks, Mommy. Daddy you may be gone but you live on in me and my children.

Table of Contents

List of Tables

# Chapter 1: Introduction to the Study

The National Commission on Excellence in Education indicated that the United States was losing its industry to other countries due to the decreased academic competencies of U.S. students. The report created a national concern that the academic achievement of U.S. students paled in comparison to the achievement of students educated overseas. More than three decades later, President Barack Obama reiterated the need to improve the U.S. educational system with reform efforts like Race to the Top designed to incentivize districts to develop programs that improve student performance in critical academic areas. President Obama attributed the cause of the U.S. decline as a formidable competitor in the global economy to the poor education students received. Additionally, President Obama blamed the decline in economic superiority on the failure of public schools to foster student interest in science, technology, engineering, and mathematics, commonly referred to as STEM (Wang, 2013). Before President Obama's acknowledgment of the poor math preparation issue, Peterson, Woessmann, Hanushek, and Lastra-Anadon (2011) reported that the math performance of U.S. students ranked 32$^{nd}$ among 65 nations. The pattern of underprepared students and the negative impact on the U.S. economy has been a persistent problem spanning over two decades for students with and without disabilities (Saxton, Burns, Holveck, Kelley, & Skinner, 2014).

Persistent math difficulties in early academic grades can affect both secondary and postsecondary opportunities for students with disabilities. In commenting on the performance of students with disabilities in STEM-related programs, Leddy (2010) stated that the success of students with disabilities is dependent on the ability of the U.S. public education system to remediate deficiencies in math. Leddy further stated that the implementation of "practices that make STEM education accessible, inviting, and stimulating for students with disabilities" (p. 5) is a critical component to increasing the participation of students with disabilities in STEM-related fields. The historical lack of adequate gains in math has forced educators to examine current policies and practices to improve student outcomes (Vigdor, 2013). In response to this need to address math deficiencies, Doabler et al. (2012) stated that “only through concentrated efforts can schools hope to meet the majority of their students’ learning needs, including both those on track for success and those struggling to learn the basics of early mathematics” (p. 56). Despite educators’ awareness of decreased enrollment in postsecondary STEM programs and the consistent underperformance of primary and secondary students on math assessments, students with disabilities do not receive an education that adequately prepares them for postsecondary opportunities (Amelga, 2012).

With the goal of addressing the instructional needs of students with math disabilities and those students labeled as having math difficulties, schools engage in the process of implementing tiered interventions as part of a multitiered system of support also known as response to intervention (RtI). Creating a variety of scheduling options such as a modified bell or block schedule to allow for additional instructional time in core skill areas such as math allows high schools to structures courses so students obtain a deeper understanding of content while simultaneously remediating deficient skills (Joyner & Molina, 2012). Vukovic (2012) pointed out that the “broader learning disabilities field tends to refer to struggling learners as a group that includes both those with learning difficulties and learning disabilities” (p. 281). Consistent with Vukovic’s (2012) definition of struggling learners, school policies that promote the use of tiered interventions to improve the college and career readiness of students positively impact the skills of students who receive special education services (Fowler et al., 2014). In this study, I sought to determine the effect of additional instruction time as a tiered intervention on the math performance of struggling learners identified under the criteria set for students with a specific learning disability in math educated at the local research setting.

Addressing the math disabilities of students with identified deficiencies allows secondary schools to produce students who will become assets in assisting the United States in regaining its standing as a formidable force in the areas of innovation and production/manufacturing industries in comparison to other countries (Leal, 2012). Additionally, increasing the math skills of students with math disabilities will increase the number of students prepared to enter college without taking remedial math courses. Chapter 1 includes the following major sections: background, nature of the study, definitions, and assumptions.

## Background

The U.S. Department of Education administers the National Assessment of Educational Progress (NAEP) across content areas to students enrolled in public schools to determine academic competency in core academic areas. National achievement scores for eighth-grade students with disabilities over the last 3 years indicated that 8.5% of students identified with a disability scored at or above the proficient range (NAEP, 2015). In contrast, 38% of students without disabilities performed at or above the proficient level in math. Regarding the math performance of Illinois students, where the study took place, the NAEP (2015) revealed 36% of eighth graders possessed skills at the proficient or advanced level. For eighth-grade students with disabilities, less than 9% obtained math scores in the proficient or above range (NAEP, 2015), which indicated a large number of students entered high school with skills below grade level. These scores mirrored those recorded in 2013. The learning deficits of students who demonstrate difficulty in eighth-grade math intensify in freshman math courses because eighth-grade skills are prerequisites for secondary math courses (Ralston, Benner, Tsai, Riccomini, & Nelson, 2014). Students with math disabilities enrolled in the study setting demonstrated a pattern of low math performance on both state and local assessments.

## Problem Statement

National and state data have shown that achievement gaps continue to exist in the performance of students with disabilities in the area of mathematics. The 2015 report card prepared by NAEP confirmed the national percentage of students with disabilities performing at or above proficiency in the eighth-grade math exam was 8%, the lowest in 6 years (NAEP, 2015). Specific to the performance of students with disabilities at the local study site, math scores on the state assessment over a 5-year period revealed less than 6% of students obtained scores in the meet or exceeds performance categories. This phenomenon of low student achievement in math continued in the local setting in subsequent years leading to the time frame of this study.

According to the Illinois Interactive Report Card (ISBE, 2015), students with disabilities in the urban high school where this study occurred consistently failed to perform at the basic level and did not meet state standards in math oftentimes underperforming in comparison to their nondisabled peers and disabled peers statewide. Students with disabilities enrolled in the school of interest also failed to meet college readiness benchmarks in the area of math as reported on the Illinois Interactive School Report Card (Illinois State Board of Education, 2014).
This study was conducted to address the inequality in the achievement scores of students with disabilities in the study setting.

Many studies (Gonsalves & Krawec, 2014; Krawec & Montague, 2014; Montague, Krawec, Enders, & Dietz, 2014; Rosenzweig, Krawec, & Montague, 2014) support the use of Tier 2 interventions to improve the math performance of students with and without disabilities. Tier 2 interventions are often administered for 30 to 40 minutes several times a week.  Results of these studies demonstrated improvements in the targeted skill or concept for students with and without disabilities. In most studies, students in the intervention group outperformed students in the control group, indicating that interventions improved student outcomes (Gonsalves &

Krawec, 2014; Krawec & Montague, 2014; Montague, Krawec, Enders, & Dietz, 2014). Additionally, some studies showed students with learning disabilities enrolled in the intervention group outperformed students without disabilities in the control group (Krawec, Huang, Montague, Kressler, & de Alba, 2013; Montague, Enders, & Dietz, 2011). These findings support the notion that strategies that focus on improving the performance of students diagnosed with a specific learning disability in math may also improve the performance of their peers without disabilities.

Despite the reported effectiveness of tiered interventions, lack of diligent implementation has created a gap between research and practice (Fuchs, Fuchs, & Compton, 2012). Marita and Hord (2017) reported the math deficits of students with math disabilities continue despite their participation in math interventions designed for struggling learners. Among the many studies concerning effective math interventions with students with disabilities, few researchers compared the performance of students with disabilities who participate in mainstream supplemental interventions to the performance of students with disabilities participating in interventions within the special education math classroom. Most studies conducted with students with disabilities at the secondary level focused on the benefits of interventions for students with similar characteristics such as those with disabilities but not solely for students identified with actual mathematics disabilities. In regards to increasing performance among students with disabilities, few researchers compared the performance of one group of students with disabilities to that of another group of students with disabilities.

The desired outcomes of this study were twofold: (a) connect research and practice as a means of determining the effectiveness of providing high school freshman students with math disabilities additional instructional time focused on additional exposure to the content covered in the traditional math course, and (b) add to the educational literature on effective supplemental (Tier 2) instructional practices for secondary students with disabilities comparing performance between groups of students with math disabilities. Both purposes provided an opportunity to enhance educational literature on the topic of effective interventions for secondary students with math disabilities. Strategies that focus on the specific learning difficulties that affect students with math disabilities may also be beneficial for their peers without disabilities (Dobbins, Gagnon, & Ulrich, 2014). Also, research focusing on the effectiveness of interventions on the performance of students with math disabilities participating in multiple tiered systems of support in general education classes compared to the performance of students receiving the same intervention in special education classes may provide insight into the benefits of inclusive education.

## Purpose of the Study

The purpose of this embedded mixed-methods study was to investigate the effectiveness of increased instructional time as a Tier 2 intervention on the mathematical performance of ninth-grade students with disabilities. Because of low performance, the district where this study took place instituted the extended time math course requirement for any student entering high school for the first time whose scores on the district-administered assessment fell below a 13. Performance below the cut-score required placement into a Tier 2 course which applied to students with disabilities whose scores on the district assessment were in the range of 9 to 13. As an intervention, the targeted group of students received an additional 25 to 30 minutes of instructional support to increase their exposure and interaction with topics covered in the traditional math course. Students enrolled in the extended time course received approximately 85 minutes of algebra instruction 5 days a week instead of the 55 minutes in the traditional algebra and special education instructional algebra courses. All courses utilized the same curriculum with access to supplemental software (Cognitive Tutor) to address student deficits. Students with specific learning disabilities in math, whose composite scores on the district assessment were below 9, were educated in the special education instructional Algebra classroom.

## Research Question(s) and Hypotheses

The extended time course served as an intervention to increase the math scores of students with disabilities. The purpose of this study was to examine the degree to which the extended course affected the math performance of students with disabilities. The study was conducted to answer the following research questions:

Guiding research question: What is the impact of extended instructional time on the mathematical performance of students with disabilities?

Subquestion 1: Is there a statistically significant difference between the math gains of students with mathematics disabilities enrolled in the Tier 2 program and students with mathematics disabilities enrolled in a special education self-contained math course?

$H_0$1: Students enrolled in a Tier 2 intervention program do not show a statistically significant difference in math gains in pre to post-test scores on the EXPLORE test compared to students who receive support in a self-contained Algebra course.

$H_a$1: Students enrolled in a Tier 2 program show a statistically significant difference in math gains compared to students who receive mathematics intervention in the special education instructional mathematics course as measured by pretest to posttest performance on the EXPLORE test.

Subquestion 2: Is there a statistically significant gain between the pretest and posttest scores of students enrolled in the Tier 2 intervention, as measured by the EXPLORE test assessment?

$H_0$2: Students enrolled in a Tier 2 intervention program do not show statistically significant gains between pretest and posttest math scores on the EXPLORE assessment.

$H_a$2: Students enrolled in a Tier 2 intervention program show a statistically significant gain between pretest and posttest math scores on the EXPLORE assessment.

Subquestion 3: What are the teachers' perceptions of the impact of the Tier 2 program on student math achievement?

## Conceptual Framework

The purpose of this embedded study was to determine whether a Tier 2 intervention that provides additional instruction time in the area of math affects the math performance of freshman students. Through this intervention, students received supplemental instruction in algebraic concepts through a software program offering additional skills practice and reteaching of concepts learned in the traditional mathematics course. The intervention program assessed individual student skills and prescribed instruction based on the students' need to bridge the gap between current knowledge and expected knowledge. Bloom's mastery learning, Vygotsky's zone of proximal development, and Carroll's degree of learning as a function of instructional time provided the conceptual framework for this study.

In the early 1970s, Bloom (1971) urged educators to consider individual differences in the rate of student learning to close achievement gaps. Bloom coined the term *mastery learning* (ML), defined as an instructional strategy in which teachers provide 1-2 weeks of instruction using units organized into specific concepts and skills. A formative assessment follows these units to provide teachers with information on adaptations and effectiveness of instruction and assess students on their attainment of the desired skills. Teachers use the feedback from the assessment to prepare individualized corrective activities that target student deficiencies to facilitate mastery of the skill (Guskey, 2007). The one caveat to the mastery learning approach is that the correctives must differ from the original instruction. These correctives are in the form of varied instructional practices and additional instructional time as seen in the Tier 2 intervention programs in many schools as supplemental intervention provided to a select group of students (Ritchey, Silverman, Montanaro, Speece, & Schatschneider, 2012).

Bloom's approach supports Vygotsky's concept of a learner's zone of proximal development (ZPD). ZPD is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). ZPD requires teacher intervention or peer learning activities to bridge the gap between what the student knows and what the student needs to know. The combination of ZPD and ML includes assessment, individualization, intervention, and progress monitoring as the foundational principles of the response to intervention model.

Gaskey and Jung (2011) pointed out that ML and RtI both require frequent assessment of student learning and the application of more intensive supports as identified students continue to exhibit learning difficulties leading to the identification of students with math disabilities. Bloom (1974) sought to remediate students early in the instructional process to prevent an increase in the achievement gap. This idea of addressing deficits early in a student's academic career supports the idea of focusing on improving the math skills of freshman students as they begin their tenure in high school.

Similarly, Carroll (1963) provided evidence that the use of Tier 2 interventions would increase student learning through his work on the impact of time on student learning. Carroll determined a positive correlation between the ratios of learning to instructional time spent on tasks. The infusion of Vygotsky's ZPD, Bloom's mastery learning, and Carroll's degree of learning as a function of instructional time presumes increased instructional time and instructional intervention as viable options for improving student outcomes. The intervention for the study provided students with an additional half period of math instruction as a supplement to the traditional math course taken by all students. The perceived outcome of this additional math time is that students will become proficient in the math skills needed for success in the traditional algebra and more advanced mathematics courses. All algebra teachers used the algebra curriculum created by the Carnegie Learning company, which includes multiple classroom resources and the Cognitive Tutor software program to facilitate student learning in the areas of math operations, variables, order of operations, distributions, proportions, percentages, and linear equations. The extended time course uses the Cognitive Tutor program as the primary resource during the additional instruction period while the special education course includes the program weekly for the one full class period. All teachers use student's ZPD to begin instruction and student's progress to the next learning objective based on predetermined criteria for concept mastery.

In this study, the extended instructional period included the tenants of mastery learning in which teachers provided systematic and sequential instruction for several weeks then assessed students to determine mastery of skills and and promote mastery learning. The structure of the intervention course consisted of direct instruction from teachers, peer-assisted learning, and use of technology to determine a student's current level of knowledge and to scaffold learning until the concept was learned. This structure aligned with Vygotsky's ZPD by using the more experienced individual (teacher or peers) to assist the less experienced student with math difficulty to internalize the target learning process through small group instruction, teacher-directed instruction, and individualization through computer-assisted instruction. Extended instructional time as a Tier 2 intervention promotes mastery learning in students at their zone of proximal development, and supports the theory of degrees of learning through increased instructional time designed to have a positive impact on student performance.

## Nature of the Study

The study included an embedded mixed-methods design to determine whether the extended time associated with the Tier 2 program affected the math performance of students with disabilities. Creswell (2012) described the purpose of embedded mixed-methods research to examine the relationship between variables by collecting two sets of data at one point in time. For this study, archived scores provided the quantitative data collected while a questionnaire given to teachers instructing the tiered intervention course served as the qualitative data source.

Kratofil (2014) used surveys, interviews of school staff, classroom observations, and document analysis coupled with the comparison of math scores from state and district assessments to determine whether extended time in an additional math course led to increased student performance in algebra. Kratofil's mixed-method approach supported the use of the same design for the current study. In the current study, the analysis of archived scores from Group A represented the performance of those students enrolled in the extended math class, and archived scores of students from Group B represented students in the special education course. I collected quantitative data for this study by compiling the results of student test scores from last school year. As a result, I did not engage with students directly. A questionnaire given to teachers who taught the extended math course served as the tool to assess the teachers' perceptions of the benefits of the additional instructional time on student performance.

In an embedded mixed methods design, the collection of quantitative data coincided with the collection of qualitative data. Quantitative data specifically included the following: (a) archived pretest and posttest scores of ninth-grade students enrolled in the Tier 2 program, and (b) archived pretest and posttest scores of ninth-grade students enrolled in the special education instructional classroom. The school district's student database system contained student course enrollment, store course grades, teacher schedules, and archived district assessment scores. This database is integrated with other systems to import data in each area and served as the data source for this study.

A comparison of the archival data in the form of pretest and posttest scores from the district's fall and spring testing of students enrolled in the identified math classes assisted in answering the guiding research question. Coding of teacher responses to the questionnaire provided common themes to supplement the quantitative data. I used the independent-and paired-samples *t-test* to determine the statistical significance of the difference in math performance from pretest to posttest, pretest to posttest performance between groups, and descriptive statistics to answer the subquestions and test the hypotheses. The *t-test* allowed me to accept or reject the null hypothesis.

The focus of this study was the math performance of students with disabilities who scored below the district's cut score on a district assessment (pretest) and who, as a result, participated in a second math course as an elective upon entering high school. Students who scored above the cutoff were not eligible for the additional course; however, they were able to receive additional support as needed in a different Tier 2 intervention. The offering of the alternative intervention addressed ethical considerations of withholding treatment from students.

## Definitions

*Algebra extended time*: a supplemental math course for high school freshman**.**

*Double dosing*: The provision of extended instructional time in mathematics through an additional academic course offered daily. Cortes and Goodman (2014) referred to the enrollment in a regular algebra plus an algebra support class as double dosing.

*Modified or block schedule*: Class periods lasting longer than traditional 40-minute class periods to allow for additional instructional time in core academic areas. A portion of the school day is organized into larger blocks of time to allow for varied instructional activities (Gilkey & Hunt, 2013).

## Assumptions

The assumptions for this study were as follows: (a) Instructors followed their lesson plans to promote fidelity of implementation, and (b) teacher responses to the questionnaire accurately reflected their opinions of the impact on student performance. The administration of the district assessment occurred without modification or interference from teachers to influence student performance.

## Scope and Delimitations

This study focused on the effect extended instructional time had on the math performance of freshman students identified with a disability in math. The study addressed whether providing students with an additional instructional period in math would improve their math scores on the district assessment. The study focused on the effect this intervention had on the pretest and posttest scores of the students in the classes receiving the intervention in comparison to their entry scores and the pretest and posttest scores of their peers enrolled in a self-contained mathematics course. Analysis of archival data of scores on the district assessment resulted in the acceptance of the null hypotheses.

## Limitations

The study had several limitations. I looked at math performance in ninth-grade algebra students, so results cannot be generalized to any other math course. Generalization of results to all ninth-grade students in the United States cannot occur because the information from the study was relevant only to the selected site. Because the intervention program is only for students with disabilities who demonstrate significant deficits in mathematics, the generalization of results to students not deemed as having a disability cannot occur. Some students may practice the math concepts taught in the curriculum outside of the school day.

## Significance

The issue of low math achievement for students with disabilities has existed in the district in which this study took place for the past 5 years. During 2015 and 2016, only 1% of students with disabilities met the benchmark on the state assessments. This low performance was also reflected on the math subtest of the ACT College and Career Readiness exam, as the median score for students with disabilities during the 2014, 2013, and 2012 school years was 9, which was 12 points lower than the state and national average of 21 (ACT, 2014). As supporting evidence of the adverse impact math deficiencies at the high school level have on postsecondary success, the Illinois Community College Board (2011) reported nearly 33% of recent public high school graduates lacked the math skills to complete a college algebra course. Due to these skill deficiencies, many colleges require students with math disabilities to enroll in remedial math courses.

The goal of a tiered system of support is to mobilize resources that provide supports and services to students for whom “typical instruction is not effective” (Sailor, 2015, p. 96). This tiered system includes students with and without identified special education services. As its Tier 2 intervention, the local school for this study implemented a supplemental math course that occured daily. The purpose of this intervention was to extend the amount of instructional time in math to students with math disabilities allowing supplemental instruction in areas covered in the first half of the course.

Improving the math performance of high school students with a disability in math has several social implications. The goal of any school is to produce students who become lifelong learners who contribute to society. Students who are underprepared mathematically are at risk of high school failure and may be unable to fill critical positions in the fields of science, technology, and mathematics thereby negatively affecting the U.S. economy. Murphy (2012) noted that despite a national unemployment rate of 8%, millions of STEM-related jobs in the United States remained unfilled. The U.S. Department of Labor projected that the need to fill STEM-related jobs will triple in comparison to those from other fields (Leal, 2012). Implementing intervention programs to improve the math performance of students may serve as a means to develop the capacity of individuals to secure steady employment supporting the U.S. economy through income taxes and purchases at local businesses.

In examining the outcomes of students who fail to graduate from high school, Bowers, Sprott, and Taff (2013) reported that high school dropouts experienced higher unemployment rates, higher rates of incarceration, a shorter lifespan, and less incomes than students who graduate from high school. Low math performance in secondary schools affects students' postsecondary options, negatively affects high school graduation rates, and negatively affects the U.S. standing in the global community (Peterson, Woessmann, Hanushek, and Lastra-Anadón, (2011). Despite the possible high school failure and effect on the U.S. economy, research on interventions at the secondary level is lacking compared to research at the elementary level. Most of the research on effective math intervention programs has focused on students at the elementary level. Prewett et al. (2012) explained the focus on the primary grades in the following manner:

> although scientific knowledge about the effectiveness of RtI in secondary settings is lacking, and even called into question by some researchers, secondary schools across the nation are continuing to implement RtI to close the achievement gap and perhaps preventing academic failure in content areas. (p.136)

In researching the effectiveness of interventions on secondary students, Vaughn and Fletcher (2012) stated that although evidence-based approaches in the area they examined were readily available at the elementary level, interventions for students at the secondary level were still developing. Fuchs, Fuchs, and Compton (2010) explained the lack of research on the effectiveness of RtI at the secondary stating “many researchers avoid middle and high schools entirely because of the scheduling problems and compliance issues often encountered when working with adolescents” (p. 22). The lack of research on effective interventions at the secondary level supported the need to conduct research on this population. I evaluated the effect of a Tier 2 intervention on the math achievement of ninth-grade students. The findings from this study may provide the district with valuable information in determining the efficacy of the existing program.

## Summary

Chapter 1 included a brief description of the impact of math difficulty on students and the need for tier 2 interventions at the secondary level. I detailed the nature of the study and the problem that prompted the research. The goal of the current study was to add to the body of knowledge on the effectiveness of extended instructional time on the math performance of high school students.

Math disabilities can negatively influence postsecondary options for high school students. Implementing interventions designed to remediate these deficits through a response to intervention model can address the learning needs of at-risk students and narrow the achievement gap between these students and their peers (Fuchs et al., 2012). For the nation to compete in the global economy, schools must invest in math education that prepares students for careers in STEM-related fields (Hegedus, Dalton, & Tapper, 2015). The No Child Left Behind Act of 2001 established that it is the responsibility of educational leaders at the secondary level to incorporate research-based intervention into the school’s curriculum based on evidence-based studies. Extended instructional time may provide students with the math skills needed to promote positive social change. Chapter 2 contains a detailed review of the literature concerning tiered interventions, math disabilities, and college readiness.

# Chapter 2: Literature Review

The purpose of this study was to determine the effectiveness of extended instructional time in the area of algebra as an intervention designed to improve the math performance of ninth-grade students in an urban high school. The data sources for this study consisted of archival test results on district assessments of treatment and comparison groups along with course enrollment data. Qualitative data in the form of teacher questionnaires supplemented the quantitative data to determine the effectiveness of the intervention. The objective of this literature review was to examine tiered systems of support as a part of school reform to address deficits in core academic areas. I provide an overview of the literature on math deficits in the United States, discuss the literature on tiered systems of supports, and include a review of literature on college readiness and research methodology.

## Literature Search Strategy

I used the Walden University databases including ERIC, Education Search Complete, and SAGE to identify a robust set of articles. The following key words were used to guide the literature search in each database: *low-achieving math students*, *Tier 2 interventions*, *secondary education*, *math interventions*, *extended instructional time*, *extended learning time*, *math disabilities*, *freshman students and math*, *Tier 2 secondary interventions*, *Response to Intervention*, *Multitiered System of Support*, *college entry*, *college ready*, and *developmental math*.

## Conceptual Framework

### Mastery Learning

Bloom (1971) framed an approach to instruction that included feedback and correctives to ensure students mastered learning. Bloom coined this approach *mastery learning* with two foundational principles at its core. First, teachers arranged instruction into units and included a formative assessment near the end of the unit to inform students of their progress in learning the intended objectives of the unit. Secondly, teachers used designed correctives to address deficits in student learning and to facilitate mastery. Through the process of formative assessment and individualized interventions that provided opportunities for additional instruction, Bloom (1976) claimed that students would demonstrate proficiency in the learning objectives. Guided practice with peer coaching, corrective feedback, and goal setting occurring on a daily basis served as the intervention for VanDerHeyden, Codding, and Gilman's  (2015) research. Aligning with the principles of mastery learning, the class-wide intervention in VanDerHeyden, Codding and Gilman's study included weekly curriculum-based measures to assess student skill mastery before moving on to the next skill.

## Zone of Proximal Development

Vygotsky (1978) explained that learning occurred as a social construct in which the interaction between a neophyte and an expert resulted in the acquisition of skill. Through the social interaction that occurs during this construct, the gap between the novice's current knowledge and expected (ZPD) closes. The closure of this skill gap signifies the point where learning has taken place. Vygotsky's ZPD supports mastery learning through teachers identifying where the student is currently functioning and providing support through instruction or intervention to assist the student in mastering content. The intervention in the Alter (2012) study included ongoing formative assessment to inform the teachers of the student's progress. The intervention was adjusted based on the formative assessment results of each student. The intervention provided supplemented traditional math instruction. According to Vygotsky, the ZPD occurs when deficits are addressed, and supplemental or additional instruction for teachers occurs to assist students in reaching proficiency. Alter found an increase in student performance due to the feedback and correctives embedded in the intervention.

## Degree of Learning

The degree of learning, as coined by Carroll (1963), established the relationship between instructional time and learning. Carroll posited a direct correlation between the time spent learning and the time needed to learn as the degree of learning. Carroll’s model comprised five variables that included the student’s capacity to learn, the student’s ability to comprehend instruction, the quality of instruction, opportunities for learning, and student perseverance for learning. The theory of the degree of learning incorporates the five variables into a formula that represents the degree of learning as a ratio of the time spent learning to the time needed for learning to occur. Rodgers (1968) summarized Carroll’s model by suggesting learning occurs as long as a student is given sufficient time for learning and is willing to persevere for as long as it takes to achieve.

Investigating the impact of standards-based versus traditional curriculum on the math performance of students with disabilities allowed Bouck, Kulkarni, and Johnson (2011) to use the tenants of Carroll’s degree of learning. Bouck, Kulkarni, and Johnson placed students in traditional and standards-based instruction to teach mathematics where the students were taught one of the identified curricula throughout the entire school year. As part of the intervention, assessment of student performance occurred on a bi-quarterly basis to determine mastery of content. Teachers implemented their respective curricula with fidelity while the standards-based curriculum included small-group student-directed learning. Although the results of the study were inconclusive, the interventions took into consideration giving students adequate time (1 year) and opportunities to persevere in the standards-based class that followed the eight math practices found in the Common Core State Standards.

## Studies Using Similar Methodologies

Zhang, Trussell, Gallegos, and Asam (2015) explored intervention effectiveness in fourth-grade students with math deficits. The study took place in response to the use of applications on mobile devices in classrooms designed to engage students in math learning. Zhang and fellow researchers sampled an inclusive fourth-grade classroom where students used three math apps to support the learning of mathematical concepts. The findings showed that use of the math apps resulted in a statistically significant increase in student scores from the pretest to posttest.

Kebritchi, Hirumi, and Bai (2010) used a mixed-methods approach to examine the effectiveness of computer games on math achievement and student motivation. The data collection consisted of quantitative instruments in the form of pre- and post-academic achievement assessments with a series of interviews serving as the qualitative data source. Kebritchi et al. found that students who used the computer games showed significant improvement on pretest and posttest measures in comparison to students who did not participate in the intervention, while controlling for motivation in the two groups.

## Studies Using Other Methodologies

Poncy, Jaspers, Hansmann, Bui, and Matthew (2015) used an alternating treatment design to examine and compare the effects of two interventions on the math fluency of second-grade students in the Midwest. In one intervention, students received an audio cue with a time delay prior to solving a math problem while the second intervention provided the audio cue without the time delay.  Twenty general education students participated in the two interventions on alternating days with probes given before the initiation of the first treatment. Poncy et al. found that while both treatments increased student performance in math fluency, the treatment that did not have a time delay between the audio cue proved to be more effective in increasing the automaticity rates with which students computed math problems.

Dennis (2015) used a *multiple probes* research design to examine the effects of Tier 2 and Tier 3 interventions on the performance of students with math issues. The study took place in two phases with Dennis first evaluating the effect of the Tier 2 intervention on the performance of all the subjects on a researcher-created outcome measure, and then later examining the impact of Tier 3 interventions on the same students in the initial study who made minimal progress. Dennis found that six out of the nine participants experienced a 15% increase in their scores from baseline and maintenaned the learned skill once the Tier 2 intervention ended. The three students who did not experience a demonstrable increase in their test scores, showed improvement on the benchmark measure administered later in the year obtaining scores equal to that of their peers who only participated in the Tier 2 intervention.

## Mixed Methodology

Creswell (2012) stated that mixed-methods designs combine quantitative and qualitative data to address the research problem and answer the research questions. Mixed-methods designs originated in 1959 when Campbell and Fiske (as cited in Creswell, 2012) used multiple measures to examine psychological traits and assessed each measure using multiple methods. Harwell (2011) noted that although considered a relatively new methodology, mixed-methods approaches to research "bridge the differences between quantitative and qualitative methods to address a research question" (p. 151).

Venkatesh, Brown, and Bala (2013) stated that mixed-methods researchers collect data concurrently or sequentially from quantitative and qualitative sources. Deciding the order of data collection is paramount to determining a design strategy. Bottge, Rueda, LaRouque, Serlin, and Kwon (2007) conducted a mixed-methods study to determine the effects on enhanced anchored instruction (EAI) on the math performance of middle school students. Bottge et al. used pretest and posttest scores as the quantitative data source and coded entries from teacher logbooks as the qualitative data source. An analysis of the data indicated that EAI assisted students in developing a deeper understanding of math concepts. Additionally, a video-based intervention was deemed effective in increasing the problem-solving abilities. With baseline measures, posttest data, and coding of data to establish patterns, Yakubova, Hughes, and Hornberger (2015) found that video-based instruction improved problem-solving abilities. Finally, Pevsner, Sanspree, and Allison (2012) used qualitative data in the form of a learning styles survey and student interviews and quantitative data in the form of test scores to compare learning styles with student performance.

## Literature Review Related to Key Concepts and Variable

### Mathematics Deficits

Math skills are critical to independent living activities such as purchasing goods and services. Poor math skills can impede postsecondary options due to the prerequisite of high school graduation including students passing high stakes assessments that evaluate their math abilities (Lembke, Hampton, & Beyers, 2012). Regarding secondary students with disabilities, Faulkner, Crossland, and Stiff (2013) reported that poor performance in math occurred more frequently in comparison to student performance in any other academic subject. Faulker et al. added that the difficulty in math resulted in many students with mild learning disabilities dropping out of school with math skills approximating that of a fifth or sixth grader.

In support of the decision of the high school that is the focus of this study to target first-year students enrolled in Algebra, Wilder (2013) connected completion of Algebra to overall success in mathematics and success in STEM disciplines studied at the college level. Kretchmar (2013) examined the role of high school courses in preparing students for college-level courses. Kretchmar's (2013) research determined students enroll in college-level courses in high school be better prepared to enter directly into college-level courses thereby avoiding the need to enroll in remedial classes during the first year of college at the University of North Carolina (UNC) at Chapel Hill. In opposition to Kretchmar's (2013) findings, Ross and Wilson (2012) found that many students enter high school with low mathematics abilities, making it impossible for these students to enroll in higher-level math courses. Ross and Wilson (2012) cited students entering high school possessed a lack of procedural and conceptual knowledge needed to grasp mathematical concepts making a differentiation in the teaching and learning process necessary to close the achievement gap and prepare students for increased levels of math. Doabler and Fein (2013) hypothesized those students with mathematics disabilities lack the skills of number sense, the ability to solve problems fluently and accurately, and are unable to acquire the conceptual and procedural knowledge of mathematics.

Math disabilities can start early in a student's educational career. Siegler et al. (2012) discussed the importance of elementary students understanding fractions. Siegler et al. (2012) hypothesized that student knowledge of fractions at the age of 10 predicted the overall mathematics achievement and algebra knowledge of that same student at the age of 16, the age at which many students participate in high school math courses. In the past decade, schools have sought to increase the rigor of their academic courses by increasing mathematics requirements in an effort to promote higher levels of academic achievement; however, there are few programs to assist teachers in remediating mathematical deficits (Mulligan, 2011). Despite increased educational requirements, many high school students remain ill-prepared for advanced mathematics courses and are labeled "at-risk" for academic failure; with their continued struggle evidenced by their enrollment in remedial level courses at the collegial level (Scott-Clayton, Crosta, & Belfield, 2014). Allsopp and Hoppey (2011) stated the variability of mathematical abilities of high school students requires an adjustment to the structure of the high school day to implement interventions.

In addressing the math deficits of students, many schools have adopted policies that require extended instructional time in the area of math realized by increasing the time students spend in mathematical classes or expanding the current curriculum to incorporate interventions and Common Cores standards for at-risk students (Powell, Fuchs, & Fuchs, 2013). Cortes, Goodman, and Nomi (2013b) reported an increase in mathematics instructional time positively affected standardized assessment scores and high school graduation rates, but the increase in instruction did not influence the dropout rates for students (Cortes, Goodman, Nomi, 2013b). Arguably, research has shown a correlation between mathematics achievement, high school completion, and college success (Cortes & Goodman, 2014; Cortes, Goodman, & Nomi, 2013b). In support of the work of Cortes and Goodman (2014), Nomi and Raudenbush (2016) found a positive correlation between the extension of instructional time and the scores of students who performed below the district's cut score. Simultaneously, these authors determined the homogeneous peer grouping as seen in the extended time course decreased the mathematics achievement of students who performed closer to the cut score.

If schools are to increase outcomes for at-risk students, they need to focus on implementing practices and interventions early and often in a student's academic career using strategies relevant to the individual needs of the student (O'Connor, Briggs, & Forbes, 2013). Froiland (2011) discussed the RtI model as a means to support students along a continuum of three tiers supported by curriculum-based measurement of academic skills to monitor student progress. This proposed mixed methods research study seeks to determine the effect of a Tier 2 intervention within the framework of a multi-tiered system of support on the Algebra performance of students.

While each of the studies discussed above exclusively collected quantitative or qualitative data, the inclusion of both data sources to strengthen the results of the study to provide additional insight into the generalizability of the results of the studies. As a mixed research design, this research study incorporated both data sources to draw a connection between student performance and the impact of mathematical interventions found within a response to intervention model.

## Response to Intervention

As a legislative mandate, the No Child Left Behind (NCLB) Act of 2001 sought to raise the standard of education in the United States (NCLB, 2002). With the responsibility of ensuring all students demonstrate proficiency in the areas of reading and math, school districts have implemented initiatives that change policies and promoted differentiated instruction and early intervention as a means of meeting the varied needs of the student population (Lee, Shin, Amo, & Buffalo, 2013). The combined implications of standards-based reform, accountability, and special education regulations such as the Individuals with Disabilities Education Act (IDEA) of 2004 required schools to become innovative and create curriculums that infuse scientifically research-based interventions and supports into the teaching and learning experience. Buffum, Mattos, (2015) coined a formula for learning that has influenced many of today’s schools. These authors postulated that schools that target both teaching and time as variable factors (i.e., affixing targeted instruction to increased instructional time) experience improved student outcomes. The use of increased instructional time gives credence to the foundational principle of the response to intervention model that more time on task coupled with targeting skill deficits leads to increased student performance. Miller (2011) stated the premise of matching the intervention to the specific deficit of the students as is inherent to Tier 2 of RtI aligns with the essential components of

Bloom’s theory of mastery learning through the zone of proximal development as explained in Vygotsky’s work.

As a cornerstone of school reform, many educational institutions supported the adoption of a multi-tiered system of support (MTSS). The adoption of an MTSS at the secondary level provides the framework for additional instruction in areas such as mathematics to students identified as performing below their peers (Hunt & Little, 2014). In support of the use of interventions such as extended instructional time to improve student outcomes, Battey (2013) confirmed that increasing student proficiency through interventions, varied instructional strategies, and offering a more rigorous curriculum in mathematics, improves the chance that students graduate from high school prepared for college and career options. Inherent to Tier 2 of any MTSS model is the concept of supplemental instruction, which increases instructional time in a particular area beyond core instruction for a targeted group of students to address deficient academic areas of such as mathematics (Cuticelli, Coyner, Ware, Oldham, & Rattan, 2015). Nomi and Allensworth (2013) determined that combining differentiated instruction with increased opportunities for skill practice into the school’s curriculum positively influences student performance.

The use of an MTSS model supports the paradigm shift in education from reacting to the failure of at-risk students to a prevention model that address potential academic failures through intensive supplemental instruction (King, Lemons, & Hill, 2012). The tiered system utilizes scientifically based curriculum programs to meet the needs of the majority of its students in tier 1, provided supplemental instruction using strategic interventions for students who fail to make adequate progress in tier 1, and provided more intensive and customized instruction in subsequent tiers (Algozzine et al., 2012). As a mechanism to help struggling learners, multi-tiered systems such as RtI served as a system of support and as an alternative to using the IQ discrepancy model to identify students with a learning disability (Hughes & Dexter, 2011). In a multi-tiered system, researchers determined special education was not a separate system, but rather an integrated system in the RtI framework where special education and general educators work together to deliver Tier 2 interventions to increase student achievement (Sansosti, Goss, & Noltemeyer, 2011).

A tiered system of support, such as RtI, shifts the paradigm in schools from one that reacts to student failure to one that proactively responds to assist students. Riccomini and Witzel (2010) identified six principles on RtI models applicable to reading and mathematics:

1. Belief System
2. Universal Screening
3. Progress Monitoring
4. Research-Based Interventions
5. Instructional Tiers
6. Ongoing Evaluation and Refinement Procedures

Of particular relevance to tiered supports, principle four incorporated research-based instruction into not only core instruction but also into supplemental intensified instruction, and while principle five utilizes trained educations to implement tiered instructional supports. This re-conceptualized framing of the learning experiences of students examines student performance through a lens that enhanced core instruction for all students (Tier 1). Additionally, the newfound learning experience afforded to students created a structured program for those individuals identified through some form of assessment as possessing academic skills below those of their same-aged peers (Johnson, Galow, & Allenger, 2012). The remediation program portion of the structured program occurs at the second tier of a tiered system and serves to engage students in learning opportunities designed to remediate deficiencies that prevent successful engagement in the educational opportunities found in Tier 1.

For discussion, this literature review considered the impact of a multi-tiered approach with Tier 2 interventions designed to expose students to math concepts in an additional supplemental class period on overall mathematics performance. Tier 2 interventions address skill deficits in a group setting with frequent progress monitoring and occur in various forms across grade levels.

## Effective Mathematics Interventions

The terms *at-risk* or *struggling learner* are often used in the research to refer to students with learning difficulties, mathematics learning disabilities, students with low mathematics achievement, and students at-risk for failure in math (Misquitta, 2011). Misquitta (2011) explained that regardless of the terminology used in the literature, interventions to improve student performance are similar and not selected based on the perceived severity of mathematics difficulty. As a means to increase student outcomes, research studies have begun examining the impact of double-dosing on student achievement. Cortes, Goodman, and Nomi (2013a) revealed that the double dose algebra policy where students participate in two Algebra courses simultaneously, adopted with high school freshman by the Chicago Public School system, increased overall high school graduation rates due to improved reading and writing skills learned by students in the context of learning algebra.

As it relates to interventions by grade level, the typical RtI process at the elementary level varies in its scope and the number of tiers in comparison to the intervention systems at the middle and high school level. Fuchs, Fuchs, and Compton (2010) provided insight into the differences of RtI in that elementary educators conduct screenings before academic deficits occur causing false positives in the form of students placed in Tier 2 interventions which may not need the intervention. Fuchs, Fuchs, and Compton (2010) also believed that the intervention supports provided to students at the elementary level failed to remediate student deficits due to the lack of variability of those interventions seen across grade levels. Conversely, middle and high school educators focused on reducing existing academic deficits and returning students to Tier 1. Sugai, et al. (2012) defined the goal of Tier 2 interventions as the reduction of academic failures to prevent student deficits from escalating to the point where special education services are needed. Chard (2012) characterized Tier 2 interventions as the support provided to students in small groups over and beyond core instruction and focusing on concepts critical to mastering the standards taught in the core curriculum.

Tier 2 interventions for students with decreased mathematical performance are designed to target deficits in the skill areas of math fluency and math problem-solving. Math fluency refers to speed and accuracy to which a student responds to a math stimulus (Arroyo, Royer, & Woolf, 2012). Math problem solving refers to finding a solution to a math problem by combing mathematical computation skills with the ability to interpret oral statements (Zheng, Flynn, & Swanson, 2013). Based on the assumptions that tiered interventions are beneficial to at-risk students, Mong and Mong (2012) conducted an alternating treatment design study on the effectiveness of two Tier 2 interventions on the mathematics deficits of elementary students. These authors provided students with instruction from two supplemental mathematics programs, which allowed for repeated practice, high rates of response, immediate feedback, and self-monitoring of progress. These lessons were in addition to core instruction that provided target instruction in the skill areas of measurement and problem-solving. Mong and Mong (2012) concluded that providing students with 14 sessions of each intervention over a period of 28 days improved the targeted students' ability to compute multiple digit problems correctly per minute increasing the mathematical fluency skills of elementary students. Similarly, to address deficits in math fluency, Baroody, Eiland, Purpura, and Reid (2013) used a training experiment with multiple baselines to assign first grades students to control and treatment groups where students in the treatment group received a computer-assisted structured discovery intervention designed to increase mathematical fluency. These lessons were a substitution for the regular instruction practice received by students in the control group. Baroody, et al. (2013) concluded that providing students with 30-minute one-to-one sessions of the computer software program twice a week for ten weeks promoted increased fluency skills in students in the treatment group when compared to those in the control group. Poncy, Skinner, and McCallum (2012) compared the effectiveness of two Tier 2 interventions in increasing the mathematical fluency of third-grade students. Poncy et al. (2012) determined that the use of taped problems and the cover, copy, and compared interventions increase the subtraction fluency of students.

Deficits in math fluency manifest as decreased automaticity and knowledge of math facts slowing down the problem-solving process. Smith, Cobb, Farran, Cordray, and Munter (2013) examined the use of one-to-one tutoring on the mathematical skills of first-grade students. Smith et al. (2013) provided students with 4-6 weeks of tutoring sessions in addition to the traditional instruction received during the school day, an intervention that led to increases in math fluency skills for targeted students. Hulac, DeJong, and Benson (2012) examined the use of a folding-in technique on the multiplication fact fluency of fourth graders. The authors discovered students demonstrated an increase in math abilities after participating in the self-administered intervention that took place bi-weekly for 20 minutes as a supplement to the instruction of the traditional math class.

Mathematics disabilities may also require intervention in the area of problem-solving. As it relates to interventions for mathematics word problem solving, Swanson, Moran, Bocian, Lussier, and Zheng (2012) assigned children with mathematics difficulties (MD) to one of four treatment conditions. This approach was used to determine the most appropriate intervention to increase mathematical performance in comparison to other students with and without MD the control group. This study synthesized published studies on word problem-solving interventions used with students with identified deficiencies in math. The single-subject and group design studies reviewed revealed that instructional components such as skill modeling and specific practice, and advance organizers were critical in increasing the mathematical performance of students. Swanson et al. (2012) used mixed regression modeling to establish generative strategies as an effective intervention that increased the problem-solving accuracy and working memory capacity of students with decreased mathematics abilities. Jitendra, Harwell, Dupuis, Karl, Lein, Simonson, and Slater (2015) conducted experimental research on the effectiveness a schema-based instruction (SBI) on students' problem-solving skills. In interpreting the data, Jitendra et al. found SBI significantly increased student performance on the posttest and students who received the intervention demonstrated retention of the concepts taught after nine weeks. In addition to math problem-solving skills, Hulac, DeJong, and Benson (2012) established that the achievement gap between average, and at-risk students and the gap between average and learning disabled students, widens in the absence of intervention for students who lack math fluency skills.

Tiered interventions can influence the performance of students with disabilities. In looking at the Tier 2 interventions implemented with students who struggle with math, Browder, Trela, Courtrade, Jimenez, and Flowers (2012) implemented story-based lessons using math graphic organizers and task analytic instruction to improve the mathematical performance of students with moderate to severe developmental disabilities. Most notably, Browder et al. (2012) hypothesized that interventions used with students with disabilities are also useful for those students who are at-risk or possess math skills in the appropriate age range. Tier 2 interventions can also incorporate technology into instruction to increase student's skills. Rosenzweig, Krawec, and Montague (2011) established the effectiveness of the think-aloud strategy in improving the metacognitive skills of students with and without disabilities. Rosenzweig et al. (2011) determined that students with and without disabilities be able to use the think-aloud strategy, but its effectiveness was limited based on the productiveness of the metacognitive utterances. The findings from the Rosenweig, Krawec, and Montague (2011) study indicated that teaching students metacognitive strategies supported mathematics success on tasks that require higher-order thinking to prove that all students could potentially benefit from learning to use metacognition.

Regardless of the grade level, the interventions found in Tier 2 of a RtI model require extended instructional time in remedial areas and may include computer-aided instruction embedded into the curriculum to support student growth. Burns, Kanive, and DeGrande (2012) reviewed Tier 2 interventions in the area of math fluency with the use of a computer-based math intervention as a supplement to math instruction for third and fourth-grade students. Burns et al. (2012) provided students extra practice with math facts using a computer software program designed to build math fluency skills three-times a week for 8-15 weeks. The software program used established computerized instruction as an effective intervention to raise math scores. Nordness, Haverkost, and Volberding (2011) determined the effect of a flashcard application found on a handheld device in improving the subtraction skills of second-grade students with learning and behavioral disabilities. Students received 10 minutes of additional practice with subtraction problems three times a week using the software application in addition to daily supplemental support in math and other subjects that occurred daily. The authors determined that the subtraction skills of elementary students improve with the use of computer-assisted instruction in the form of a math application downloaded on a handheld device.

Tier 2 intervention unions supplement core instruction; however, interventions can occur on an alternating basis with core instruction. Powell, Fuchs, and Fuchs (2013) examined the effectiveness of small group tutoring that supplanted regular classroom instruction on the fraction understanding of low-risk and at-risk students. Students in the target group received equal amounts of instructional time of fraction conceptualization activities as students in the control group; however, students in the treatment group received small group tutoring three days a week for 12 weeks in place of the traditional math course. Powell et al. (2013) determined small group tutoring be instrumental in decreasing the fraction knowledge gap that existed between at-risk and low-risk students who participated in the treatment group over those students who were a part of the control group. The study proved individualizing instructional supports benefited students with mathematical deficits. Tier 2 interventions whether at the elementary or secondary school levels can have a positive impact on student's academic skills.

## College Readiness

The adoption of the Common Core standards represented an attempt to provide consistency in the learning standards and expectations of students irrespective of the state or school district in which the education occurs. These standards shaped high school curriculum, as they promote a means to ensure all students receive an education that will prepare them for college and career readiness. Research suggests addressing the academic needs of students with, and without disabilities, is a necessary component of academic preparation and affects the successful navigation of real-world experiences (Browder, Trela, Courtrade, Jimenez, & Flowers, 2012).

The targeted supports of Tier 2 interventions can potentially enhance the academic knowledge and skills of students, thereby increasing the likelihood of high school and college completion. Several studies (Scott-Clayton, 2014, & Zelkowski, 2011) acknowledged the shortcomings of high schools in preparing students for entry-level college courses. McDonald and Farrell (2012) gained insight from 31 high school seniors on their perception of being college ready citing difficulty acclimating to the academic and social expectations of college as primary reasons for student failure. Zelkowski (2011) deduced that high school students, who consistently enrolled in mathematics courses throughout their high school educational career, would produce students who are ready to enter college without the need for remedial courses. When students enroll in college because of college eligibility instead of college readiness, universities provide remedial education before students can begin taking credit-bearing courses towards their chosen college course of study. This need for remediation is due solely to low student performance on university entrance exams (Bahr, 2012). These entrance exam scores determined student admission into the college or university of their choice and affected scholarship award offers that could have assisted with paying for college (Bahr, 2012). Frost, Coomes, and Lindeblad (2012) stated the performance of high school seniors on college math placement tests often "places them in remedial math courses that do not earn college credit" (p.25) decreasing the likelihood that these low performing students will pass college courses. The results of this proposed study will assist in determining interventions that may increase the math scores for high school seniors on college entrance exams.

## Summary and Conclusions

Students who demonstrate difficulty with academic content limit their college and career options. The National Center for Education Statistics (2011) reported a lack of the academic skills of students entering college resulting in their inability to take college-level courses. Unpreparedness for enrollment into college-level courses creates instances where students have to take remedial courses thereby prolonging their college completion dates, increasing their financial obligation to the college, and causes these students to have difficulty choosing a career (Hughes, Gibbons, & Mynatt, 2013). Of specific relevance to this study was the impact Tier 2 interventions had on improving the mathematics skills of students, thereby positively affecting college readiness and dropout rates.

As elementary and high schools implement tiered systems of support, the types of interventions selected directly impact student growth. Due to the differences in the educational accommodations and modifications imposed upon elementary schools and high schools by state and federal legislation and those requirements placed on post-secondary institutions, K-12 educators are challenged to adequately plan and prepare students for the rigor of college and high expectations of the industrial workforce. Robust research exists on tiered interventions for students in the primary years of their educational careers; however, this same research on interventions with students in the secondary years is sparse. Tiered supports can be instrumental in enhancing mathematics skills of students, thereby increasing their college readiness and decreasing the likelihood of those who may drop out of school without a high school diploma. Chapter 3 will focus on the components of the research design utilized in this study.

# Chapter 3: Research Method

This purpose of this embedded mixed-methods study was to determine the effectiveness of a tiered intervention on the mathematical abilities of ninth-grade students with disabilities enrolled in algebra at an urban school. The specific intervention for this study was extended instructional time in an algebra extended time course with all students having varying degrees of math difficulties and disabilities. Students participated in the tiered intervention in the form of extended instructional time as a supplement to the traditional algebra course. The research occurred in a school district outside of Chicago. Archived district assessment scores of students enrolled in the intervention course and those enrolled in a special education instructional course served as the quantitative data while a questionnaire given to general education teachers who currently teach the intervention course served as the source of qualitative data. Special education teachers who taught the algebra instructional class were also asked to participate in the qualitative process to provide their perspective on the effectiveness of the instructional course. Analysis of the quantitative data occurred concurrently with the analysis of the qualitative data. The findings provided insight into the impact of extended instructional time on deficient academic areas, allowed for suggestions for improved student outcomes, and assisted in closing the achievement gap between students with math disabilities and their peers without disabilities.

The first two chapters of the study contained information on the current performance of secondary students in math and a literature review on math deficits and the impact such deficits have on students' postsecondary opportunities. This chapter contains information on the mixed-methods embedded design, the setting, and the study participants. This chapter concludes with a discussion of the data collection and analysis procedures and methods to protect participants' rights.

## Setting

During the 2016-2017 school year, the study site implemented a Tier 2 intervention course called algebra extended time. The course was for ninth-grade students who performed below the district cut score on a district-administered assessment, including students identified as having a specific learning disability in math. Participants in the tiered intervention course received core instruction in the district's algebra curriculum and 25 minutes of additional instructional time 5 days a week. The research design included a nonequivalent control group due to the inability to assign students to the pretest and posttest groups randomly. Enrollment in the intervention is contingent on prior performance on the entrance exam taken during the eigth-grade year. The data set consisted of scores of all students enrolled in the Tier 2 intervention course and scores for all ninth-grade students enrolled in the self-contained special education algebra course. The total freshman population for the 2016-2017 school year during the study time frame was 350 students, of whom 75 received the intervention with less than 20 of those students receiving special education services due to disabilities in Math.  For the 2016-2017 school year, four freshman math teachers were assigned to teach the Tier 2 intervention course. These teachers also taught sections of the traditional math course. All four freshman teachers were invited to participate in the qualitative data collection process through responses to the questionnaire addressing the impact of the extended math course on the math performance of students. Teachers of the special education instructional course were also asked to provide input on the effectiveness of the special education instructional Algebra course they instructed.

## Research Design and Rationale

An embedded mixed-methods research design to address the problem established for this study allowed me to answer the following research questions:

Guiding research question: What is the impact of extended instructional time on the mathematical performance of students with mathematics disabilities?

Sub-question 1: Is there a statistically significant difference between the math gains of students with math disabilities enrolled in the Tier 2 program and students with mathematics disabilities enrolled in a special education self-contained mathematics course?

$H_o1$**:** Students enrolled in a Tier 2 intervention program do not show a statistically significant difference in math gains in pre to post-test scores on the EXPLORE test compared to students who receive support in a self-contained Algebra course in the Tier 2 intervention.

$H_s1$**:** Students enrolled in a Tier 2 intervention program show a statistically significant difference in math gains compared to students who receive mathematics support in the self-contained instructional mathematics course as measured by pretest to posttest performance on the EXPLORE test.

Sub-question 2: Is there a statistically significant gain in the pre and posttest scores of students enrolled in the Tier 2 intervention, as measured by the EXPLORE test assessment?

$H_o2$**:** Students enrolled in a Tier 2 intervention program do not show statistically significant gains between pretest to posttest math scores on the EXPLORE assessment.

$H_{s2}$**:** Students enrolled in a Tier 2 intervention program show a statistically significant gain between pretest and posttest math scores on the EXPLORE assessment.

Sub-question 3: What are the teachers' perceptions of the impact of the Tier 2 program on student math achievement?

Creswell (2012) described mixed-methods research as a means to explain the relationship between variables by collecting data at one point in time using quantitative and qualitative methods simultaneously or sequentially based on the research question. The embedded mixed-methods design involves the collection of both data types to answer the research questions in the study. Concurrent with the collection and analysis of the quantitative data, the researcher collects and analyzes qualitative data to assist in explaining the quantitative data (Clark & Creswell, 2011). The quantitative data collected for this study was obtained from archived data sources in the form of the previous school year's test scores and course recommendation forms. Qualitative data were obtained from a questionnaire (see Appendix A) given to all teachers assigned to teach the algebra extended course. A pilot questionnaire given to two seasoned math teachers who previously served as instructional leaders in the math department, who taught various levels of algebra, and who assisted teachers in math data-driven decisions was used to establish the validity of the questionnaire.

In discussing the limitations of quantitative and qualitative research as separate approaches to enhancing the knowledge base of the math profession, Ross and Onwuegbuzie (2012) stated that qualitative research is used to answer research questions of why and how while quantitative research is used to examine the relationship between variables. Combining both approaches may yield stronger results (Venkatesh, Brown, & Bala). Mundia (2012) cited advantages to mixed-methods research as the incorporation of the strengths found in qualitative and quantitative approaches, which allows for comprehensive insight into the problem that is the focal point of the study. Using multiple sources of data serves as a means to increase the validity of research findings.

In the current study, I used the embedded mixed-methods design in which the simultaneous collection of quantitative and qualitative data allowed me to examine the impact of additional instructional time on math performance. Mixed-methods research designs are appropriate for educational research. Robles-Pina and Denham (2012) used a mixed-methods approach to determine the impact resource officers had on the selection of bullying prevention interventions. Robles-Pina and Denham collected quantitative data using a standardized instrument, and qualitative data using an open-ended questionnaire to determine how school resource officers' knowledge affected the effectiveness of bullying interventions. Kratofil (2014) used surveys, interviews of school staff, classroom observations, and document analysis together with the comparison of archived math scores from state and district sources to determine how the extended time in an additional mathematics course led to increased student performance in algebra. Kratofil's study supported the use of a mixed-method approach for the current study.

## Role of the Researcher

I have worked in the educational field for the past 13 years, and 9 of those were spent in the school district where the study took place. As the primary data collector, I held a position of authority but did not have the responsibility of supervising any of the participants. I worked at one of the schools in the study, and I worked more than 7 years ago with two of the participants, but this did not affect data collection or analysis. Lodico, Spaulding, and Voegtle (2010) reported that removing all researcher bias from a study is impossible. However, I maintained objectivity and did not engage directly with the teachers recruited to complete the questionnaire. I used my Walden University email to communicate with staff and sought approval through a neutral party to engage the two teacher leaders in the completion of the pilot study and member checking of the qualitative data. In interacting with the teacher leaders, I used neutral body language and did not add my opinions. Neutral language and reiteration of voluntary participation were keys to ensuring collection of credible data. To ensure the accuracy of the archived data, I met with the database manager and executive director of curriculum and instruction to explain the types of data needed for the study.

# Methodology

## Quantitative Data Source

The current study included the test scores of students enrolled in 9th grade at an urban high school outside of the city limits of Chicago who received Tier 2 academic support in an extended time math course. A total of 75 students qualified for enrollment into the Tier 2 extended time course based on their performance on the district assessment. Marita and Hord (2017) reported that many students with learning disabilities perform two standard deviations below the mean of their non-disabled peers on mathematics subtests. The standard deviation point of reference, the district cut scores, and discrepant performance on the curriculum-based and standardized measures serve as the basis for which this district qualifies students for special education services. Relevant to the current study, the Tier 2 course included 15 students who met the criteria for qualification to receive special education services under the Individuals with Disabilities Education Act (IDEA) based on discrepant scores in the area of mathematics. The scores of these 15 students served as the first source of quantitative data. Students who obtained a score 5 points below the district cut score on the district-wide assessment and who qualified for services under IDEA criteria received instruction in the special education instructional Algebra course. The initial number of archived test scores of students supported in the instructional Algebra course totaled 15 and served as the second data source for quantitative analysis.

## Qualitative Data Source

Based on current staff schedules, a total of seven teachers taught mathematics in either the extended time course or the special education Algebra course. Four teachers instructed students in the extended time course, and three teachers served as instructors for the instructional Algebra course. All teachers possessed the appropriate licensure in the content area.

## Instrumentation

I used a researcher created questionnaire to collect qualitative data for this study. A pilot study was conducted to ensure the validity and reliability of the qualitative instrument before administering it to the teacher participants. Archived test scores from the EXPLORE test used as the district assessment as the quantitative source of data. The EXPLORE was administered in accordance with established district protocol by trained school staff and scored by a third party assessment company. Assessment results were entered into the district-wide student database system-PowerSchool by the district database manager. To gain access to the archived data, I received permission to conduct research via a signed Letter of Cooperation from the district.

# Data Analysis Plan

## Quantitative Data Analysis

A comparison of the 2016-2017 archived test data served as the information source to answer 2 of the three research questions. Specifically, the pre and post-test scores of students enrolled in the extended time and special education instructional classes were instrumental in answering the research questions. Student files with incomplete data such as those of students who were not present for the pre and posttest sessions were removed before analysis. The independent variable for research questions 1 and 2 is the Tier 2 intervention course while the dependent variable for each question is the mathematical performance of students with disabilities. These variables appropriately answered the research questions based on the need to exam the impact of extended instructional time (independent variable) on student mathematical performance (dependent variable).

The dataset that included the pre and posttest scores of students in both Groups A and B was organized in a Microsoft Excel spreadsheet. Data was organized into groups by the course enrollment (self-contained Algebra or Algebra Extended Time) with numeric representation used to differentiate the scores of one student from the next. Appropriate t-tests were conducted once the data from the spreadsheet was imported into the Statistical Package for the Social Sciences (SPSS) software program with the proper variables created. An independent-samples and paired *t-test* determined the statistical significance of the differences of a.) the two group means to address research sub-question 1 and b.) pretest to posttest changes in student performance for the students in the extended time course. Simple descriptive analysis procedures assisted in the analysis process. The use of the *t-test* as the statistical hypothesis test for the study meant: the data is continuous and the data followed the normal probability.

The Discussion portion of this paper describes any violations of the assumptions that have a negative impact on the validity of the study results. As the statistical measure used, the *t-test* could compare differences between two groups on one dependent variable. The statistical significance chosen for this study is .05, which Creswell (2012) describes as the most commonly used probability level in educational research. Due to the incapability of using random assignment of participants to groups and in consideration of the possible impact variables such as maturation, low motivation, and variations in deficits resulting in math disabilities, the use of a .05 statistical significance level created a statistical environment where the probability of differences in scores is due to chance.

An independent *t-test* run on the pretest scores of both student groups, those with mathematics disabilities enrolled in the tiered intervention, and those students enrolled in the self-contained class determined if the characteristics of the two groups were equal. Since homogeneity was established, the individual differences between pre and post-test scores for each student in each group were calculated after which an independent sample t-test determined the statistical significance of the scores between groups. The results from the *t*-tests fell above the .05 level, thereby requiring acceptance of the null hypothesis of no difference between the groups. As a second form of data analysis, the differences determined for each student were added together, then the total divided by the number of students in that data set to determine the mean differences between the pretest, and posttest scores for each group. Determining the means allowed a comparison of the average score of the two groups. After performing descriptive statistics, the SPSS program concluded with a paired samples *t*-test to determine whether the gains from one test session to the next were significant for students enrolled in the extended time course. The level of statistical significance above the predetermined value of .05 allowed for the acceptance or rejection of the null hypothesis.

## Qualitative Data Analysis

Teacher responses to a brief questionnaire served as the qualitative source of data for this study. Saldana (2016) described coding as "an interpretive act that summarizes, distills or condensing data" (p.5) for analysis. Thematic analysis and descriptive coding were selected as the vehicles to interpret the qualitative data. Information was coded manually through the use of Microsoft Word and Excel software programs used to manage and organize the qualitative data. Responses to questions on the questionnaire were exported from Survey Monkey. I began the analysis process by first reading the data to become familiar with the content. After becoming acquainted with the content of the responses, I reread the data to gain a sense of the impact of the Tier 2 intervention from the teachers' perspective through first cycle coding. The first cycle of coding required the separation of each response into text segments as a way to begin identifying recurring statements. According to Lodico, Spaulding, and Voegtle (2010), coding allows researchers to categorize responses to describe a phenomenon. Furthermore, descriptive coding assigns words or phrases to data that captures the topic being explored (Salanda, 2009). For this study, coding allowed the observance of common themes and determination of keywords to disseminate data on teachers' perceived success of the program. Repetitive words or phrases found in the responses constituted a theme and served as a means to interpret the qualitative data. To further summarize the qualitative findings, the characteristics of the themes led to the development of two categories that defined them. Discrepant responses will be reviewed to determine the emergence of additional themes and discarded if found contradictory to be an isolated contradiction of the identified themes. Member checking to ensure accurate interpretation of the responses assisted in addressing the internal validity of the findings.

The quantitative and qualitative data collected for this study was securely stored in a Dropbox cloud storage account. Storage in Dropbox allowed me sole access to the data and protected the data from loss in the event of technological failure. This data will remain in the Dropbox folder for five years at which time the file will be deleted from the file-hosting server.

## Threats to Validity

Due to the interpretative nature and human interaction of research studies, there is the potential of adverse influences on data results. The threats to validity for this study included the following: inaccuracy of quantitative data due to third party collection, incorrect interpretation of qualitative data and potential researcher bias. To combat threats to the archived data, the database manager provided a third party with the original datasets for verification. Additionally, the database manager confirmed the use of standard district procedures used to generate data reports from the student information system. These standard procedures include a step by step process followed by any staff authorized to create data reports within the information system. Archived data was sent to me electronically on an encrypted spreadsheet to ensure access by only the appropriate individuals.

## Credibility

As it relates to the qualitative data, the teacher leaders assisted in confirming the accuracy of the verbatim recording of the teacher participants responses on the questionnaire and factchecked the responses based on first-hand knowledge of the teaches impressions of the extended time course. Lastly, I ensured any interactions with teacher participants occurred via email from my Walden University email address and any correspondence were sent outside of work hours. These precautions were taken to decrease the likelihood of teacher participants responding to items in a manner thought favorable to the researcher. The use of a pilot study assisted in the use of a poorly designed questionnaire that would not accurately measure the proper variables.

## Transferability

Transferability refers to the "degree to which the results of qualitative research can be generalized or transferred to other contexts or settings" (Patton, 2015). Due to the sample size used in this study and various limitations, the results cannot be generalized to other settings. Practitioners can review the methodology, setting, and another context of the study to determine the feasibility with which it resembles their current setting and make assumptions of its usefulness in other environments.

## Trustworthiness

Researcher bias and inappropriateness of the researcher created questionnaire were items that had the potential of affecting the reliability of the study. The issue of researcher bias was minimized by using a form of member checking once the qualitative data was interpreted and by incorporating informed consent procedures. As the researcher, I maintained a neutral disposition by ignoring previous knowledge and presuppositions of the extended time course which allowed me to concentrate on locating themes in the data and interpreting the information reasonably. Additionally, a pilot study ensured the developed tool was adequate in measuring factors critical to collecting data on the teachers' perceptions of the course which was instrumental in answering the research question. Related to the quantitative data, the statistical tests were executed multiple times to address reliability. Once the results from the quantitative and qualitative data are interpreted, triangulation to determine if similar conclusions are drawn from each form of data will assist in supporting the final research findings.

## Ethical Procedures

One of the most important ethical rules governing research is the protection of participants' rights by providing informed consent and the understanding that participation in the study is voluntary before individuals take part in the research. Archived test scores served as the quantitative data for study thereby eliminating the need to personally interact with students. The data dashboard and student information system accessed by the database manager eliminated the need for me to manipulate the test scores. Responses to the questionnaire served as the qualitative data source requiring me to interact directly with teacher participants via email. An informed consent document (see Appendix B) explaining the following: a.) the purpose of the research study, b.) an explanation of what they are expected to do and how long it will take them to do it, c.) whom to contact if questions arise and d.) the assurance that participation is voluntary and anonymous ensured teachers were aware of their rights as study participants. Teachers were invited to participate in the survey via email. Destruction of all data sources shall occur five years following the completion of the study with files deleted from the secure online storage file hosting service Dropbox where all information for this study was organized, stored, and accessed. Approval to conduct the study was granted by the Walden University IRB. The approval number for this study is **03-15-17-0309994** and it expires on **March 14, 2018.**

## Summary

This chapter explained the methodology for the study. As stated, an embedded mixed methods design was the approach chosen to answer the research questions and investigate the problem. Most uses of embedded research designs use quantitative data as the first data point then qualitative data to support the quantitative findings. The section above contained information on the following: a.) research design of the proposed study, b.) the role I played as the researcher, c.) information on instrumentation and d.) information on data collection and data analysis procedures. The subsequent sections detail the results and implications of the study

# Chapter 4: Results

The purpose of this embedded mixed-methods study was to investigate the influence of extended instructional time on the mathematical performance of freshman students with disabilities enrolled in an extended time algebra course. Archived test scores from the 2016-2017 district assessment provided the data needed to answer of the study's two subquestions:

1. Is there a statistically significant difference between the math gains of students with mathematics disabilities enrolled in the Tier 2 program and students with mathematics disabilities enrolled in a special education self-contained math course?
2. Is there a statistically significant gain between the pretest and posttest scores of students enrolled in the Tier 2 intervention, as measured by the EXPLORE test assessment?

Questionnaire responses from current instructors of the extended time course allowed further exploration of the research problem by providing data to answer the third subquestion: What are the teachers' perceptions of the impact of the Tier 2 program on student math achievement?

## Setting

The current study included one public high school located in outside of the City of Chicago. The school includes students in Grades 9-12 and had an enrollment of 1500 students at the time of the study, 350 of which were considered first-year or Grade 9 students. According to the 2016 Illinois School Report Card, the demographics of the student body during the time of the study were 72% Black, 24% Hispanic, 3% White, and 1% in three other categories. In stark contrast, the same report card listed the demographics of the staff as 80% White, 10% Black, and 4% Hispanic. Specific demographics of students whose scores were used as part of the quantitative data and teachers whose responses were part of the qualitative data were not captured.

I selected the teacher sample for the study based on current teaching assignments. The sample consisted of seven teachers, four who taught the algebra extended time course and three special education teachers who taught the instructional algebra course. At the time of the study, teachers were reviewing semester failures and beginning the process of making suggestions for next year's programming. Demographically, three out of the four extended time teachers possessed a graduate degree, and one had a bachelor's degree. All had been teaching algebra for 5 or more years with the same amount of time spent teaching at the high school level. Only one had been teaching the course in question at the study site for less than 5 years. All teachers had more than 5 years of professional and content-specific experience.

## Data Collection

### Quantitative Data Collection Procedures

The quantitative data for this study consisted of the following:

- pretest and posttest scores of students with disabilities enrolled in the Tier 2 intervention, and
- pretest and posttest scores of students with disabilities enrolled in the self-contained special education course.

The Illinois State Board of Education data dashboard and the district's student information system served as sources for additional archival data in the form of district performance data, current course enrollment, and individual student scores on the district assessment. The database administrator collected staff and student data for the study. Approval for the data collection was gained from the principal of the local school. During the query process, student identifiers were removed and numerical scores were used in place of names along with alpha markers (Letter A or B) indicating students' enrollment in either the special education math course or the extended time math course. I followed the required data collection procedures outline by Walden University institutional review board before beginning the collection process.

A member of the school's database management team compiled data from the 2016-2017 testing sessions for ninth-grade students enrolled in the algebra extended time course and special education instructional algebra and provided them to me on a password-encrypted Microsoft Excel spreadsheet. This raw data served as the source for the quantitative analysis process. After reviewing the file, I organized the data on the spreadsheet into the following four column headings: ID, pretest score, posttest score, and group. The ID column included a student identifier (ID) for the previous data set found in the row, and the group column included the specific course enrollment (A or B) of the student. The final number of archived scores available for analysis was 10 for students enrolled in the extended time course and 11 for students enrolled in the instructional algebra course. The data from the excel spreadsheet were transferred into the Statistical Package for the Social Sciences (SPSS) software system for analysis. The headings from the spreadsheet were translated into the following variables based on the SPSS software parameters needed to analyze the data: ID, pretest, posttest, and group.

## Qualitative Data Collection Procedures

A questionnaire (see Appendix A) served as the qualitative instrument to explore teachers' perceptions of the extended math course. The questionnaire was created using the online platform Survey Monkey and was accessed by teacher participants via the Survey Monkey website. Participants were given 15 days to complete the questionnaire with reminders scheduled for 5 and 10 days following receipt of the questionnaire link. Participants logged into Survey Monkey to enter their responses, and the once the response window closed, responses were exported from the website into Microsoft Excel. After initial submission, teachers were unable to change their responses; however, the ability to resubmit another survey using the same link was unknown. At the close of the data collection period, the number of questionnaires equaled the number of participants, which suggested that no participants submitted duplicate questionnaires.

Teacher participants were identified as those currently teaching either the extended time course or the special education course. All participants received informed consent documents, a participation letter, and the questionnaire in separate e-mails. Within the e-mail communications, teachers were informed that their participation in the study was voluntary. Only the responses of the four teachers assigned to the extended time course were part of the qualitative data for this study.

To ensure the content of the questionnaire included questions necessary to guide my inquiry into the benefits of the extended time course, I conducted a pilot survey to ensure the questions given to participants were not ambiguous or biased and were closely related to the purpose of the study. I provided an electronic copy of the questionnaire via Google docs to the two pilot participants and requested feedback on the quality of the questions and connectivity with the overall research question. The pilot participants were experienced in the field of mathematics: one was a teacher leader with 20 years of experience teaching various levels of algebra, and the other served as the math team teacher leader as well as a former member of the MTSS team.

I revised the questionnaire based on the feedback suggestions (see Appendix A). These suggestions included the removal of a question deemed unrelated to the research topic, clarifying language to define terms such as *basic math facts,* changing the questionnaire design to add a rating scale in addition to the open-ended question format, and providing explanations for each rating (i.e., slight improvement means *s*). All potential survey participants received the following three emails over the course of two days: (a) an invitation for participation in the study (Appendix C), (b) the consent form, and (c) the appropriate questionnaire sent from Survey Monkey on my behalf. The time frame for questionnaire completion was 15 days after initial receipt of the survey, with e-mail reminders scheduled for 5 and 10 days into the 15-day time frame.

## Data Analysis

### Quantitative Data Analysis

Initial review of the archived data revealed 15 students enrolled in the extended time course who also received special education services based on deficits in mathematics. Upon further review of the 15 data sets, five were removed due to missing scores. Either pretest scores were available but posttest scores were absent, or posttest scores were recorded and pretest scores were missing. After the removal of the incomplete data sets, 10 archived scores remained for analysis.

Of the 15 students enrolled in the special education course, four were removed due to incomplete data sets, leaving the archived scores of 11 students to serve as the sample for this group. Incomplete data sets were defined as students whose files were missing either pretest or posttest scores. The final data set for this study included the performance scores of 10 students with disabilities enrolled in the extended time, and 11 students with disabilities enrolled in the special education instructional math course.

### Qualitative Data Analysis

I used the thematic analysis process of qualitative coding data to examine the text from the teacher responses. To begin the coding process, I exported the raw data (individual teacher responses) from Survey Monkey to an Excel document. The document was then printed to allow for further review and manipulation of the data. I began reading each response and separating each into text segments by placing brackets at the start and end of a complete thought or by placing brackets at the start and end of a complete sentence if punctuation was evident. Once all responses were segmented, I reread them and summarized them into words or phrases in the margin of the document. Next, I copied a list of all the words and phrases in the margin to a separate document, and highlighted common or similar words and phrases. I reviewed the document again and placed common words used by teachers in quotation marks and highlighted them in a different color. Similar responses to open-ended questions were examined to determine themes with the sorting of data to combine responses that included terms such as *slight*, *minimal*, *drastic*, *none*, *no*, and *not*. I further examined the narratives of the responses highlighting similar terms for analysis and placing a tally mark next to the recurring terms or themes. The items in quotation marks and common phrases/words were cross-referenced, and I created another list of only the redundant codes. The redundant codes led to several themes that allowed the identification of two key ideas or categories under which each theme was distributed.

The themes and categories were used to answer the third research question: What are the teachers' perceptions of the impact of the Tier 2 program on student math achievement? The first category from the qualitative data analysis was that student characteristics negatively affected outcomes in the extended time course. Two themes emerged from this finding under this category. Theme 1, lack of knowledge, reflected the belief of all teachers that wide disparities in students' prior knowledge and deficit gaps complicated the student's ability to navigate the content of the course. Theme 2, student motivation in the form of lack of work completion or lack of engagement in the course, reflected the hindered potential for students to make significant gains in the deficiencies and the limited mastery of the course content.

The second category identified from the questionnaire responses was that program characteristics inherent to the extended time course rendered the course ineffective. Three themes supported the teachers' perceptions. Theme 1, lack of remediation opportunities explained teachers' belief that the software for the course was ineffective. Theme 2: identified the curricular scope and sequence of the extended time course of factors that impede the improvement of student outcomes.

Lastly, Theme 3, the use of an inadequate screening and benchmarking tool that selects students for enrollment in the extended time course and to determine student growth was an agreed-upon limitation to the effectiveness of the extended time course. There were no discrepant responses to consider additional emerging themes or different perspectives that contradicted identified themes or responses across participants.

## Results

### Quantitative Data Results

The p-value was set at .05 to establish statistical significance to answer research questions 1 and 2. Any value higher than .05 ($p>.05$) resulted in the acceptance of the null hypothesis. Any value less than .05 ($p<.05$) resulted in the rejection of the null hypothesis.

### Research Question 1

Is there a statistically significant difference in the math gains of students with math disabilities who are enrolled in the Tier 2 program in comparison to students with mathematics disabilities enrolled in a special education self-contained math course?

- $H_0$1: Students enrolled in a Tier 2 intervention program will not show a statistically significant difference in math gains in pre to post-test scores on the EXPLORE test compared to students who receive support in a self-contained Algebra course.
- $H_a$1: Students enrolled in a Tier 2 program will show a statistically significant difference in math gains compared to students who receive mathematics intervention in the special education instructional mathematics course as measured by pretest to posttest performance on the EXPLORE test.

**Group statistics**. Examination of the pretest scores for each target group revealed a mean pretest score of 10.3 for the students enrolled in the Algebra Extended Time course and a pretest mean score of 7.6 for the Special Education Instructional Algebra course. These results are presented in Table 1.

Table 1

*Group Statistics*

| | Group | *N* | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pretest | Alg ET | 10 | 10.300 | 2.31181 | .73106 |
| | SpEd Algebra | 11 | 7.6364 | 4.45584 | 1.34349 |

**Independent samples *t-test* for pretest scores**. I used an independent samples t-test to determine if the pretest scores of the students enrolled in the extended time course and those enrolled in the special education math course differed significantly from one another. As the first step of calculating the independent t-test, an examination of the amount variability between the individual scores recorded for each student in the two groups. The process of determining the level of variability allowed for the determination of homogeneity. A determination of equal variance meant the individual test scores of each group were relatively the same. The Levene's Test of Equality of Variance is the measure that revealed the variability between the initial test scores on the assessment for students enrolled in the Algebra Extended Time and the test scores of students enrolled in the Special Education Algebra course, was unequal (not the same). The first step of this measure calculated a significance value of .026, which was below the predetermined significance value of .05. A value less than .05 ($p<.05$ =unequal variances), meant student performance on the assessment for students in one of the groups varied much more than the performance of students in the second group and required me to use the significance value of .102 for the 2-tailed test for equality of means. Based on the parameters for significance (p<.05=statistical significance), the value found from the 2-tailed significance meant there were no statistically significant differences between the pretest means of both groups, thereby establishing homogeneity between the samples. In relationship to the research question, this meant the test scores achieved by students in both groups were not drastically different. Any differences found were due to chance and not related to any particular extraneous variables that may affect the further analysis of the quantitative data. One explanation of the unequal variance found in the first step of the independent samples analysis correlated with the manner in which students are placed into Group A, the extended course or Group B the special education instructional Algebra course. Students are placed into each course based on their scores proximity to the cut score established by the district. Since students are not randomly assigned to these groups, it makes sense that a difference between pre-test scores exists between participant groups. The results of the pretest independent samples t-test are presented below in Table 2.

Table 2

*Pretest Independent Samples t-test*

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Pretest | Equal variances assumed | 5.794 | .026 | 1.692 | 19 | .107 | 2.66364 | 1.57425 | -.63130 | 5.95857 |
| | Equal variances not assumed | | | 1.741 | 15.308 | .102 | 1.52951 | 1.52951 | -4.28304 | 5.91802 |

**Independent samples *t-test* posttest results**. Following the procedures described above, I used the SPSS software to conduct an independent samples t-test on the posttest scores for each group. Levene's Test for Equality of Variances yielded a significance level of .419 a value determined to be statistically significant meaning the individual scores in each group were not drastically different. Further interpretation of the t-test resulted in a p-value of .691 concluding no significant differences between the means of the posttest scores of both groups based on the parameters set for the study (p>.05=no statistical significance).As it relates to research question 1, the null hypothesis is accepted. The math gains of students enrolled in the Algebra Extended Time course are not more significant than the math gains of students in the Instructional Algebra course. The results of the posttest independent t-test are presented in Table 3.

Table 3

*Posttest Independent Samples t-test*

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | T | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Posttest | Equal variances assumed | .683 | .419 | .404 | 19 | .691 | -.68182 | 1.68966 | -.4.21832 | 2.85469 |
| | Equal variances not assumed | | | -.399 | 17.231 | .695 | -.68182 | 1.70863 | -4.28304 | 2.91941 |

**Paired samples *t-test***. I utilized the paired samples t-test to determine if there was a statistically significant difference in the pretest and posttest score means of students enrolled in the extended time course. The purpose of the test was to answer question 2 by calculating the difference in test sessions (pre and post) within the group of students assigned to the intervention course.

## Research Question 2

Is there a statistically significant gain in the pre and posttest scores of students enrolled in the Tier 2 intervention, as measured by the EXPLORE test assessment?

- $H_0$2: Students enrolled in a Tier 2 intervention program will not show statistically significant gains in pretest to posttest math scores on the EXPLORE assessment.
- $H_a$2: Students enrolled in a Tier 2 intervention program will show a statistically significant gain in pretest and posttest math scores on the EXPLORE assessment.

The goal of this statistical test was to determine if the students in the Algebra Extended Time course experienced statistically significant growth in their mathematical performance from pretest to post-test. Using the SPSS software, I conducted the paired samples t-test. Results revealed a mean pretest score of 10.3 and a mean post-test score of 9.5. On the surface, these scores demonstrate a lack of student growth. However, further evaluation was needed to establish statistical significance ($p < .05$=statistical significance). The paired t-test determined a significance level of .458 resulting in the acceptance of the null hypothesis. Since the calculated significance level is higher than the predetermined value of p<. 05, the post-test scores of students enrolled in the Algebra Extended Course do not demonstrate statistically significant growth. Therefore, a positive correlation between increased post-test scores and additional instructional time inherent to the extended time course does not exist. The results of the paired-samples t-test are presented in Table 4.

Table 4

*Paired Samples t-test Extended Time (ET) Course*

| | | Paired Differences | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | | | | |
| | | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | t | df | Sig. (2-tailed) |
| Pair 1 | ET pre ET post | .80000 | 3.25918 | 1.03064 | -1.53147 | 3.13147 | .776 | 9 | .458 |

## Qualitative Data Results: Research Question 3

What are the teachers' perceptions of the impact of the Tier 2 program on student math achievement? Current Teachers were asked to share input on the effectiveness of the extended time program. After responding to demographic information, each teacher was asked to respond to the following questions:

1. What impact does the Extended Time course have the basic math skills (math computation) of students?
2. What impact does the Extended Time course have on the mathematical problem-solving skills of students?
3. To what extent do you feel the Extended Time course impacts student performance on the district-wide assessment (EXPLORE)?
4. How do you think participation in the Extended Time course affects student performance on coursework in more advanced math courses?
5. Please provide your perspective on the impact of the effectiveness of the extended math course.

A summary of each respondent's replies to the questions follows:

Respondent 1. As it related to basic math facts, the first respondent stated the extended time course led to a slight improvement in skills. The respondent further stated the course does not focus on remediating deficits in math computation to improve proficiency in that particular area. The course does not focus on the automaticity of computation, so students are not aware of the importance of basic math fact knowledge. The respondent believed students are handicapped by the use of calculators and struggle with using the more scientific models of calculators needed for the Algebra course to solve algebraic formulas. Similarly, this teacher stated the extended time course produced only a slight improvement in the students' problem-solving skills of due to student's inability to retain the steps needed to solve problems and students' inability to connect prior knowledge to scaffold understanding of new concepts. This teacher indicated students' inability to generalize skills coupled with the fast pace of the curriculum as significant obstacles to the success of students in the extended time course.

As a means to improve student performance on the district-wide assessment, Teacher 1 shared that multiple exposures to the test without changing the problems or the order in which they are presented caused students to focus on selecting answers from memory instead of attempting to engage in processes to solve the problems. The respondent stated that students had taken the same version of the test twice before the final administration of the assessment, which is when the district records test scores are as a measurement of student growth. Additionally, this respondent expressed a belief that students are desensitized to these types of the test because they have been testing their entire academic career without the score meaning much since the scores are often not weighed into the course grade or grade level progression requirement.

When responding to the prompt concerning student performance on more advanced math courses, this individual shared that students in the extended time course will struggle with more advanced mathematics because the current course does not offer the actual remediation students need. The teacher further described that the extra time of the course focuses on the providing additional exposure to current units covered, however, despite the extra time given in the course, the massive numbers of standards teachers are required to cover prevents a more in-depth exploration into critical areas needed for success in future courses. The respondent believed students could obtain a passing grade and complete the course despite not reaching mastery of the necessary building block skills or decreases in their deficit areas. The responded stated these factors further impede student success in more advanced math courses.

When given the opportunity to expound upon the impact of the current course on student mathematical performance, the respondent wrote, that the course "gives students additional exposure to the content but since many lack motivation, have poor work ethic and have such significant skills deficits, the extended time is of no benefit."

Respondent 2. The second respondent agreed with the first on the slight improvements in the areas of basic math facts and math problem-solving. This respondent cited the primary emphasis on teaching students' multiple methods to solve problems and not addressing the lack of student's ability to perform basic mathematical computations as a significant contributor to the lack of growth seen in students who enroll in the extended time course. Teacher 2 stated there was a slight "natural" improvement in problem-solving skills meaning the improvement is not due to the current curriculum or course but rather due to the repeated formula sequences and mathematical operations inherent to an individual receiving multiple exposures to the same concepts. This teacher attributed the lack of significant increases in problem-solving skills to the failure of the curriculum used in the extended time course to provide students with strategies for problem-solving despite many students possessing insufficient executive functioning skills such as the ability to organize information, which is critical to solving mathematical equations.

This teacher also reported minimal growth in student performance on the district-wide assessment because students are tested on items, which have not been taught. Additionally, this individual stated students' "poor retention of the concepts" learned in the course and the lack of basic math skills perpetuated the cycle of minimal growth on the district-wide assessment. The respondent cited the absence of test-taking strategies and assessment endurance as further mitigating factors that prevented students from performing better on the assessment.

From this teachers' perspective, a small fraction of students would do well in advanced math courses because they were "misplaced" into the extended time course because of false positives from the initial process used to place them in the tiered intervention due to their displacement in the extended time course. The respondent further clarified that the extended time course failed to influence performance in more advanced math courses because students spend the additional time in the course receiving instruction via an online format instead of tailored direct instruction from a teacher that teaches "vertical concepts" that can be used in math classes across the board. This respondent stated that pacing of the content in the extended time course is slowed so students can access the online software but coverage of the curriculum is not deep enough to cover standards that will lay a strong foundation for more advanced courses. Teachers 2 provided additional insight into the benefit or lack thereof to the extended time course stating the class equates to tracking as it places low-performing students in one classroom without the benefit of higher performing peers to model and support cooperative learning. The respondent stated the deficits of students in the extended course are so vast that bridging the gap by merely giving a student extra time to focus on current content is unrealistic.

Respondent 3. Lack of opportunities to focus on remediation and depth of student deficits were reasons respondent number 3 provided for lack of demonstrable growth in the areas of basic math facts and problem-solving abilities of students enrolled in the extended time Algebra course.

The respondent further stated that students do not see the connection between success in Math and using strategies for problem-solving or the importance of memorizing basic math facts. In this respondents' estimation, the amount of growth for students is slight in both areas. In elaborating on the lack of growth in problem-solving skills, the respondent cited decreased reading comprehension skills, which are critical in deciphering the math hidden in the elaborate text now inherent to curriculums that follow the Common Core Math Standards. Student's lack of motivation and their perceived desire to be "spoon-fed" answers was disclosed as another barrier to growth in the area of problem-solving.

Increases in performance on the district-wide assessment and the ability to successfully navigate the content of more advanced math courses were the next questions posed on the questionnaire, and this respondent maintained that students' enrollment in the extended time course did not significantly affect either area. In reply to the former, Teacher 3 shared that most students fail to apply themselves to daily instruction, which limits their mastery of the content tested on the assessment. This respondent further explained that the current assessment used to measure growth in Algebra skills is inadequate due to its inclusion of non-algebraic content. This teacher rationalized the lack of gains on the district assessment because of the curricular sequence and scope of the course, which excludes many concepts tested on the assessment.

As it pertains to student performance in more advanced math courses, Teacher 3 responded that while the extended time course may "bridge some of the achievement gaps by exposing students to algebraic content the increased expectations on students to take ownership of their learning inherent to more advanced courses impedes their ability to succeed." The respondent supported this statement by adding that the extended time course does not require students to complete work outside of the classroom and decreases the amount of work given during classes thereby imposing lower expectations on students. Teacher 3 shared the following points as additional reasons for the limited effectiveness of the extended time course: 1.) student resentment of mathematics due to historical struggles 2.) increased occurrences of misbehavior inherent to placing struggling learners in homogenous groups, 3.) the pacing of the course prohibits remediation or in-depth re-teaching of concepts 4.) drastic variances in skill deficits among students and 5.) high student to teacher ratio resulting in an inability to proper address the learning needs of each student.

Respondent 4. The final respondent found the extended time course failed to increase the basic math and problem-solving skills of students, which consequently results in continued poor performance on the district assessment. Teacher 4 surmised the lack of increase in the areas above results in students from the extended time course performing poorly in more advanced mathematics courses. The respondent attributed this lack of growth across the board to factors beyond the curriculum and capability of the extended time course. This teacher’s input identified large voids in not only prerequisite skills for Algebra but also in the pure computation of basic operations as stumbling blocks to success in the extended math course. From this teachers’ perspective, the deficient skills of the students impede the teacher from progressing through the current curriculum, which in turns leaves less time for adequate coverage of the necessary standards and makes the adequate closure of the performance gap impossible. As it relates to problem-solving skills, the respondent felt the current curriculum failed to foster improvement in the necessary cognitive functions (organizing and recalling information) and failed to provide alternative problem stems which would take into consideration students’ deficits in reading comprehension and vocabulary. Additionally, this teacher perceived students’ inability to engage in mental math, lack of proficiency with graphing calculators, and high need for visual models as causes of the formation an environment in the extended course where teaching and learning are not reciprocal. This failure to cover standards impacts performance on the district assessment as it decreases students' exposure to concepts presented in the assessment. Additionally, the inadequate closure of the skill gap becomes more evident in advanced math courses as the prerequisite skill requirement increases.

From this teacher's viewpoint, the extended time course provides students with additional opportunities to learn content but the areas covered may or may not be directly linked to the concepts of the district-wide assessment. The lack of exposure coupled with the fact that the assessment does not count towards a grade in the extended time course results in students not valuing their performance on the assessment. The respondent believes these factors explain the lack of growth in scores on the district-assessment. On a final note, this respondent connected the ineffectiveness of the extended time course to student's inability to conceptualize aspects of mathematics and their inability to transfer knowledge from one lesson to the next. The respondent also stated that the process by which students are selected to participate in the extended time course is flawed. This teacher explained that the use of one measure to determine a need for intervention places students in a full-year course unnecessarily with many students with behavioral issues that impede their learning placed in a class with students who possess valid mathematics deficits due to learning disabilities.

The final portion of the questionnaire contained an open-ended question whereby teachers could share additional thoughts on the impact the Extended Time course had on the mathematics performance of students. Though their rationale may have differed based on the wording used in the actual responses, the teachers unanimously confirmed the Extended Time course failed to increase the mathematical performance of students drastically. Teacher responses began with identifying that slight to no improvement in student skills occurred across all factors examined in the study (growth in basic math facts, problem-solving, district-assessment, and performance in advanced math courses). As it related to student performance, all extended time teachers felt the course had little to no effect on the problem-solving and basic math skills of students. The same applies to the impact of the course on student's performance on the district-wide assessment. All teachers believed the extended time course did not cause marked increases in test scores nor did it close the achievement gap to the degree that students from the extended course would experience success in more advanced math courses. Teacher comments on the effectiveness of the extended time course resulted in supporting the quantitative data that the course was ineffective. The wide range of deficits found in students and improper placement of students into the extended time course were factors that influenced the overall effectiveness of the course.

Information from the respondents concluded that teachers perceived the extended time course as an ineffective means to improve the mathematical performance of students with disabilities. The two categories and the themes that defined them indicated that all teachers echoed the sentiment that students come into high school with a "wide array of mathematical understanding and deficiencies in math skills that should have been mastered in elementary school." Teacher participants believed these diverse skills in automaticity of math facts and comprehension of math problems made it difficult for students to grasp the algebraic content. All teacher participants stated that student motivation (Subtheme 1b) also inhibit mathematical growth. Research studies conducted (León, Núñez, & Liew, 2015; Stevenson & Reed, 2017) support the teachers' perceptions that student characteristics negatively affect student performance in the extended time course. These researchers asserted that motivation to learn could profoundly limit student outcomes as it is difficult for students with disabilities and those who struggle to persist at something with which they experience little success. Furthermore, the authors stated self-efficacy, or the belief in oneself to complete a task, directly shapes student performance and students who find their schoolwork meaningful and their teachers' supportive show an increase in achievement.

Teacher respondents also attributed the lack of success of the program to the failure of the curriculum to provide direct remediation of deficient skills. This theme developed from the shared idea that while the software used during the extended time allowed students to receive additional exposure to the content on an individualized basis, the software did not engage students in activities directed towards learning strategies to improve problem-solving abilities or activities to increase computational automaticity. More specifically the vast number of standards and curricular topics covered as an impediment to teachers' abilities to "dig deeper into topics" that would increase student's understanding of recurring mathematical concepts that will aid in the successful completion of more advanced courses and allow for mastery of current topics that would improve student outcomes. Additionally, respondents agreed that the sequencing of the curriculum was a limiting factor to their ability to increase student performance on the district-wide assessment. Teachers reported that often students are tested on concepts covered later in the school year. This lack of exposure decreases the possibility that students would answer questions correctly. The teacher participants noted that attempting to address the variances in student understanding led to teachers getting behind in their class pacing making it challenging to reteach concepts.

Although reported as a measurement of qualitative data collection for this study, the teachers who took the pilot study felt the questions posed to the special education teachers were irrelevant and unrelated to the research problem or the purpose of the study. The teacher leaders that completed the pilot study believed the information concerning the special education math course was unrelated to the research topic. In my review of the questions on the questionnaire designed for special educators, I concluded that all the questions solicited input on the special education teachers' insight on the effectiveness of the special education instructional math course. This inquiry did not have any correlation to the effectiveness of the extended time course, which is the purpose of this study. As a result of the irrelevance to the study, the data collected from the teachers of the special education instructional course was reviewed for informational purposes only and not included in the interpretations and findings sections of the study nor was the information a part of the qualitative data analysis.

## Evidence of Trustworthiness

### Quantitative Data

The research partner provided the quantitative data. As a part of the data compilation process, the database manager performed accuracy checks by referring back to the original data source and having a third party randomly verify scores. This verification occurred before finalizing the spreadsheet for delivery to for me to begin manipulating. Once entered into SPSS, multiple runs of the t-tests were conducted to ensure the researcher followed the steps correctly and to establish results from one test cycle to the next. The process of repeating the test measures supported the reliability of the test results.

### Qualitative Data

The pilot study and multiple measures to protect the anonymity of teacher participants constituted strategies to ensure reliability and validity of the qualitative data. In order to validate the qualitative findings and to ensure my interpretations were accurate, I engaged in the following: a.) provided the mathematics leader from the pilot study with the qualitative section of the study and the original responses to the questionnaire submitted by teacher participants as a means of member checking in Survey Monkey and b.) provided a veteran math teacher who currently serves as the Division Leader for the mathematics department and who has taught the extended time course with the survey to determine if the themes and categories concerning the effectiveness of the intervention from this individual's vantage point aligned with those of the teacher participants. This leader's responses supported the questionnaire participants in the opinion that student factors such as motivation, the variability of deficits and decreased executive functioning skills along with program processes such as lack of focus on remediation of skills and pacing of curriculum negatively affected student and program outcomes. The triangulation of the data from the teacher leaders' questionnaire responses with the lack of increased performance found in the results from the quantitative data supported the accuracy of the findings.

## Summary

This section began with a restatement of the purpose of the research and presented the data collected using a mixed methods research approach undertaken to examine the effectiveness of a Tier 2 intervention on the mathematical performance of students with deficient math skills. Results of the quantitative data in the form of archived test scores were examined using the independent-samples t-test and the paired-samples t-test to answers to research questions 1 and 2. The independent samples t-test compared the means from pretest and posttest scores of students enrolled in the target mathematics course against the scores of students enrolled in a special education Algebra course. Significant findings from this data were that the tiered intervention in the form of additional instructional time did not result in significant differences in student performance despite calculated gains.

Qualitatively, results of the teacher questionnaire provide answers to research question 3. Analysis of themes and common responses from the coding process revealed teachers' beliefs that the intervention was ineffective in improving the mathematical performance of students. Two overarching themes to support the findings of the quantitative data were identified. The first theme identified was that the teachers did not feel the extended math course affected student performance on the district assessment. The second overarching theme identified was that teachers did not believe the extended math course increased student’s math skills to prepare them for more advanced math courses better. The section also described procedures used to ensure the accuracy of the quantitative data and validity of the questionnaire. Appropriate evidence such as data tables was included in the body of this section or as identified as being located in appendices. Section 5 contains an interpretation of the findings, implications of social change, and recommendations for action or further study.

# Chapter 5: Discussion, Conclusions, and Recommendations

The need to address the poor math performance of students with identified math deficits spans several decades. Martinez, Bragelman, and Stoelinga (2016) stated that success in high school algebra positively correlates to success in college and career endeavors. In response to high failure rates in high school algebra, many schools have increased instructional time for students who struggle in math. Dennis (2015) reported the multitiered system of support (MTSS), also known as response to intervention (RtI), promotes math competence and ameliorates skill deficits for students with math difficulties. This dissertation served the following purposes: (a) to determine whether the math performance of students with math disabilities exposed to a Tier 2 intervention differed from the math performance of students with math disabilities enrolled in a special education instructional math course, (b) to examine whether the extended math course significantly impacted student performance on the district-wide assessment, and (c) to explore teacher perceptions of the impact of the Tier 2 intervention on the math performance of students.

The interpretation of the quantitative data collected required acceptance of the null hypotheses ($H_0$1 and $H_0$2), meaning the differences in the test scores of students enrolled in the extended time course were not related to the additional instructional time received in the course. The effectiveness of providing freshman students identified as having math disabilities with additional instructional time as a means to increase their performance in algebra may be valuable to secondary educators in other settings.

## Interpretation of the Findings

Findings of this study are discussed relative to the appropriate research subquestion(s) addressed by the particular type of data collected. The quantitative findings revealed the algebra extended time course did not improve students' performance significantly when compared to the performance of students with disabilities enrolled in the special education algebra course. The math skills of students enrolled in the algebra extended time course showed gains from pretest to posttest; however, that improvement was not statistically significant. The findings indicated extending the instructional time for students with mathematics disabilities was not an effective intervention. This finding contradicted several studies discussed in Chapter 2 indicated providing students with extended time or additional instruction improved math performance.

### Research Subquestion 1

The first research subquestion was as follows: Is there a statistically significant difference in the math gains of students with math difficulties/disabilities who are enrolled in the Tier 2 program in comparison to students with disabilities who are enrolled in a self-contained mathematics course? The lack of statistically significant increases in student performance contrast with findings from Smith et al. (2013) who showed that providing additional instruction to students with math disabilities increased the students' math fluency skills. The findings of the current study also contradicted those of Cortes et al. (2013a) who found that providing students with an extra period of algebra led to increases in student performance in several areas. The Smith et al. study included progress monitoring measures lasting one full school year, random sampling to assign participants to the treatment group, and 1 to 1 tutoring as the intervention. In examining the lack of improvement in student performance found in the current study in comparison to the improvement found in the Smith et al. study, I hypothesized that the 1 to 1 intervention more closely matched the students' ZPD with the intervention occurring by an adult at precisely the level the student needed to increase achievement. The 1 to 1 tutoring also allowed teachers to differentiate the support based on the formative assessment. The absence of these factors in the current study may have negatively influenced the effectiveness of the extended time program.

### Research Subquestion 2

The second research subquestion was as follows: Is there a statistically significant gain in the pretest and posttest scores of students enrolled in the Tier 2 intervention, as measured by the EXPLORE test assessment? Findings contradicted the work of VanDerHeyden and Codding (2015) who found that participation in intervention sessions decreased the likelihood that students would perform poorly on high stakes testing. Responses to the teacher questionnaire supported the conclusions of the quantitative data that the extended time course did not significantly improve the basic math skills and problem-solving abilities of students with disabilities. In comparison to the VanDerHayden and Codding study, the current study included a smaller sample size containing only special education students. Although the comparison study included a slightly larger sample size of students with math disabilities (28 versus 21), VanDerHayden and Codding examined student performance at three points throughout the year instead of in the fall and early spring. Additionally, participation in the intervention was determined at the classroom level rather than at the district level. Additionally, VanDerHayden and Codding focused on remediation of target skills and weekly assessment of progress before moving on to the next skill. As illustrated in the teachers’ responses in the current study, the extended time course provided additional support with current concepts but did not focus on skill deficiencies until mastery. The lack of skill mastery could impede the growth in math skills.

### Research Subquestion 3

In response to Research subquestion 3, current teachers of the extended course did not view the Tier 2 course as an effective means to improve performance on the district-wide assessment, and they did not believe the course improved students’ basic math skills and problem-solving skills in advanced math courses. A plausible rationale for these beliefs could be a lack of longitudinal scores of students enrolled in the program or the short time frame in which students participated in the course. Vaughn et al. (2011a) suggested secondary students who struggle the most could require multiple years of intervention to demonstrate substantial gains. This statement was supported the findings of Pane, Griffin, McCaffrey, and Karam (2014). These authors examined the effectiveness of the Cognitive Tutor program in increasing algebra proficiency of middle and high school students. Pane, Griffin, McCaffrey and Karam (2014) found no significant increases in the test scores of students enrolled in the Cognitive Tutor program during the first year of implementation, however, the authors noted that gains were expected to occur during the second year of enrollment in the program. These findings suggested that the short time frame of the current study along with the study's limitations may have accounted for the lack of improvement in the math performance of students with disabilities enrolled in the extended time course.

## Limitations of the Study

Several limitations are relevant to the study conclusions. The use of convenience sampling instead of random sampling was a limitation due to the possible bias of teacher participants. Experiences shape opinions and, depending on the individuals' personal experience with the curriculum, there may be a propensity to rate the course negatively. Likewise, use of a group of teachers who work collaboratively on a regular basis sets the stage for consensus building instead of independent thought. This type of group thinking and preconceived notions of the effectiveness of the program before the study may also have been a limitation. Additionally, the results of the study cannot be generalized due to the characteristics of the sample. Although increases in student performance were noted, the changes were not significant. If finer analysis had been conducted, the gains or lack thereof could have been attributed to some characteristic of the extended time course or student characteristics such as the degree of math skill deficiency or comorbidity of disabilities. Future studies should incorporate additional data points and include a larger sample size. Using a larger sample sizes and incorporating more data points would give more reliable results because of an increase in statistical power to detect differences and more opportunities to examine student performance over time.

## Recommendations for Further Study

The limitations of this study serve as a starting point for future research. The student population examined in this study included students who met the criteria for receiving special education services in math. Although math deficits were evident, deficiencies in other areas may have limited students' ability to progress through the curriculum. Future studies could include consideration of coexisting deficits. Another opportunity for further research is the replication of this study using students who only receive special education services in the general education setting. This would provide information to special educators on the efficacy of extended time on the performance of students in this population.

The use of the EXPLORE assessment as the primary source of quantitative data for this study was another limitation. Students may not perform well on assessments, and intrinsic motivation, test-taking skills, and knowledge retention/replication may vary on a case-by-case basis. Future studies could incorporate only algebra performance measures. Additionally, future studies could expand the student population to include the test scores of students previously enrolled in the intervention, making the study longitudinal in nature. Lastly, future studies could expand the qualitative participant sample to include teachers who previously taught the extended time intervention course and teachers of advanced math courses who instruct students formerly enrolled in the extended time course.

## Implications

The outcomes of the study suggested that the Tier 2 intervention that involved extending instructional time was an ineffective means of improving student outcomes in algebra. Hegedus, Dalton, and Tapper (2015) reiterated the vital role algebra plays in serving as a gateway to opportunities for disadvantaged students. The inability of the intervention used in this study to improve the math skills of students has the potential of creating a barrier to the students' completion of more advanced math courses. According to Kim, Kim, DesJardins, and McCall (2015), students who fail to complete higher levels of math courses in high school are more likely to earn less income as adults and are less likely to pursue postsecondary opportunities. This lack of adequate math preparation and decline in postsecondary enrollment greatly influences student enrollment in STEM-related fields, which negatively affects the U.S. standing in the global economy (Harrington, Llyod, Smolinski, & Shahin, 2016). Although findings from the current study did not reflect the desired result for an initiative that includes many of the local setting's resources, there was a positive outcome stemming from this study from a change agent perspective. From the perspective of a change agent, the perceptions of the teachers and lack of growth discovered from the quantitative data could result in consuming additional research and using the data to make recommendations for programmatic improvements. Martinex, Bragelman, and Stoelinga (2016) believed research on supporting underprepared freshman students led to success in Algebra assisting districts in meeting the rigor found in the Common Core State Standards in Mathematics. The examination of the quantitative data prior to analysis showed small increase in test scores from one administration of the test to the next. Although statistically insignificant, the small gains in raw scores show an increase in the student's knowledge base. From a curricular standpoint, something is expanding the students' knowledge base requiring exploration into individual components of the program. Building upon the student's increases in mathematical knowledge can potentially result in more students taking advanced math courses and seeking post-secondary opportunities.

Upon interpretation, the responses on the questionnaire showed teachers at this school did not believe the extended math course was useful. The strength in this perception is that it creates an opportunity for collaborative discussions around effective instruction. The acknowledgment of the weaknesses of the extended time provided an opportunity for the refinement or implementation of new strategies/programs, consumption of research to guide intervention selection, and the potential to research and implement a new strategy or refine the current strategy to meet the needs of students. On a larger scale, the findings provide educators with a research-based resource to support curricular decisions. This resource could help educators determine appropriate approaches to address the needs of students with mathematical disabilities thereby supporting students at-risk of becoming those identified with disabilities.

## Conclusion

A longstanding concern about the mathematical performance of the nation's students has led to many initiatives designed to increase educational opportunities that will address student deficits. Many students with mathematical disabilities lack the essential skills necessary for participation in more rigorous coursework thereby limiting their post-secondary options (Sailor, 2015). Additionally, insufficient mathematics skills lead to barriers in areas such as managing personal finances and being able to compete for employment in skilled and technical labor markets (Moran, Swanson, Gerber, & Fung, 2014). The use of tiered interventions in schools enables the application of evidence-based practices to students with mathematics deficits to close the achievement gap and improve student outcomes. This study examined the use of extended instructional time as a means to improve mathematical abilities of students with identified performance deficits. Despite research supporting the provision of additional time on task as an effective means to improve student outcomes, this study resulted in contrary findings. As educators, we are obligated to ensure success for all students, continuing research on effective means of increasing the mathematical skills of students with mathematics disabilities is of paramount importance.

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# Appendix A: Extended Time Course Instructor Questionnaire

Background information:

- What is the highest level of school you have completed or the highest degree you have received?
- How many years of experience do you have teaching Algebra to students in grades 9-12?
- How many years have you taught the Algebra Extended Time course in your current school?

2. What impact does the Extended Time program have on the basic math skills (math computation) of students?

3. What impact does the course have on the mathematical problem-solving abilities of students?

4. To what extent do you think the course will influence student performance on coursework in more advanced/future math courses?

5. To what extent do you feel the course affects student performance on the district-wide assessment (EXPLORE)?

6. Please provide your perspective on the impact of the effectiveness of the extended math course.

## Special Education Teacher Questionnaire

Background information:

- What is the highest level of school you have completed or the highest degree you have received?
- How many years of experience do you have teaching Algebra to students in grades 9-12?
- How many years have you taught the Algebra Extended Time course in your current school?

2. What impact does the Instructional Algebra program have on the basic math skills (math computation) of students?

3. What impact does the Special Education Instructional Algebra program have on the mathematical problem-solving abilities of students?

4. To what extent do you think the course will influence student performance on coursework in more advanced/future math courses?

5. To what extent do you feel the course affects student performance on the district-wide assessment (EXPLORE)?

6. Is there anything else you'd like to share about the impact of the instructional math course on students' mathematical performance?

# Appendix B: Informed Consent Form

You are invited to take part in a research study about the effect of additional instructional time provided through the Algebra Extended Time course on the mathematics performance of students with disabilities. The mathematical performance of students with disabilities in the Tier 2 Algebra Extended Time course will be compared to the mathematical performance of students with disabilities in the Special Education Algebra course**.** This study is being conducted by me, Ms. Rena Cureton, currently a doctoral student at Walden University. You know me as Mrs. Rena Whitten, the Director of Student Services, but this study is separate from that role. This form is part of a process called “informed consent” to allow you to understand this study before deciding whether to take part.

As the researcher, I am inviting all teachers who currently teach one or more sections of the Extended Time Algebra course and those who instruct students in the Special Education course to be in the study. Additionally, I am including teachers who instruct students formerly enrolled in either one of the target programs. I obtained your name/contact information from the Building Administration who used the course schedule found in the student database system.

**Background Information:**

The purpose of this study is to investigate the benefits of extended instructional time on the mathematical performance of students with disabilities.

**Procedures**

If you agree to be in this study, you will be asked to complete a questionnaire. You will be asked to complete the questionnaire one time only, and your participation and responses will be anonymous.

**Participation details:**

- You will be asked to open the email from SurveyMonkey
- You will be asked to complete an 8-9 item questionnaire based on your professional experience. The questionnaire should take less than 10 minutes to complete.

Here are some sample questions:

- What impact did the program have on the basic math skills of students?
- What impact did the program have on the mathematical problem-solving skills of students?

**Voluntary Nature of the Study**

This study is voluntary. You are free to accept or turn down the invitation. No one at your school or from the District 215 Administrative Center will treat you differently if you decide not to be in the study. If you decide to be in the study then change your mind, you may exit the questionnaire at any time.Your participation in the study is appreciated. In order to maintain the anonymity of participation, there will not be any compensation for participation nor will you be asked to disclose any personal information. You can accessthe survey from any computer via the untracked email sent by a third party (SurveyMonkey). As the researcher, I do not have any way of determining who views and/or completes the survey.

Appendix B: Informed Consent Form (continued)

**Risks and Benefits of Being in the Study:**

Being in this type of study involves some risk of the minor discomforts that can be encountered in daily life, such as difficulty expressing thoughts on a topic with which an individual is personally and professionally vested. Being in this study would not pose a risk to your safety or wellbeing. The potential benefits of this study include data on student performance which can be used to inform curricular decisions. Data that can be used to increase the mathematical performance of students and thereby improve their post-secondary options.

**Privacy:**

Reports coming out of this study will not share the identities of individual participants or the list of individuals solicited for participation. Details that might identify participants, such as the location of the study, also will not be shared. Even the researcher will not know who you are. The researcher will not use your personal information (school e-mail address) for any purpose outside of this research project. Data will be kept secure by using a secured server to access questionnaire responses and categorize and store data on a password protected spreadsheet. Participant responses will be coded for themes. Data will be kept for a period of at least 5 years, as required by the university.

**Contacts and Questions:**

You may ask any questions you have now. Alternatively, if you have questions later, you may contact the researcher via the following email address: rena.cureton@waldenu.edu. If you want to talk privately about your rights as a participant, you can call the Research Participant Advocate at my university at 612-312-1210. Walden University's approval number for this study is **03-15-17-0309994** and it expires on **March 14, 2018.**

**Obtaining Your Consent**

If you feel you understand the study well enough to make a decision about it and wish to participate, please complete the questionnaire found in the separate email sent on my behalf from SurveyMonkey.

# Appendix C: Letter to Participants

## Participation Letter

Hello,

My name is Rena Cureton, and I am an Ed.D. Candidate in Special Education at Walden University. I am currently working on my dissertation, involving The Impact of a Tier 2 Algebra Intervention on Freshman Students with Disabilities. Your perspective is paramount to understanding the impact the Extended Time math course offered in your district has on the mathematical skills of students identified with mathematics deficits. In order to gain your insight, I would like to invite you to complete a brief questionnaire.

The questionnaire should take roughly 10-15 minutes to complete and would need to be submitted within 15 days of receipt of the email containing the survey link (no later than April 5, 2017). Your participation is voluntary and confidential. Additional information concerning the risk and benefit of participation in this research and an overview of the study will be sent to you in a separate email containing the survey link.

I sincerely appreciate your willingness to share your time, knowledge, and experience with me to advance understanding of the benefits of additional instructional time on the mathematics skills of students. Once the dissertation is complete, I will share a summary of the results with the Building Leadership Team, which will include the Special Education and Mathematics Division Leaders who can then share the results with the respective departments.

Respectfully Submitted,

Mrs. Rena Whitten (Cureton)
Walden University-Doctoral student