2021

A Causal Comparative Examination of the Effects of Tiered Interventions Within the MTSS Framework in One Intermediate Grade

Hope Strange

University of Central Florida

A CAUSAL COMPARATIVE EXAMINATION OF THE EFFECTS OF TIERED INTERVENTIONS WITHIN THE MTSS FRAMEWORK IN ONE INTERMEDIATE GRADE

by

HOPE STRANGE
B.S. University of Iowa, 2001
M.Ed. University of Florida, 2006

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Education
in the Department of Educational Leadership and Higher Education
in the College of Community Innovation and Education
at the University of Central Florida
Orlando, Florida

Summer Term
2021

Major Professor: Daniel Eadens

ABSTRACT

This post hoc quantitative research used a causal-comparative design to explore the relationship between tiered interventions as part of an MTSS intervention and student achievement. Data from the Florida Standards Assessment for English Language Arts (FSA ELA) and mathematics (FSA Mathematics) from 2018 and 2019 formed the basis of the study; student demographic data also identified each student's highest level of reading, mathematics, and behavior interventions during the 2018-2019 school year. Students who received interventions were coded into a separate higher tier. Percentile change was calculated and analyzed using an ANOVA to determine how percentile change differed by intervention tier. In addition, a factorial ANOVA was used to determine whether student demographic characteristics moderated any intervention effects. Results were reported for FSA ELA percentile change for reading, mathematics, and behavior interventions and FSA Mathematics percentile change for each intervention category.

Results of the analysis were mixed. Students in Tier I for reading and mathematics showed positive changes in percentile; there was no evidence that Tier II and Tier II students for reading and mathematics interventions improved faster than students in Tier I. The results for Tier IV, those students receiving ESE services, revealed positive changes greater in reading that were greater than Tier II and Tier III. In addition, mathematics change in percentile for students receiving Tier IV ESE services was significantly positive and showed promise for reducing the achievement gap. Race and economically disadvantaged status did not moderate intervention effects. However, English language learner status and gender did moderate intervention effects.

This research extended other large-scale MTSS research by including data on students' reported intervention level. However, data regarding intervention program, duration, and fidelity were not collected. Lack of specific data about intervention implementation limited conclusions that could be drawn; future researchers should consider collecting intervention data to understand better when, where, and for whom interventions are most impactful. Further suggestions for research, implications for policy and practice are discussed.

ACKNOWLEDGMENTS

If not for the support of mentors, colleagues, friends, and family, this dissertation might still be an aspiration instead of a reality. I would like to thank my dissertation chair, Dr. Daniel Eadens. Your advice and guidance have been exactly the support I needed at that moment. To my committee members, Dr. Gordon and Dr. Vitale, thank you for your support, feedback, and wisdom both as part of this dissertation and throughout this doctoral journey. To Dr. David Maddock, you have been an invaluable committee member, methodologist, and mentor throughout this process. Thank you.

To the incredible educational leaders in Cohort 9, we have been an Ohana since day one. Thank you for your support, positivity, and patience with my endless questions. The experience was richer because of the twelve of you.

I am extremely lucky to have incredibly supportive family members who were so patient during the many hours I spent reading and writing this dissertation. To my parents, thank you for everything you have done to help me reach this goal and for everything you continue to do. To my three children, Eli, Madison, and Nathan thank you for your patience throughout this process. I hope that my work inspires you never to stop learning. Finally, to my incredible husband, Mike, without whom I literally could not be Dr. Strange. You help me to be the best version of myself. Thank you for all the ways you have supported me as I pursued this degree.

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LIST OF ACRONYMS/ABBREVIATIONS

ANOVA	Analysis of Variance
EAHCA	*Education for All Handicapped Children Act*
EBD	Emotional Behavioral Disabled
ELA	English Language Arts
ELL	English Language Learner
ESE	Exceptional Student Education
ESSA	*Every Student Succeeds Act*
FSA	Florida Standards Assessment
IDEA	*Individuals with Disabilities in Education Act*
IEP	Individualized Education Plan
LRE	Least Restrictive Environment
MTSS	Multi-tiered Systems of Support
PBIS	Positive Behavior Interventions and Supports
RtI	Response to Intervention
SAM	Self-Assessment of MTSS
SIS	Student Information System
SLD	Specific Learning Disability

CHAPTER ONE: INTRODUCTION

Introduction

Multi-Tiered Systems of Supports (MTSS) are systems of hierarchical interventions for academics and behavior; the three-tiered system emerged from the field of medical prevention (Mrazek & Hagerty, 1994). MTSS is the conceptual model that includes Response to Intervention (RtI) and Positive Behavior Interventions and Supports (PBIS). Typically, educators use RtI to refer to academic interventions and PBIS to refer to behavioral interventions (Illinois Center for School Improvements, n.d.). The literature frequently uses MTSS synonymously with RtI and PBIS (Brown-Chidsey & Bickford, 2016; DuFour et al., 2016). Since 2004, schools have expanded their intervention options to include multiple tiers of reading, mathematics, behavior, and motivation interventions at all grade levels (Buffum et al., 2018). Because federal legislation requires early intervention services and allows schools to use RtI to determine special education eligibility (Specific Learning Disabilities, 2019), schools needed to create an integrated problem-solving and intervention process. In this system, students receive increasingly intensive academic or behavioral interventions based on their responses to instruction and a problem-solving team's data-based analysis of the response (Kratochwill & Bergen, 1978). MTSS includes both academic and behavior supports (Brown-Chidsey & Bickford, 2016). This study used the MTSS to refer to the combined supports for academics and behavior.

RtI is a multi-tiered response to students' degree of success in response to the academic curriculum (Brown-Chidsey & Bickford, 2016). Through RtI, students demonstrate the educational need for Exceptional Student Education (ESE) services (General Education Intervention Procedures, Evaluation, Determination of Eligibility, Reevaluation, and the

Provision of Exceptional Student Education Services Rule, 2014). The reauthorization of the *Individuals with Disabilities in Education Act (*Posney, 2007) granted the Office of Special Education Programs authority to allow up to 15% of federal special education funds to be used for a system of interventions for the general population (Munson, n.d).

A recent meta-analysis of reading interventions in the primary grades found positive effects; however, many studies of these interventions reported immediate intervention impacts (Gersten et al., 2020). In addition, the research on the effectiveness of interventions for comprehension and vocabulary is limited (Gersten et al., 2020), as are studies of long-term effects **(**Schulte, 2016**)**. For example, Balu et al.'s (2015) seminal three-year study of the effect of interventions on student performance in first through third grades found that intervention effects were negative or not statistically significant. Following the study's conclusion, Balu et al. (2015) did not follow the students' cohort to determine whether effects were maintained. Ultimately, Balu et al. called into question the effectiveness of RtI in the natural school setting.

Similarly, there is little research on the effectiveness of RtI in the intermediate grades (Fuchs et al., 2003; Schulte, 2016). An examination of the effectiveness of RtI in the intermediate grades (specifically, fourth grade) is necessary because, when students start fourth grade, they transition from learning the skills of reading to applying their reading skills to learn new content (Annie E. Casey Foundation, 2010). When students lack basic reading proficiency, half of the fourth-grade curriculum is unavailable (Annie E. Casey Foundation, 2010). Furthermore, 75% of students who are struggling readers in third grade continue to struggle in high school (Annie E. Casey Foundation, 2010). Finally, fourth-grade students tend to underperform relative to third-grade expectations (National Research Council, 1998). Because fourth-grade students need to be proficient to succeed in secondary education and fourth-grade students underperform relative to their third-grade performance, there is a need to study the effects of tiered interventions within the MTSS model in fourth grade.

Statement of the Problem

To date, the most important study of MTSS in a natural school setting was conducted by the Department of Education on the overall effectiveness of RtI (2015). This 2015 study of the overall effectiveness of RtI included roughly 100 schools each at the first-grade, second-grade, and third-grade levels. The researchers compared fall screening scores to spring screening scores for students at the intervention cut (40% percentile), with those just above the cut (41%; Balu et al., 2015). Although related to MTSS, this large-scale study looked only at reading interventions in the primary grades; it did not consider Tier II's effectiveness against Tier III (Balu et al., 2015).

So far, the body of MTSS literature includes studies on how pieces of MTSS affect student achievement. The comparative effect across the tiers of intervention within the whole system in intermediate grades has not been the focus of any study known to this researcher. Scott et al. (2019) explored how MTSS implementation fidelity relates to student achievement and found fidelity of academic interventions was not directly related to improved student outcomes in any specific academic area. Interestingly, the data revealed greater fidelity in English language arts (ELA), led to increased language mechanics and mathematics scores. Increased fidelity in mathematics was also associated with improved outcomes in language mechanics but not in mathematics.

While some researchers have focused on how implementation fidelity impacts student outcomes, others have explored the value of different assessment types as tools for placing students in MTSS tiers. For example, a recent study reported a universal screener could be used to put students into tiered groups, showing differing achievement levels on state achievement tests (King et al., 2016). In 2017, Stevenson explored whether curriculum-based assessments predicted student achievement scores as well or better than measures typically used to predict whether students would drop out of high school. Relevant to this study is the finding that the state's achievement test, one measure typically used to determine drop-out risk, was predictive of student achievement on the statewide assessment the following year (Stevenson, 2017). However, other drop-out prediction data were not strong indicators of potential student achievement. Other recent results focused on implementation (Hollingsworth, 2019; Mahoney, 2020; VanLone et al., 2019), special education identification (Barrett & Newman, 2018), implications for leading the MTSS (Dulaney et al., 2013), training teachers to implement MTSS (Hoover & Soltero-González, 2018; Prasse et al., 2012) and specific Tier I strategies (Freeman et al., 2016; Jitendra & Im, 2019; Weisenburgh-Snyder et al., 2015).

While some researchers have studied the effects of interventions in natural school settings, many of these studies have been small in scale and scope (ALSuliman, 2010; Barrett & Newman, 2018; Cowan & Maxwell, 2015; Gage et al., 2019). Whereas experimental studies are the gold standard for determining cause and effect relationships, educational research does not lend itself to the conditions of truly experimental research (Fraenkel et al., 2015). As such, practitioners and educational decision-makers can benefit from research exploring the relationships between variables in the school setting as it exists naturally. For the purpose of conducting research, Tisot and Thurman (2005) described natural environments as "…the physical places, and the activities that occur in settings" (p. 2). While the purpose of their research was to identify how the natural setting of early childhood behaviors impacts the student's behavioral needs, Tisot and Thurman define behavior setting as "patterns of a behavior and a milieu" (p. 2). Based on this definition, the natural setting is the setting relevant to the behavior. In the case of MTSS, the natural setting is the school. The patterns of behavior are the teaching and learning within hierarchical tiers. The milieu is all of the ways in which people and competition for resources interact. Chapter Two will expand on the body of research on MTSS in the natural school setting.

Purpose of the Study

There is an existing gap in the MTSS literature relating to MTSS tiered interventions' effectiveness in intermediate grades (Fuchs et al., 2003; Schulte, 2016). None of the results reported the academic impact of Tier I, Tier II, Tier III, or ESE interventions against each other. Of interest in the current study is whether student achievement varies for students in different tiers of MTSS and whether student characteristics moderate any of these differences. These studies did not compare the extent to which student achievement varies based on receiving support in Tier I, in Tier I and Tier II, in Tiers I, II, and III, or in receiving ESE services, Tier IV. In MTSS, some students only receive Tier I core instruction, some receive Tier II supports, some receive Tier III supports, and some receive ESE services. Reading, mathematics, and behavior instruction each start with Tier I and progress through the higher tiered intervention levels. Some students received a combination of interventions across and tiers; some models include students receiving ESE services in Tier III while others provide ESE services at a level beyond Tier III. Officially, Florida has a three-tiered MTSS system; however, ESE services in Florida provide additional support beyond what is available to Tier II and Tier III general education students(Bureau of Exceptional Student Education, n.d.). This study considered ESE services an additional fourth tier to Florida's MTSS framework based on those additional services and accommodations. Burns et al. (2020) found positive impacts for second-grade and third-grade students who received reading interventions compared to their peers who received Tier IV ESE services. However, this researcher could not find a study that analyzed whether Tier III interventions were more effective for improving student achievement than Tier IV ESE services in fourth grade.

The purpose of this study was to address a gap in the literature by investigating the impact of tiered MTSS interventions on student achievement in one intermediate grade in a natural school setting. The researcher investigated the possible differences in the effects of the MTSS intervention tiers on student achievement in fourth grade by using post hoc data to measure student achievement on the Florida Standards Assessment for English language arts (FSA ELA) and the Florida Standards Assessment (FSA) for mathematics. The data collected included post hoc FSA ELA and FSA Mathematics data and intervention assignment data for all students enrolled in one Florida district from August 2018 through the end of the 2018-2019 school year. The current study expanded the literature by examining each of the MTSS tiers' effects on student achievement when implemented in one intermediate grade in a natural school setting.

Significance of the Study

This study is significant on three levels:

- On a broad scale, it expands the body of literature on MTSS and helps to explains other results;
- Regarding state implementation, this study provides evidence of whether MTSS is achieving the goal of reducing SLD classification's disproportionality in one district and procedures for analyzing data in other districts;
- At the district level, the data provide insight into which tiers of MTSS are most in need of further review.

By reporting how tiered interventions in an intermediate grade affect student achievement in the natural school setting, the results expand the literature to include a perspective not previously studied. Because the bulk of the research has focused on interventions in the primary grades (Fuchs et al., 2003; Schulte, 2016), this study, while not generalizable outside the selected immediate school district, provides insights into areas of further study for MTSS.

The results of the current results may help others interpret the mixed results from the literature. For example, the Balu et al. (2015) report found negative or no effects for students closest to the cut scores in first, second, and third grades. Suppose the data showed Tier II interventions did not lead to significant effects on student achievement, and Tier III interventions did lead to significant effects. In that case, the data support the Balu et al. findings. The differential effects would provide evidence that interventions for students at low risk for failure are less effective. Differences in effects between Tier II and Tier III may also support Fuchs and

Fuchs (2017) response to the Balu et al. study that the current MTSS frameworks may be too complicated for the limited resources in natural school settings.

Previous studies have found that, although RtI reduced the number of students who qualified for ESE services, students' achievement gap persisted (Barrett & Newman, 2018). Vanderheyden et al. (2005) hypothesized that short-term interventions might be less effective in higher grades because the gap between struggling students and grade-level performance is more significant. If the data indicated that those in Tier II had a more significant change in scores than those in Tier I, Tier II interventions are likely to close the achievement gap. If student performance in Tier I indicated a more significant change in percentile, that would mean Tier II interventions were not meeting the promise of improving student outcomes. Burns and Ysseldyke (2005) posited that RtI could be a valid method for determining ESE eligibility if students in intensive tiers of support demonstrate higher achievement than their peers receiving Tier IV ESE services. If the data indicate Tier III's effects are significantly different from those students who receive Tier IV ESE services, the reduction in ESE qualifications may benefit students. Conversely, if the data indicated that students who receive Tier III interventions do not perform at a higher level than students receiving Tier IV ESE services, then MTSS may be exacerbating the ESE achievement gap.

The current study provides insights into what aspects of MTSS in natural school settings, if any, are associated with positive effects on student achievement. Based on these results, the local school district can determine which intervention tiers or demographic subgroups need more support for their interventions to be more effective. In addition, administrators can use this analysis model to evaluate how their MTSS procedures impacted the intervention tiers at the district level. In summary, while generalizability is limited, this study provides data that can further explain previous research, highlight areas needing additional research, and help the school district improve its MTSS for future students.

Definition of Terms

The following terms are defined to clarify the entirety of the study. Where appropriate, this study operationalized these terms based on the definitions provided by the Florida RtI Network because the state of Florida guides Florida school districts in their RtI implementation. Using the Florida RtI Network's definitions also aligned the study's definitions with those used in the school district in which the research took place.

English Language Learner (ELL)– A student who speaks a language other than English such that it impedes the student's ability to be successful with instruction in the English (Florida Department of Education, 2019).

LA – ELL who has exited the ESOL program and the two-year follow-up but is still part of the ESOL demographics for federal *Every Student Success Act* reporting (Florida Department of Education, 2019).

LF – ELL who has exited the ESOL program and is being monitored during the two-year follow-up period (Florida Department of Education, 2019).

LP – ELL who has identified more than one language spoken in the home. Initial reading and speaking tests reveal English proficiency; however, the student is awaiting reading and writing test data to determine ESOL placement (Florida Department of Education, 2019).

LY –ELL who is classified as limited proficiency in English and actively receiving services through the ELL program (Florida Department of Education, 2019).

LZ – ELL who has been exited from the ESOL program (Florida Department of Education, 2019).

ZZ – Student who is not eligible for ESOL services (Florida Department of Education, 2019).

Fidelity – Fidelity is "the degree to which key components of an intervention are delivered as planned by developers across time" (Sanetti & Luh, 2019, p. 4).

Multi-Tier System of Supports (MTSS) – A multi-tiered system of supports in which problem-solving teams place students in tiers of increasingly intense interventions based on student data. MTSS includes academic and behavioral supports (Florida Problem Solving and Intervention Project, Florida's Positive Behavior Support Project, & University of South Florida, n.d.).

Natural School Setting – The natural environment of a school (Tisot & Thurman, 2002) in which policies are enacted and limited resources are allocated based on the priorities of school leaders and personnel (King Thorius & Maxcy, 2015). The natural setting alternative is the highly controlled experimental research setting (Fraenkel et al., 2015).

Schoolwide Positive Behavior Interventions and Supports / Positive Behavior Interventions and Supports (SWPBIS / PBIS) – A tiered system of supports specifically for behavior and social support (Sugai & Horner, 2020).

Problem-Solving – A process by which school teams identify problems, use data to understand the problem, propose and implement a solution, then reconvene to determine the solution's effectiveness (Personnel Development Support Program at FCIM/FSU, 2015a).

Response to Intervention (RtI) – A tiered intervention process in which students receive interventions that match their needs. RtI includes using student data to determine the learning rate over time and make instructional decisions based on the rate compared to peers. (Personnel Development Support Program at FCIM/FSU, 2015a).

Tier – One level in a hierarchical system of academic or behavioral supports (Personnel Development Support Program at FCIM/FSU, 2015a).

Tier I – The education all students receive in the general education curricula, including differentiation to support students (Personnel Development Support Program at FCIM/FSU, 2015a).

Tier II – Additional smaller group instruction integrated with Tier I for students who need additional support (Personnel Development Support Program at FCIM/FSU, 2015a).

Tier III – Tier III is the tertiary intervention level; it is the most intensive support level. Tier III supports are individualized based on the student's learning need (Personnel Development Support Program at FCIM/FSU, 2015a).

Tier IV – Students receiving ESE services in Florida. Florida MTSS guidance identifies three tiers of interventions; however other states include students receiving ESE services as an additional intervention tier (Burns & Yesseldyke, 2005). Students in Florida who receive ESE services are eligible for additional services and accommodations not available to general education students (Bureau of K-12 Student Assessment, 2020).

Theoretical Frameworks That Guide This Study

Critical Theory of Education

MTSS grew from the RtI approach as an alternative to the discrepancy model for determining SLD eligibility (Sabnis et al., 2019). One of the aims of using RtI rather than the discrepancy model was to reduce the disproportionate number of minority students who received the SLD label (Sabnis et al., 2019). Although studies have found RtI reduced the overall number of students identified as SLD, the disproportionality of Black students identified as SLD has increased (King Thorius & Maxcy, 2014; Sabnis et al., 2019). As one of the goals of MTSS was to increase equity, the critical theories of education and policy constitute the lens by which researchers should judge the effectiveness of MTSS in school settings (King Thorius & Maxcy, 2014). The critical theory of education posits that policies are enacted rather than implemented (King Thorius & Maxcy, 2014). Schools are constrained by their resources, structures, and beliefs (Sabnis et al., 2019). As a result, schools "make sense" of policies and enact them differently (King Thorius & Maxcy, 2014), even when schools implement policies with fidelity. Using a critical theory framework to understand how the MTSS improves or exacerbates existing equity issues is key to ensuring schools meet one of the objectives of MTSS. This study aimed to clarify where to direct future research to improve the equity of educational outcomes. As the gap in the literature narrows, critical race theory may help to explain the data.

Living Systems Theory

Viewing MTSS as an organization through the lens of Capra's "Criteria for Understanding Life" (Burke, 2018, p. 64), the hierarchical tiers of supports for academics and behavior, as well as data-driven problem-solving processes, shape the pattern for MTSS. Tiered interventions and problem-solving are keystones of MTSS (Brown-Chidsey & Bickford, 2018). The decisions regarding the standard intervention protocols and solutions make up the structure of the MTSS. Similarly, available resources and local implementation decisions comprise Capra's structure (Burke, 2018; Capra, 1996). Interventions vary greatly, as evidenced by the more than 4,000 results for an ERIC search of Reading Interventions, even within the consistent pattern of MTSS. Finally, Capra's (1996) "process" is the attitudes and beliefs about MTSS as an organization. Accordingly, MTSS is a "living system" (Burke, 2018), just a Capra proposed. The patterns, structures, and processes interact, so MTSS can look very different even when implemented with fidelity (King Thorius & Maxcy, 2014). This study sought to understand the patterns of MTSS and determine its effectiveness in intermediate grades to better understand the system's effectiveness as a whole and guide which structures or processes need further study.

Prevention Framework

MTSS is rooted in the medical prevention framework and draws from intervention theory to a lesser extent. Prevention models were first introduced in public health research after World War II (Schulte, 2016). In early prevention theory, the first level of intervention took place before the symptoms emerged, and a second level occurred once symptoms emerged (Schulte, 2016). Eventually, a third level was added to describe medical intervention activities after the disease was diagnosed (Schulte, 2016). Intervention theory, first proposed by Argyris (1970), is based on studies of interpersonal relationships, group dynamics, and organizational behavior. Argyris defined intervention as moving into an ongoing system to help the system or organization. The intervention consultant's role is similar to the consultative problem-solving theoretical model proposed by Kratochwill and Bergen (1978).

PBIS was built on the behavioral consultation model (Fuchs et al., 2003). In this model, psychologists act as consultants to help teachers replace undesirable student behavior (Kratochwill & Bergen, 1978). The consultation model has four steps: (1) identify the problem, (2) analyze the problem (determine variables, frequency, and desired outcome), (3) implement the intervention, including data collection, and finally, (4) evaluate the response to the intervention (Kratochwill & Bergen, 1978). As initially proposed, the model was individualized, so one teacher worked with one behavior consultant to intervene for one child (Kratochwill & Bergen, 1978).

Researchers who specialize in reading disabilities presented a separate model for intervention. In this model, a standardized intervention is used for a small group of students (Fuchs et al., 2003); in the reading model, the intervention program needed data to show its effectiveness (Fuchs et al., 2003). One of the research-based intervention goals was to determine whether the students' reading difficulties result from poor classroom instruction rather than a reading disability (Fuchs et al., 2003). This model became known as RtI (Fuchs et al., 2003).

Because both models (PBIS and RtI) share the notion that schools should intervene to improve outcomes when students struggle, these two theoretical models merged into the common three-tiered RtI / PBIS framework (Schulte, 2016). The RtI/ PBIS framework's final addition was using a universal screening protocol to identify potentially struggling students in reading and mathematics (Schulte, 2016). With the inclusion of the universal screener, the conceptual model of the MTSS triangle was complete.

Research Questions

The research questions and the statement of the problem emerged from a preliminary review of the scholarly literature. Students referred to in the research questions were enrolled as fourth-graders in one Florida district in August of 2018 and remained in the district long enough to have FSA ELA and FSA Mathematics scores through the 2018-2019 school year. The following questions guided this research:

1. What are the differences between intervention levels (Tier I, II, III, or IV) and student English language arts achievement (FSA ELA)?
2. What are the differences between intervention levels (Tier I, II, III, or IV) and mathematics achievement (FSA Mathematics scores)?
3. Do student characteristics moderate any differences between intervention levels (Tier I, II, III, or IV) and student achievement (FSA ELA and FSA Mathematics scores)?
    A. Gender
    B. Race
    C. ELL status
    D. Economically disadvantaged status

Limitations

Because the study explores MTSS in a natural school setting, the study has the following limitations:

1. The study cannot verify the accuracy of the intervention documentation; this may affect the results if students were documented as having received an intervention but did not receive it or it was not implemented as designed.
2. The researcher did not verify the fidelity of implementation for the reported interventions. Fidelity might have affected the results if interventions were not implemented as designed
3. The population of students is drawn from a single district in one state. Since states and counties vary in their MTSS implementation, the data may not be generalizable to other states and districts.
4. Many variables outside of the MTSS interventions could impact student achievement, such as student mobility, Tier I instruction quality, and the intervention's quality.
5. Schools may set different criteria for placement in Tier II and Tier III, causing students in the same tier in different schools to have different skill levels, possibly impacting the central tendency measures used to analyze the data.

Delimitations

The current study only looked at one cohort of students in one Florida district. Students were grouped based on their most intensive level of intervention.

1. The current study did not account for interventions received before fourth grade. Previous researchers have examined the effectiveness of interventions in the primary grades (Balu et al., 2015; Nelson et al., 2018). An analysis of the cumulative effects of interventions is beyond the scope of this study.
2. The researcher did not consider the specific type of reading, mathematics, or behavior intervention implemented. As discussed in Chapter Two, there have been many research studies on the effectiveness of particular interventions. Since schools have choices in which intervention a student receives, not all Tier II interventions within a given subject area are the same. For these reasons, this study did not include this particular intervention.
3. Evaluating whether the intervention was appropriate for the student's educational needs was outside the research scope because the study analyzed quantitative student achievement data, and intervention placement includes qualitative analysis.
4. Although the tiers of intervention and the content areas are consistent through the target school district, schools have autonomy in facilitating tiers. Because of variation in interventionists, the specific person who provided the intervention was not considered.
5. The study did not include intervention intensity. Mellard et al. (2010) identified multiple variables that can intensify interventions; dosage, group size, instructors' expertise, and curricular goals. While each variable could impact student learning, the purpose of this study was to examine the effects of the framework of

interventions rather than the specifics of each intervention group. As such, the examination of each factor is beyond the scope of the present study.

6. The data included overall scale scores. This study did not examine raw scores for individual reporting categories within FSA ELA and FSA Mathematics. Because previous researchers have explored the effect of interventions on curriculum-based measures such as oral reading fluency (Burns et al., 2020); like the Balu et al. (2015) study, this study sought to understand the effects of interventions on generalized achievement measures.
7. The researcher did not consider any accommodations for FSA ELA or FSA Mathematics tests required by Individual Education Plans or Section 504 requirements.
8. Only those students receiving Tier IV ESE services who took the Florida Standards Assessment were included in the study.
9. Only students enrolled in the target district in August of 2018 who remained enrolled long enough to have FSA ELA and FSA Mathematics scores reported for the 2018-2019 school year were included in the study.
10. The administration of the Spring 2020 FSA was canceled due to COVID-19 school closures (FDOE Press Office, 2020). Due to the unique circumstances of the 2020 school year, this study compared data from 2018 and 2019 because those were the most recent years student FSA data were available prior to publication.

While each of the above may have influenced the results, they are outside this study's scope.

Assumptions

The researcher used historical data to assign subjects to the intervention level; thus, the current study made the following assumptions.

1. The data collected were accurate.
2. Interventions were implemented as designed.
3. Schools accurately documented intervention start dates, end dates, and categories in the student information system (SIS).
4. School leaders and teachers understood what MTSS is and the critical factors for MTSS success; specifically, the school leadership provided the resources and training for teachers to implement universal screening. Teachers and school staff provided three tiers of increasingly intense research-based interventions, and students participated in systematic progress monitoring. The team engaged in data-based decision-making.
5. The FSA ELA and FSA Mathematics have been used to measure Florida's students' achievement since 2015 (Florida Department of Education, 2018b). The test is a valid and reliable measure of student achievement on the grade-level standards (Florida Department of Education, 2018b). The study assumed that interventions would impact performance on grade-level content; therefore, FSA would indicate the effect of an intervention.

Organization of the Study

This study consists of five chapters. Chapter One included the study's background, the statement of the problem, the purpose of the study, definitions of relevant terms, the conceptual framework, research questions, limitations of the study, delimitations of the study, and the study's assumptions. Chapter Two reviewed the literature, including the theoretical and conceptual frameworks, ESE eligibility, response to intervention, positive behavior intervention and supports, and multi-tiered systems of supports. Chapter Three describes the study's methodology, including the study sample, data collection, and data analysis procedures. Chapter Four presents the study's findings, including demographic data, the process of analyzing the data, and analyzing the research questions. Chapter Five summarized the entire study, discussed the findings, identified implications for MTSS theory or practice, suggested future research, and drew final conclusions.

Summary

MTSS, as a conceptual framework, is a more just and equitable path to determine eligibility for ESE services (Sabnis et al., 2019). While there is significant evidence that reading interventions in the primary grades have an immediate, positive impact on student achievement (Gersten et al., 2009), there is a dearth of research on the effectiveness of tiered interventions in intermediate grades (Schulte, 2016). This study contributes to the literature by examining each of the MTSS tiers' effectiveness in one intermediate grade. For clarity, key terms were operationalized based on guiding documents from the Florida Department of Education. The research questions focus on analyzing each intervention tier's differential effects on student achievement and whether student demographics moderated those effects. Because the data for this study was post hoc, the researcher did not consider variables related to intervention selection, implementation, and fidelity. A fundamental assumption was that school-based personnel understood the components and practices necessary for MTSS fidelity. While some relevant studies were highlighted in the first chapter, Chapter Two includes a thorough review of the literature of MTSS and its impacts on student achievement.

CHAPTER TWO: LITERATURE REVIEW

Introduction

The researcher conducted a full review of the literature, including the relevant theories, frameworks, and components to understand the complexities of MTSS. Themes included; critical theory, living systems theory, prevention theory, history of prevention, and interventions, including the evolution of ESE eligibility criteria, response to intervention, positive behavior intervention and supports, and the integration of a multi-tiered system of support. The researcher conducted multiple searches using the search terms “multi-tier system of supports or response to intervention,” “mathematics or English or language arts,” and “tiers or levels and academic achievement”; databases included APA ProQuest, Science Direct, and Web of Science. Results were limited to those studies published after 2015. The initial search found 154 results, of which 56 were reviewed. A search of the Sage journals database found an additional 152 results, of which 41 were reviewed. Articles analyzing Tier I or examining the effects of specific Tier II interventions were excluded. Similarly, studies of interventions specific to a disability outside the study's scope (e.g., the effectiveness of specific language interventions, effects of a specific intervention on students with disabilities, or specific diagnostic tools for identifying students with disabilities) were excluded from the review. Based on the literature review, a snowball search around the constructs, effectiveness, and implementation of RtI, PBIS, ESE eligibility, and MTSS was conducted to understand the various dimensions at play in the multiple frameworks. The comprehensive literature review demonstrated that although the various components of MTSS have been the focus of the study, no study of the differential effects of tiered interventions on student achievement was found.

Theoretical Frameworks

To understand what is happening within an organization, leaders must first understand the theories which underlie organizations (Larson et al., 2011). Theories provide a construct from which leaders can determine solutions for the problems schools face (Larson et al., 2011); thus, it is essential to identify the frameworks that determined how the researcher viewed the problem. The philosophical framework through which the researcher examined MTSS effects was the critical framework. As the epistemological framework, critical theory is the perspective of the researcher (Butin, 2010). The critical researcher asks the question, who benefits from MTSS (Butin, 2010)? Capra's (1996) *Web of Life* provides a framework to understand the need to examine the patterns of MTSS from a high level. Capra's (1996) theory, based on the evolution of theoretical constructs in mathematics and science, is based on the natural phenomenon of patterns repeating at multiple levels. A long-range view and a magnified view look similar in form, a mathematical concept based on Mandelbrot's work (Capra, 1996). In this way, MTSS is the same three-tiered pattern regardless of the subject. The tiered pattern is the essence of the prevention model. In prevention models, whether medical (Frieden, 2010), psychological (Caplan, 1964), or educational (Fuchs et al., 2003), hierarchical tiers of interventions were used to intervene when data indicates the outcomes are inadequate.

To summarize the researcher's perspective, the angle and vantage point from which the researcher views MTSS is a critical epistemology. After determining the perspective, one must then determine at which level of magnification to analyze MTSS. In this case, the analysis is comprehensive, as if using binoculars to see the whole system, rather than a microscope to view a single component. Finally, the prevention framework is how the researcher defines the system of interventions that consists of multiple tiers of intervention in multiple areas. Figure 1 shows how the researcher views MTSS through the lens of selected frameworks.

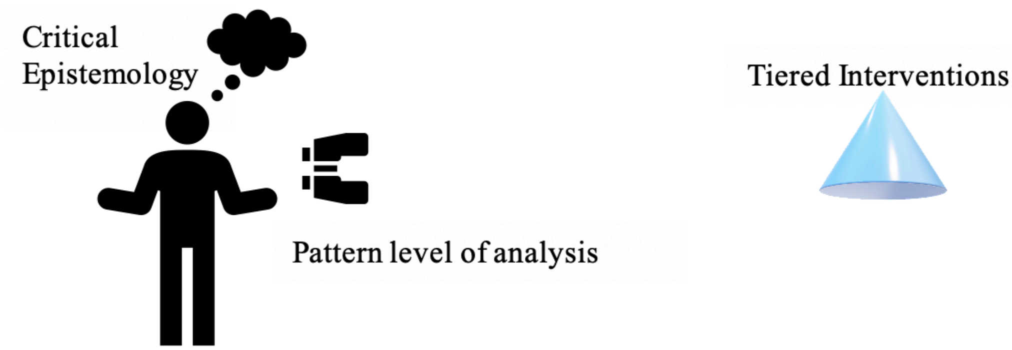

Figure 1. Representation of the Interaction of Frameworks: Critical Epistemology, Web of Life Theory, and Prevention Framework.

Critical Perspective

One of the aims of MTSS is to decrease the over-identification of minorities as SLD or EBD (Sabnis et al., 2019). A critical perspective calls researchers to answer challenging questions: "Who or what is driving education policy? Who wins and who loses because of education policy? What are the effects of policy?" (Gillborn, 2005 p. 9). The critical perspective was the epistemology from which the researcher investigated whether MTSS met the goals of reducing disproportionality in ESE identification and equalizing achievement outcomes. A critical theory of education seeks to identify how education systems and beliefs reinforce the dominant culture's norms (Giroux, 1979). Built on Bourdieu's theories of power and social class, critical theory questions how the curricula and relationships in education reduce or reinforce existing power structures (Grioux, 1979). Critical theory can be applied to race, law, or education practice (Ladson-Billings, 1998). The Critical Theory of education posits that schools reproduce the dominant culture (Giroux, 1979). Even within the research on disproportionality, there is a dearth of research on positive outcomes for Black students with disabilities (Gatlin & Wilson, 2016). Recent research indicates that ESE placement's disproportionality, educational outcomes, and student achievement persist despite legislative policies that correct the inequity (Kramarczuk Voulgarides et al., 2017). In California, overall rates of students receiving ESE services decreased; however, the proportion of Black students qualifying increased (Kramarczuk Voulgarides et al., 2017).

A recent study of how teachers' perceptions of race affect their recommendations for RtI support found teachers were more likely to refer White students for RtI support than Black students regardless of ELL status (Fish, 2017). Results indicated that teachers perceived low-achieving White students as capable of better achievement and low achieving Black and Latino students as achieving their potential. Conversely, teachers were more likely to refer Black students for behavior interventions and White students for gifted services (Fish, 2017). The study found that teacher feedback in MTSS reinforced existing disproportionalities rather than eradicating them. Teachers’ unconscious beliefs impact their recommendations for interventions. Moreover, as Willis (2019) points out in her review of RtI reading research, interventionists decide whether to value the students' various cultures and linguistical styles or not. An interventionist, then, can interpret a student’s linguistic culture as deficient and in need of continued or increased intervention. Willis (2019) identifies the effects of RtI on students of color as an area in need of further research.

Based on a critical epistemology, researchers must ask to what degree MTSS reduces perceptions of minority students as "less than" through intervention or reinforces it by labeling students as Tier II students and Tier III students and perpetuating "deficit discourse" (Sabnis et al., 2019, p. 21). Additionally, Critical Theory posits that schools do not implement policies; they enact them, so implementation fidelity is a function of competition between directives, discourse, politics, and organizational cultures (Sabnis et al., 2019). Finally, Critical Theory asks educators to reflect on the extent to which our system is socially just (Sabnis et al., 2019). The proposed study seeks to understand better the extent to which MTSS is socially just at the pattern level.

Living Systems Theory

Organizations comprise interrelated parts serving different roles and impacting the organization differently (Larson et al., 2011). Using Capra's theory of organizations as living systems (Burke, 2018) can help leaders understand how the various parts of MTSS interact and focus attention on future analysis and change.

Capra's (1996) theory is based on living systems but applies to any organizational system. Capra's three levels of understanding: pattern, structure, and process, are interdependent and help leaders understand organizations at a deeper level (Burke, 2018). The patterns are interactions, which are the non-negotiable characteristics of an organization (Burke, 2018). Organizational patterns do not often change because of the external environment (Burke, 2018). Fuchs et al. (2003) identified five critical components to multi-tiered supports: effective classroom instruction, monitoring progress toward goals, additional support for students not making progress, additional progress monitoring, and special education services for those who fail to respond to intensive supports. These five components make up the pattern of MTSS. The multi-tiered pattern exists in public health (Darcy et al., 2020), social, emotional learning (Greenberg et al., 2017), social skills (Albrecht et al., 2015), mental health (Marsh & Mather, 2020), mathematics (Fuchs et al., 2008; National Center on Intensive Intervention, 2016; Weisenburgh-Snyder et al., 2015), and behavior (Bradshaw et al., 2010; Cohen et al., 2007; Debnam et al., 2012; Gage et al., 2019; Horner et al., 2015; Scott et al., 2019; Sugai & Horner, 2009, 2020)

Structures, by contrast, do change (Burke, 2018). External factors influence structures. However, changes to structures do not change the patterns that make up the organization (Burke, 2018). The human body pattern is universal; how it is structured, the length of the legs, the hair color, and body fat percentage vary considerably based on internal and external factors (Burke, 2018). MTSS always has the same pattern: hierarchical tiers of support for student learning. However, the tiers' structure varies significantly between states, districts, and schools (Berkeley et al., 2009).

An analysis of state tools for implementation evaluation showed the widespread inclusion of the components above. The specifics within those components, however, varied (Schiller et al., 2020). Ninety percent of state evaluations included Tier I components; however, only 45% required Tier I programs to be evidence-based. While 84% of states offered Tier II interventions, less than half required these interventions to correspond to grade-level content; only 29% required schools to attend to group size and instructional dosage. Finally, although 77% of states monitored Tier III, no Tier III factor existed that most states agreed on (Schiller et al., 2020). The evaluation data shows that while the core components are consistent, the structures vary by state.

Furthermore, any structures states do not monitor may vary significantly from school to school. One of the RtI promises was to make learning disabled (SLD) determinations more consistent (Bradley et al., 2005). The variability of MTSS between states indicates that RtI may not be a more consistent framework than the much-maligned severe discrepancy model (Fletcher et al., 2004; Fuchs et al., 2003; Painter & Alvorado, 2008).

Capra's process is how an organization understands itself; Burke (2018) uses the metaphor of structure as the brain and process as the mind. Organizationally, processes are how leaders interpret internal and external factors and direct their structures (Burke, 2018). Part of the MTSS "process" acknowledges how school resources, culture, and climate impact structures. Enactment, rather than implementation, explains how Capra's processes impact structures (Burke, 2018). As a factor of implementation, the process intersects with the Critical Theory that policies are enacted rather than implemented.

The process associated with MTSS consists of multiple levels because process factors exist at the state, district, school, and classroom levels. In a recent study of state-level MTSS leaders, "…competing priorities, philosophies, and procedures…" (Charlton et al., 2018, p. 7) was a common barrier to scaling up MTSS. Competing federal requirements create process tensions from the federal level. As part of the reauthorization of IDEA in 2004 (Specific Learning Disabilities, 2004), states must report and rectify any disproportionality in ESE determinations (Posney, 2007). Legal scholars, Sullivan and Osher (2019), have pointed out that this requirement is at odds with schools' responsibilities under Child Find (2019), a requirement that schools identify and provide services to students with disabilities. State education agencies must balance their responses to multiple (and sometimes contradictory) federal requirements that different federal agencies oversee. Concerns of disproportionality are addressed through the Office of Special Education and Rehabilitative Services (Posney, 2007; Sullivan & Osher, 2019), while Child Find violations are enforced through the Office of Civil Rights (Sullivan & Osher, 2019).

In the absence of a statewide MTSS framework, district superintendents are responsible for creating a common language for MTSS, building a culture that supports MTSS collaboration, and putting supports in place to build the necessary capacity for MTSS (Dulaney et al., 2013). Each of these areas creates points of variability for MTSS. Even while the pattern of screening, intervening, and monitoring exists, the specifics vary based on how district leaders or school leaders enact them. In a recent meta-analysis of Tier II reading interventions, researchers found inconsistent operationalizing of "at-risk" (Gersten et al., 2020 p. 23). Indeed, the implementation of MTSS components has been the subject of much research (ALSuliman, 2010; Barrett & Newman, 2018; Berkeley et al., 2009, 2020; Choi et al., 2019; Cohen et al., 2007, Cowan & Maxwell, 2015; Fisher & Frey, 2013; Fuchs & Fuchs, 2017; Hollingsworth, 2019; Kiss & Christ, 2019; Lopuch, 2018; Muscott et al., 2008; Peshak George et al., 2018; Scott et al., 2019; Seibel, 2014; Sugai & Horner, 2020; Swindlehurst et al., 2015).

Finally, the MTSS process varies at the teacher level. As noted earlier, teacher perceptions of students impact the interventions they suggest (Fish, 2017). Additionally, individual teacher variables impact MTSS. Researchers found positive statistically significant effects for teachers who had better classroom management in a study of early literacy intervention effectiveness than those with poor classroom management (Gage et al., 2015).

Teachers recommend the students, select the intervention program, and often implement the intervention; thus, they influence the process of MTSS.

There are countless ways MTSS can change at the structure and process level. The proposed study seeks to understand to what extent the core patterns of MTSS impact student achievement. The current study results provide insights into what aspects of MTSS need additional research at the pattern, structure, or process level.

Prevention Framework

MTSS is rooted in the medical prevention framework and draws from intervention theory to a lesser extent. Prevention models were first introduced in public health research after World War II (Schulte, 2016). As initially theorized, the first level of intervention took place before the symptoms, and a second level occurred once symptoms emerged (Schulte, 2016). Eventually, a third level was added to describe medical intervention activities after the disease was diagnosed (Schulte, 2016).

In 1964, Gerald Caplan published his principles of preventive psychiatry (Caplan, 1964). Caplan proposed three prevention levels based on previous research on the prevention of mental illness (Caplan, 1964). A primary level, in which practitioners take steps to avoid potential problems (Caplan, 1964), like flu shots. Patients get flu shots before they get the flu. If patients wait until they show symptoms, the flu shots are not effective. The secondary level addresses symptoms as soon as they occur to mitigate the problem before it worsens (Caplan, 1964), like a doctor prescribing medication for a patient who has contracted the flu. The purpose of the medication is to shorten the duration of the flu and minimize the symptoms. The tertiary prevention level provides more intensive intervention to lessen the long-term effects of the problem (Caplan, 1964), for example, hospitalization and respiratory therapy for a patient whose flu has progressed to pneumonia. In education, the prevention framework is the Multi-Tiered System of Supports.

Intervention Theory, first proposed by Argyris, is based on studies of interpersonal relationships, group dynamics, and organizational behavior (Argryis, 1970). Argyris (1970) defined intervening as moving into an ongoing system to help the system or organization. Argyris' intervention consultant's role is like the consultative problem-solving theoretical model proposed by Kratochwill and Bergen (1978). PBIS was built on the behavioral consultation model's theoretical foundations (Fuchs et al., 2003). In the behavioral consultation model, psychologists act as consultants to teachers intervening to replace an undesirable student behavior (Kratochwill & Bergen, 1978). The consultation model has four steps: identify the problem, analyze the problem (determine variables, frequency, and desired outcome), implement the intervention including data collection, and finally evaluate the Intervention (Kratochwill & Bergen, 1978). As initially proposed, the model was individualized, so one teacher worked with one behavior consultant to intervene for one child (Kratochwill & Bergen, 1978).

Researchers in reading disabilities presented a separate model for intervention in which a standardized intervention is used for a group of students (Fuchs et al., 2003); in the reading model, the intervention program needed to have research to show its effectiveness (Fuchs et al., 2003). One of the research-based intervention goals was to determine whether reading difficulties resulting from poor classroom instruction rather than a reading disability (Fuchs et al., 2003). This model became known as RtI (Fuchs et al., 2003).

The RtI/ PBIS prevention framework's final addition was using a universal screening protocol to identify potentially struggling students in reading and mathematics (Schulte, 2016). Because both models emerged from the idea that schools should intervene to improve outcomes when students struggle, these two theoretical models merged into the common three-tiered RtI / PBIS framework (Schulte, 2016). With the inclusion of the universal screener, the theoretical model of the MTSS triangle was complete

As shown in Figure 2, MTSS is a system of hierarchical supports. Students receive increasingly intensive interventions based on the response to instruction and a data-based analysis (Kratochwill & Bergen, 1978) of the response.

History of Prevention and Intervention in Education

MTSS is the framework that includes RtI and PBIS (Illinois Center for School Improvement, n.d). When the IDEA was reauthorized and amended in 2004, response to intervention was included as one-way students could demonstrate an educational need for ESE services in the LD or SLD category (Specific Learning Disabilities, 2019). This change resulted from research on prevention and intervention in psychology and early reading (Schulte, 2016). To understand the complexities and importance of MTSS in education today, one must first understand the history of MTSS as a framework for intervention and prevention.

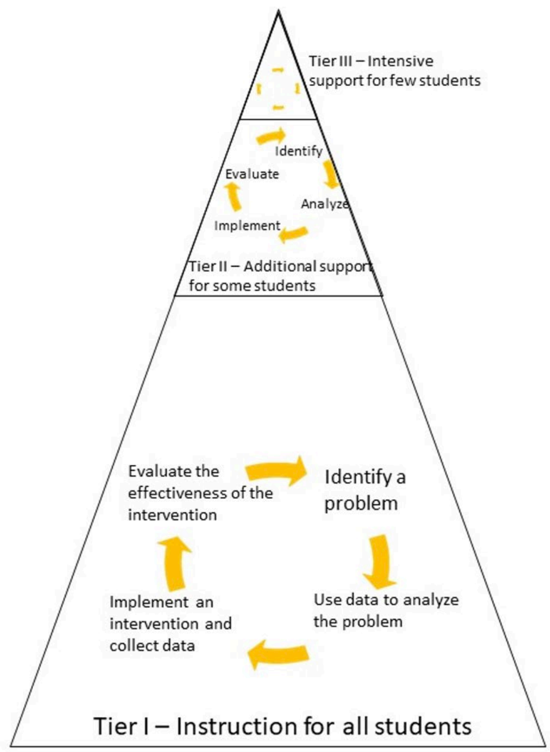

Figure 2. Tiered Supports with Embedded Problem Solving.

History of ESE Eligibility

Schools for the deaf began in the early 1800s (Alexander & Alexander, 2019); other schools or institutions for students with hard disabilities continued to grow in number throughout the nineteenth century and into the mid-twentieth century (Alexander & Alexander, 2019). Hard disabilities are those disabilities such as hearing and vision disabilities, severe mental retardation, and physical impairments, which can be easily observed (Karagiannis, 2000). Disabilities that are more difficult to recognize, such as specific learning disability (SLD), speech and language impairments (LI), emotional, behavioral disabilities (EBD), and mild mental retardation (MMR), are classified as "soft disabilities" (Karagiannis, 2000). While initial education efforts were for hard disabilities, soft disabilities were diagnostic challenges.

The *Education for All Handicapped Children Act* of 1975 (EAHCA) established a federal requirement for all students with disabilities to be provided a free, appropriate public education (FAPE) in the least restrictive environment (LRE), and an individualized education plan (IEP), which provides for special education services. The act also required due process procedures for parents who object to their student's IEP (*Education for All Handicapped Children Act*, 1975). Additionally, the EAHCA also required the Commissioner of Education to develop criteria to determine whether a condition can be considered a SLD (*Education for All Handicapped Children Act*, 1975). When the Federal Government enacted EAHCA in 1975, it took the responsibility of determining special education eligibility from doctors and dropped it squarely in the laps of school officials (Holdnack & Weiss, 2006). In 1988 Congress amended Section 504 of the Rehabilitation Act to include public education definitively. As a result, students who do not qualify for special education services under the *Individual with Disabilities in Education Act* (IDEA) can receive accommodations under Section 504 (Alexander & Alexander, 2019).

While a school can quickly determine whether a student has a hard disability, such as a significant auditory, visual, or mobility disability (Karagiannis, 2000), proving whether a student has an SLD or LD has proven to be much more subjective. A controversial issue since 2004 has been determining eligibility for special education in soft disability categories, including SLD. Until 2004, most states used the severe discrepancy model to determine eligibility as LD (Fuchs et al., 2003) or SLD. The reauthorization included RtI to determine eligibility for some ESE services, including SLD and LD (Burns et al., 2008). Research literature refers to LD and SLD depending on the specific context of the study. Under the discrepancy model, schools made eligibility decisions based on whether a severe enough discrepancy existed between two assessments: intelligence quotient and academic achievement (Togut & Nix, 2012). This eligibility model was problematic because the definition of *severe* varied from state to state and could vary from school to school, depending on which tests students took. The reauthorization of the *Individuals with Disabilities in Education Act* in 2004 stated states could neither require nor prohibit the severe discrepancy model (SLD, 2019).

The intent of including RtI for ESE qualification was to provide an alternative to the previous discrepancy model. Student IQ data had to be discrepantly different from their school achievement (Burns et al., 2008). Based on some educational researchers' recommendations (Fletcher et al., 2004), the 2004 law requires interventions to be scientific and research-based (Burns et al., 2008). Scientific research-based interventions use systematic empirical methods, involve rigorous data analysis, provide valid data across multiple measurements, and have been accepted through a peer review or independent panel review (Burns et al., 2008). As a result of RtI, demonstrated student success in an intervention is a legally justifiable reason for a school not to provide ESE services (Burns et al., 2008).

The amendment to the IDEA also allowed states to adopt a process utilizing the student's response to research-based interventions or other research-based methods for determining eligibility (SLD, 2019). Additionally, up to 15% of the federal money allocated for students with disabilities can be used for early intervention services (SLD, 2019). The goal was for schools to get a more comprehensive picture of the student's educational needs. In response to the reauthorization, the Florida Department of Education adopted a rule requiring schools to use multiple sources of information to determine a student's eligibility for special education services (Department of Education, 2007).

An additional aim of including RtI was to reduce the time necessary for students to demonstrate SLD eligibility since primary students are unlikely to demonstrate a discrepancy large enough to qualify (Painter & Alvarado, 2008). The Federal Government's reference to how students respond to research-based interventions is commonly known as RtI.

Response to Intervention

After the amendment to the IDEA, research interest in RtI increased. Based on medical prevention science, RtI is a multi-tiered response to students' success with the academic curriculum (Brown-Chidsey & Bickford, 2016). With a RtI system, a problem-solving team uses student data to determine whether a student succeeds with the general curriculum. Those students who are not successful receive a research-based intervention based on the student's area of need. After some time, the student is re-evaluated to see if the intervention is working (Fuchs et al., 2003). If the data indicates the student is not progressing, the school problem-solving team moves the student to a Tier III intervention. Tier III interventions may or may not be the same interventions offered to currently eligible special education students (Brown-Chidsey & Bickford, 2016; Fuchs et al., 2003). Some school districts refer students for special education evaluation as part of their Tier III interventions; other school districts refer for evaluation when data indicates Tier III is insufficient to support the student's learning needs (Ciolfi & Ryan, 2011).

Reading

Research-based reading instruction includes phonemic awareness, phonics, vocabulary, reading fluency, and reading comprehension (Burns et al., 2008). While a full review of the research on reading interventions is beyond the current study's scope, some studies are relevant to understanding reading interventions' effects. In 2009, Gersten, Compton et al. published a study outlining the practices with the promise of helping struggling readers in the early grades. These recommendations became the foundation for MTSS. The recommendations included universal screening to identify at-risk students, differentiated Tier I instruction, more intense instruction for struggling students, monthly progress monitoring, and intensive daily instruction for students who do not respond to Tier II instruction (Gersten, Compton, et al., 2009). Only Tier II interventions showed strong research-based support (Gersten, Compton, et al., 2009).

The most extensive MTSS study is the 2015 study of the effects of interventions on students closest to the intervention cut score (Balu et al., 2015). The United States Department of Education's large-scale study looked only at those students immediately below the 40th percentile and compared their achievement to those immediately above the cut score (Balu et al., 2015). Based on the MTSS framework, those students should have received Tier II interventions. The 2015 study examined factors related to implementation and student results by comparing schools that reported implementing RtI for at least three years compared to schools that did not report implementing RtI for that period. The analysis found that all schools in the study, both impact, and control, were using RtI in the first grade. The comparison of implementation across first, second, and third grades showed greater implementation in the impact schools. Across the implementation domains, the differences were greatest in Tier III implementation and universal screening. The movement between tiers found that Tier II students moved up or down to more or less intensive tiers. Tier I and Tier III students did not show the same mobility (Balu et al., 2015). Sixty-five percent of students remained in Tier III; this finding is important since lack of progress in Tier III is one-way students can demonstrate eligibility for SLD or LD services. The study did not report whether Tier III students received services or were evaluated to determine eligibility for ESE services. Most reading intervention studies use outcome measures directly related to the Intervention (Gersten et al., 2020); the national study used general student achievement data as their independent variable for intervention effects (Balu et al., 2015). The study found that assignment to interventions negatively impacted reading for first-grade students, and results were not statistically significant for second- and third-grade students.

Gersten and colleagues responded to the national RtI study results by completing a meta-analysis of the research on Tier II reading interventions in grades one, two, and three. Their research found significant positive effects (Gersten et al., 2020). The largest effect sizes were found in word reading and pseudo-word reading (Gersten et al., 2020). Pseudo-word reading is a primary skill used to assess students' ability to use letter sounds to identify a word. The meta-analysis found a limited emphasis on vocabulary and comprehension. There is a need for future research to examine moderator variables that account for the variance in intervention effects, long-term effects, vocabulary, and comprehension (Gersten et al., 2020).

A Danish study of Tier II reading interventions found greater effects for lower-achieving students than higher-achieving students (Dale et al., 2018). These results may do more to explain the Department of Education study results than the frameworks or implementation. Since the Department of Education examined effects on those closest to the cut scores, there was a minor difference between the control and experimental groups. If the study explored the results by tier of intervention, the outcomes might have been different.

In their meta-analysis of how Tier III interventions affect student outcomes in grade K-3, Austin and colleagues (2017) found that although Tier III interventions helped struggling reading students make statistically significant gains, the gains were not enough to close the achievement gap. One of the researchers' challenges is that there is no universal definition of what qualifies a student for a Tier III intervention (Austin et al., 2017).

Finally, Fuchs and Fuchs (2017) also responded to the national report by arguing that the lack of positive effects resulted from the complexity of MTSS. In their response, Fuchs and Fuchs advocated for a two-tiered model in which Tier I is high-quality general instruction with differentiation, and Tier II includes ESE services, rather than having three tiers in addition to ESE services (Fuchs & Fuchs, 2017). In practice, content is being added to MTSS, further complicating it rather than simplifying the framework.

Mathematics

RtI was developed to prevent reading difficulties in the primary grades (Gersten, Beckmann, et al., 2009). Since the inclusion of RtI in the IDEA reauthorization (SLD, 2019), MTSS has expanded to include tiered interventions in other areas. Of interest in the current study is the research base for mathematics interventions. Like reading, individual intervention programs have been the primary focus of study, rather than a holistic view of the effectiveness of MTSS on preventing or remediating mathematics difficulties. While a comprehensive review of the literature of the effectiveness of specific mathematics interventions is outside the scope of this research, a review of relevant findings is necessary. Research-based mathematics instruction includes moving from concrete to representational to abstract understandings of mathematics (National Center on Intensive Intervention, 2016). A mathematics intervention lesson should consist of the following stages: modeling, guided practice, independent practice, and maintenance (National Center on Intensive Intervention, 2016). Like the recommendations for reading, the Institute of Educational Science created a guide to best practices for struggling mathematics students in elementary and middle school. The two areas with strong support were explicit, systematic instruction and support for solving word problems using common structures of word problems (Gersten, Beckman, et al., 2009). An analysis of the effects of tutoring without validated classroom instruction found tutoring more effective in conjunction with validated classroom instruction than without (Fuchs et al., 2008). The study results reiterated the importance of high-quality Tier I instruction in concert with Tier II interventions. Additionally, the study provided evidence that effective Tier II mathematics interventions directly support Tier I content (Fuchs et al., 2008). Finally, the research provided evidence that Tier II interventions with validated Tier I instruction may close the achievement gap between students at-risk for mathematics disabilities and those who are not at-risk (Fuchs et al., 2008).

In 2008, a study of the effects of mathematics interventions expanded on previous research on how progress monitoring affected teachers' adjustments to their instruction (Fuchs et al., 1991). The earlier study found teachers who used curriculum-based measurements made adjustments to their mathematics instruction more than the control teachers. Data showed that instructional adjustments based on progress monitoring assessments positively impacted student achievement when teachers could consult with experts on adjusting instruction (Fuchs et al., 1991).

In 2015, VanDerHeyden and Codding examined the effects of a whole-class intervention on specific sub-groups. In addition to the core mathematics instruction, the intervention had students work in pairs for guided practice, independent practice, peer coaching, and progress monitoring. Effects were greatest for students whose baseline score was lowest, indicating this intervention, like some reading interventions, was most effective for those at greater risk for mathematics difficulty than those at less risk (VanDerHeyden & Codding, 2015).

A 2019 meta-analysis of mathematics interventions found 94% of the studies were in elementary schools. Almost 79% of studies failed to indicate the tier level of the intervention. 44% of the studies that reported student criteria included students below the 25th percentile. 31% of studies used curriculum-based measures such as fluency as their outcome variable rather than generalized mathematics achievement (DeFouw et al., 2019). The analysis reported themes in treatment intensity and fidelity. It did not include student outcome data and suggested outcomes of mathematics interventions as an area needing further research (DeFouw et al., 2019). A meta-analysis of mathematics learning difficulties research indicated a lack of research supporting students with mathematics learning difficulties, those most at risk for a mathematics learning disability (Deruaz et al., 2020). A meta-analysis of the research on geometry interventions also failed to examine the outcome effects on student learning (Bergstrom & Zhang, 2016). The research on mathematics interventions has focused on specific programs or program modalities without attention to what tier of intervention the program would best fit. Studies on how group size, duration, or intensity impact mathematics achievement are also lacking. Based on the research and despite their inclusion in MTSS frameworks, the research on mathematics interventions and their impacts on student achievement is minimal.

Positive Behavior Interventions and Support

Managing student behaviors is a fundamental part of teaching (Hudson-Baker, 2005). PBIS is a school-wide support system consisting of hierarchical tiers moving from expectations, rewards, and consequences to individualized behavior intervention plans (Cohen et al., 2007). Much of the original research into prevention and the problem-solving framework was based on behavior modification. As such, tiered supports and interventions specifically for behavior are one of the original systems of MTSS.

Schoolwide Positive Behavior Interventions and Supports

Schools implementing PBIS are expected to have policies, structures, and routines to support students' behavior (Sugai et al., 2000). Tier I PBIS should include; a problem-solving team, school-wide behavior expectations, explicit teaching of school-wide expectations, reinforcing students when they follow the expectations, and corrective processes for when students do not follow the expectations (Elfner Childs et al., 2010). Schools implementing PBIS also need systems to collect and analyze data on the school's Tier I needs (Elfner Childs et al., 2010). A recent qualitative study of PBIS found the interpersonal skills and knowledge of faculty supporting PBIS were vital to successful implementation (Peshak George et al., 2018). Studies have demonstrated that when schools implement school-wide PBIS with fidelity, they reduce the number of discipline referrals, in-school suspensions, and out-of-school suspensions (Elfner

Childs et al., 2010, Cohen et al., 2007, Gage et al., 2019). PBIS Tier I's direct impacts on student academic achievement are positive but less significant (Bradshaw et al., 2010; Elfner Childs et al., 2010; Houchens et al., 2017; Scott et al., 2019).

Targeted Behavior Supports

Tier II for PBIS should include data analysis to identify students at higher risk for discipline referrals and have systems in place to closely monitor those students and provide support for their behavior (Horner et al., 2015). A common belief in education is that academic achievement is directly related to behavior (Algozzine et al., 2011). The logical assumption then is that efforts to improve student behavior will lead to improvements in academic outcomes. While there is evidence to support this supposition for Tier I of PBIS (Bradshaw et al., 2010; Elfner Childs et al., 2010; Houchens et al., 2017; Muscott et al., 2008), the impact of Tier II behavior interventions on student achievement is less clear. A study of the effects of three tiers of support for social skills demonstrated positive effects on behavioral outcomes but mixed impacts on academic outcomes (Albrecht et al., 2015). The effects varied by cohort and by subject. Three cohorts showed positive changes in English language arts proficiency levels, while four cohorts showed negative changes. One cohort showed positive changes in proficiency; three cohorts had negative changes in mathematics. One cohort did not show significant changes in ELA or mathematics (Albrecht et al., 2015).

Multiple studies have examined the effectiveness of an individualized Tier III intervention and the impact on student achievement (Hagan-Burke et al., 2015; Hurwitz et al., 2015; Nelson et al., 2002). The third tier of PBIS follows the behavioral consultation model

(Fuchs et al., 2003). In the behavioral consultation model, psychologists act as consultants to teachers to intervening to replace an undesirable student behavior (Kratochwill & Bergen, 1978). The consultation model has four steps: identify the problem, analyze the problem (determine variables, frequency, and desired outcome), implement the intervention including data collection, and evaluate the intervention effects (Kratochwill & Bergen, 1978). Fundamental to Tier III is the functional behavior assessment during which teams define a behavior along with its context and antecedents (Sugai et al., 2000). Just as in the original intervention model, Tier III is individualized to intervene for one child (Sugai et al., 2000). Based on the understood definition of the behavior, teams engage in observations to confirm the behavior and its antecedents. Finally, the team develops and implements a behavior plan to reduce unwanted behavior and encourage replacement behaviors (Sugai et al., 2000). The Hurwitz et al. (2015) study was not of the effects of an intervention but rather whether access to consultants as part of the problem-solving process affected intervention outcomes. Their analysis found that teachers working with consultants had significant positive effects but that those effects can vary based on the consultant's quality (Hurwtiz et al., 2015). Like the Hurwitz et al. study, this study demonstrates that Tier III interventions are more effective when teachers receive support in analyzing student behaviors and developing intervention plans. The 2002 study by Nelson et al. was a more holistic study of the effects of a multi-tiered PBIS implementation in elementary schools. Although the study included implementing Tiers II and III and found positive impacts on student discipline and achievement, the results were not disaggregated by intervention level, meaning the evidence of Tier III effects is not clear.

Hagan-Burke et al.'s (2015) study analyzed which specific classroom activities served as antecedents for unwanted student behaviors and examined the effects of classroom modifications on decreasing unwanted behaviors. While the study was an accurate examination of Tier III interventions, it was limited to two students, limiting the study's generalizability.

Multi-Tiered Interventions and Supports

1964 Gerald Caplan published his principles of preventive psychiatry (Caplan, 1964). Based on previous research on the prevention of mental illness, Caplan proposed three prevention levels. Practitioners taking universal proactive steps to avoid potential problems, like flu shots, is the primary level (Caplan, 1964). Patients get flu shots before they get the flu. If patients wait until they show symptoms, the flu shots are not effective. The secondary level addresses symptoms as soon as they occur to mitigate the problem before it worsens (Caplan, 1964), like a doctor prescribing medication for a patient who has contracted the flu. The purpose of the medication is to shorten the duration of the flu and minimize the symptoms. The tertiary prevention level provides more intensive intervention to lessen the long-term effects of the problem (Caplan, 1964), for example, hospitalization and respiratory therapy for a patient whose flu has progressed to pneumonia. In education, the prevention framework is the Multi-Tiered Systems of Support.

MTSS is the broader framework, including RtI and PBIS (Brown-Chidsey & Bickford, 2016; Illinois Center for School Improvement, n.d.). RtI is a multi-tiered response to students' success or lack of success with the academic curriculum (Brown-Chidsey & Bickford, 2016). Response to intervention is a process by which students can demonstrate the educational need for

Exceptional Student Education (ESE) services (General Education Intervention Procedures, Evaluation, Determination of Eligibility, Reevaluation, and the Provision of Exceptional Student Education Services Rule, 2014). With a RtI system, a problem-solving team uses student data to determine which students benefit from the general curriculum (Tier I). Students who are not successful with the general curriculum are assigned to a targeted research-based intervention (Brown-Chidsey & Bickford, 2016). These targeted interventions constitute Tier II (Fuchs et al., 2003; Hannigan & Hannigan, 2018; Sugai et al., 2000). Tier II interventions are based on the student's area of need and correspond to the specific grade-level curriculum (Buffum et al., 2018; Personnel Development Support Program at FCIM/FSU, 2015b). In Tier II, school teams continue to collect progress monitoring data. After some time, the student progress monitoring data is re-evaluated to determine if the intervention had the desired effect (Brown-Chidsey & Bickford, 2016; Gersten, Compton, et al., 2009). If the data indicates the student is not progressing, the school problem-solving team moves the student to a Tier III intervention (Gersten, Compton, et al., 2009). Tier III interventions may or may not be the same interventions offered to currently eligible special education students; regardless, they should be individualized and in greater duration or frequency than Tier II interventions. (Brown-Chidsey & Bickford, 2016). Some school districts refer students for special education evaluation as part of their Tier III interventions; other school districts refer for evaluation when data indicates Tier III is insufficient to support the student's learning needs (Ciolfi & Ryan, 2011).

RtI and PBIS are independent frameworks; they are typically represented as one triangle, like Figure 1. MTSS brings together interventions across content and student need. As such, the typical triangle is insufficient to represent MTSS. Dulaney et al. (2013) represented MTSS as a pyramid. As shown in Figure 3, their pyramid includes tiered supports for high achieving students and those struggling with reading, mathematics, and behavior.

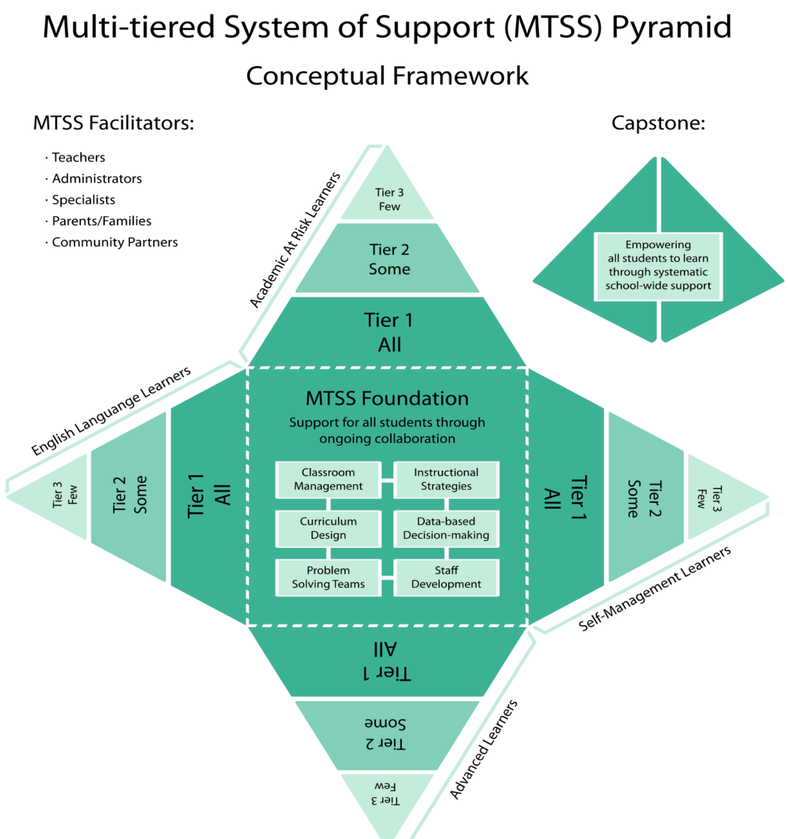

***Figure 3*.** MTSS Pyramid Representing Multiple Contents of Tiered Supports.
Note. From "Superintendent Perceptions of Multi-Tiered Systems of Support (MTSS): Obstacles and Opportunities for School System Reform," by S. K. Dulaney, P. R. Hallam, and G. Wall, 2013, *ASA Journal of Scholarship & Practice, 10*(2), p. 33. Copyright 2013 by the American Association of School Administrators.

MTSS frameworks assume Tier I instruction is of high enough quality for 80% of students to succeed (Gresham & Little, 2012; Nelson et al., 2018). Also, MTSS requires the use of a universal screener to determine which students are not at risk for learning difficulties (Fuchs & Fuchs, 2017). As demonstrated above, there have been many research studies on specific interventions and the effectiveness of Tier I of PBIS. There is far less research on the effectiveness of MTSS as an integrated system.

While the three-tiered framework of supports seems simple enough, there is a disagreement between researchers on whether ESE services exist in addition to the three-tiered model or within the three-tiered model. Since MTSS models vary across states, some states implement MTSS as a four-tiered system (Burns & Yesseldyke, 2005), and others officially have three intervention tiers. Still, ESE services serve as an additional tier beyond their official Tier III, while other states incorporate those services into their lower tiers (Berkeley et al., 2020). Indeed, two camps of thought emerged regarding the role of ESE services in MTSS. One group views MTSS as a continuation of services that could extend the benefits of ESE services to all students. The other group sees MTSS and RtI as tools to explore whether a student might benefit from remediation, avoid ESE services, and better assist students who fail to respond to interventions (Fuchs et al., 2010). Whether ESE services are within MTSS or in addition to MTSS depends entirely on guidance from state education departments or individual school districts.

According to the Florida Problem Solving and Intervention Project (n.d.) MTSS has three tiers. Beyond the three tiers, Florida law states that a student may need ESE services if their intervention intensity to so high it is unsustainable in the general education classroom, or the students fails to show sufficient growth following intensive interventions (General Education Intervention Procedures, Evaluation, Determination of Eligibility, Reevaluation, and the Provision of Exceptional Student Education Services). Once students qualify for ESE services in Florida, they are eligible for additional support such as classroom accommodations or modification and support from additional teachers and staff through pull-out or push-in programming (Bureau of Exceptional Student Education, n.d.). Additionally, students who receive ESE services in Florida are eligible for accommodations on state and school-based assessments. These accommodations may include the following:

- Verbal delivery of written texts,
- Verbal encouragement,
- Use of tools to increase visual attention to the text,
- Access to a transcription of written responses,
- Extended time for testing,
- Frequent breaks during testing,
- Small group or individual testing, and
- Stress-relieving aids (Bureau of K-12 Student Assessment, 2020).

Although some of these accommodations are also available to students who are designated English language learners or have Section 504 plans to accommodate a disability, these accommodations are not available to general education students in Tiers II and III. Because ESE services in Florida provide additional support beyond what is available to Tier II and Tier III students, ESE services are an additional fourth tier to Florida's MTSS framework.

Fidelity

Fidelity of MTSS matters. A recent study comparing MTSS implementation fidelity to proficiency rates found high levels of fidelity for reading interventions led to improved mathematics proficiency. High levels of fidelity in mathematics led to improved language mechanics (Scott et al., 2019).

According to implementation science, fidelity is an implementation outcome (Sanetti & Luh, 2019). Implementation outcomes seek to answer the question, "Was the practice implemented?" (Sanetti & Luh, 2019). Like the supports that define it, MTSS fidelity is layered. Each Intervention within MTSS can be administered with varying degrees of fidelity. The fidelity of the intervention's implementation impacts the analysis of the students' responses (Sanettie & Luh, 2019). An analysis of the effects of intervention fidelity was beyond the scope of this study. Fidelity to the MTSS framework, however, is an assumption of the current study. In 2009 the Institute of Education Science published five recommendations for multi-tiered interventions. Those recommendations included: screening all students, core instruction with differentiation, more intense systematic, small group instruction for those students who are at risk, progress monitoring to evaluate interventions, and more intensive interventions for those who continue to do not improve with Tier II interventions (Gersten, Compton, et al., 2009). These recommendations are echoed in the RtI Fidelity of Implementation Rubric (2014). The rubric for monitoring RtI fidelity includes:

- Assessments (both screening and progress monitoring);
- Data-based decision making (i.e., using data to determine whether a student is responding to an intervention;

- Multi-level instruction; and
- Three tiers of increasing levels of support (infrastructure and leadership support, MTSS resources) in the context of a research-based curriculum ("RTI Fidelity of Implementation Rubric," 2014).

The Self-Assessment of MTSS (SAM) implementation, used to assess MTSS fidelity in Florida, assesses 39 components across six domains (Stockslager et al., 2016). Those domains include: "leadership, building capacity/infrastructure, communication and collaboration, data-based problem solving, three-tiered instructional / Intervention, and data evaluation (Stockslager, 2016, p. 12). The SAM is an iterative version of the RtI Fidelity of Implementation Rubric. The SAM retains the original five recommendations of RtI, expands to include the leadership and support from the RtI Fidelity of Implementation Rubric, and adds specificity in the supports by calling out the capacity and infrastructure necessary for MTSS. For the current study, the assumption of MTSS fidelity means school leaders provide the resources and training for teachers to implement universal screening, provide three tiers of increasingly intense research-based interventions, systematic progress monitoring, and data-based decision making.

As schools implement an integrated MTSS, guidance from state and national sources proposes significant burdens to schools. For example, according to a guidance document published by the Florida Problem Solving and Intervention Project, Florida's Positive Behavior Support Project, and the University of South Florida (n.d.), eight leadership elements are critical to the success of MTSS:

1. Leadership that connects the work of MTSS to the school mission and vision
2. Alignment of policies and procedures across levels

3. Accurate and ongoing use of the problem-solving process
4. Collaboration with stakeholders
5. Data systems that facilitate the problem-solving process
6. Professional development based on data
7. Communication of successes and needs to stakeholders

Each component takes time and effort to ensure the moving parts of MTSS are aligned and functioning throughout the school. Additionally, these factors are highly influenced by the process (Burke, 2018) at the school. The critical elements are subject to how school leaders interpret them and allocate their resources to support them. These elements would be enacted through a critical theory lens rather than implemented (Sabnis et al., 2019).

Foundational to MTSS is effective Tier I instruction (Hattie et al., 2017). Tier I instruction should be effective enough such that 80% of students are achieving the grade-level learning targets (Brown-Chidsey & Bickford, 2016). Having less than 80% of students successful with grade-level standards should not preclude schools from implementing MTSS; however, schools will find MTSS more difficult because they try to intervene with more students (Brown-Chidsey &Bickford, 2016). When Tier I is effective for 80% of students, schools can focus their intervention resources on the 20% of students needing Tier II and Tier III interventions.

The RtI Action Network published guidance on differentiating Tier I from Tier II, including Tier II support, which should include 30 minutes of additional instruction 3-5 days per week in groups of 5-8 students for 8-15 weeks (Harlacher et al., n.d.) Tier III interventions should last 45-120 minutes 5 days per week in groups of 1-3 students for a minimum of 20 weeks (Harlacher et al., n.d.). The national guidance indicates students should receive Tier II and

Tier III supports in addition to the core instruction. According to these recommendations, a student struggling in mathematics and reading would need core instruction plus an addition 120 minutes of Tier II and Tier III support each day. During the required minutes, core instruction must be provided by a certified teacher, the Tier II time would need to be in a group of 8 led by a certified teacher, and Tier III would need to be in a group of 3 students led by a specialist or interventionist (Harlacher et al., n.d.). Given the realities of the suggestions for implementation, it is not surprising that researchers have begun to suggest that the MTSS model may be too complicated to work in the natural school setting and its limited resources (Fuchs & Fuchs, 2017; Lupoch, 2018).

Natural School Setting

Thus far, many of the studies reviewed have occurred in highly controlled settings, with fidelity oversight vital for the researcher(s). The national RtI study discussed earlier examined RtI effects in natural school settings and found negative or non-significant results (Balu et al., 2015). Other natural setting studies include a study examining the effects of implementing a RtI program in a single high school in the southwest United States. Data showed instructional changes led to improved student achievement on state assessments (Fisher & Fry, 2013). A study of the impact of progress monitoring on special education students over four years, using a control group and test group design, found improved reading outcomes for eighth-grade students (Augustin, 2015). Another small-scale natural setting study reported the impact of RtI on 11 students in the fourth grade, seven of which received Tier II interventions and four of which received Tier III interventions (ALSuliman, 2010). In Tier II, 64% of students showed a pattern of growth. In Tier III, only one student showed a pattern of growth (ALSuliman, 2010). An additional qualitative dissertation studied how instructional coaching impacted Tier I of RtI for English language learning students but did not report on the impact on student achievement (Valadez, 2012). Finally, a dissertation studying the impact of early reading intervention and progress monitoring for first-grade and second-grade students with no significant findings (Samuelson, 2010).

A natural setting study of the school-wide impact of reading interventions over six years (Seibel, 2014) found a positive correlation between the number of years the school had implemented MTSS and reading achievement. Finally, a study of the impact of PBIS on student academic outcomes for two years after an initial baseline year found a non-significant impact on mathematics achievement. (Ward, 2016).

There is a paucity of research on the effectiveness of interventions in the intermediate grades (Hattie, 2009). However, success in the middle grades is critical. According to the Annie E. Casey Foundation (2010), fourth-grade reading ability is key to long-term success. When students start fourth grade, they begin applying their reading skills to learning new content (Annie E. Casey Foundation, 2010). Half of the fourth-grade curriculum is unavailable because the curriculum appears in text form (Annie E. Casey Foundation, 2010). Furthermore, 75% of students who are struggling readers in third grade continue to struggle in high school (Annie E. Casey Foundation, 2010). Students who are not proficient readers by fourth grade are not on track to graduate from high school (Annie E. Casey Foundation, 2010).

A 2009 report by Balfanz found that students who failed in either mathematics or English language arts had only a 20% chance of graduating on time. The researcher found that failure later in the middle grades was less likely to impact graduation rates (Balfanz, 2009). The conclusion, then, is that those students who enter middle school already behind are at greater risk of dropping out of high school than those who fall behind during middle school (Balfanz, 2009). The goal of fourth-grade interventions is to help close the achievement gap before middle school and increase the probability of students graduating from high school. Hattie (2009) reported a plateau of reading achievement after the primary grades. The limited research on reading in the intermediate grades indicates a need to improve understanding of how reading interventions impact student achievement.

Finally, the National Assessment of Educational Progress (NAEP) is administered in fourth grade. Fourth-grade proficiency data is the federal government's metric to determine educational outcomes across states and decide national education policy ("Focus on NAEP," n.d.). A study of the effects of MTSS in fourth grade is useful because the fourth grade focuses on national and international achievement comparisons.

Student Achievement

Measures of response to intervention exist at three levels. Standardized tests are considered macro-level tests. Meta-level tests can help identify student learning effects that the standardized test may be too broad to identify. Examples of meta-level assessments would include grade-level specific curriculum-based measures for ongoing progress monitoring (Weisenburgh-Snyder et al., 2015). Micro-level assessments include the daily assessments that inform instructional decisions (Weisenburgh-Snyder et al., 2015). Intervention research frequently uses a combination of data levels. Typically, smaller studies of specific interventions used combinations of micro-level and meta-level data to determine effects.

In contrast, larger-scale studies used macro-level data to determine the overall effects of an intervention system. ALSuliman (2010) used micro and meta-assessments for a very small case study, while Samuleson (2010) and Fuchs et al. (2008) used only meta-assessments for small-scale studies of interventions. In a 2017 meta-analysis of reading intervention research, the studies analyzed used meta-level assessments to determine whether students responded to Tier III interventions (Austin et al., 2017). Seibel (2014) utilized macro assessments to examine the relationship between MTSS implementation factors and student achievement. Ward (2016) also used macro-level data to determine the effect of school-wide PBIS on mathematics achievement.

The use of macro-level data for more systemic analyses is likely due to State and federal accountability measures that hold districts, schools, and teaches accountable for student performance on their state's standardized tests. Florida schools are assigned a letter grade based on state standardized tests, including FSA ELA and FSA Mathematics. The data from these assessments determine which schools qualify as Comprehensive Support and Improvement Schools and Targets Support and Improvement under the federal *Every Student Succeeds Act* (Florida Department of Education, 2018a). Florida's approved ESSA plan includes the use of Florida's current statewide assessments to determine and progress toward closing the achievement gap between ELL students and general education students (Florida Department of Education, 2018a).

In Florida, English language learners are coded based on their initial home language survey and subsequent English language acquisition assessments. Students range from LY (limited English proficiency) to LA students who have exited both the ELL program and the two-year follow-up but are still considered part of the subgroups for demographic reporting purposes (Florida Department of Education, 2019). Florida uses the ACCESS for ELLs to determine students' English proficiency (Florida Department of Education, 2018a).

Finally, FSA ELA and FSA Mathematics as a metric to determine the effectiveness of a particular intervention have been used previously in the target district. One study examined the effects of i-Ready usage on FSA Mathematics achievement and found small but significant increases in scale scores (Seabolt, 2018). The other examined the effects of i-Ready on seventh grade FSA ELA scale scores and found it did not significantly raise scores for students in the lowest score category (Pierce, 2018).

The disproportionality of Black students in Tier III may indicate low expectations rather than a lack of cognitive ability. As a result, schools reduce the disproportional referrals but do not impact the learning gap in a meaningful way. Similarly, since teachers' biases and assumptions can cause them to underestimate what students receiving special education are capable of (Eadens & Eadens, 2018), it follows that teachers' biases and assumptions may also impact their expectations of students in intensive interventions.

Maki et al. (2020) studied which decision-making factors had the strongest correlation to SLD identification. In addition to race and economic data, they also looked at three types of student performance data; RtI progress monitoring, standardized achievement tests, and tests of cognitive ability. RtI progress-monitoring uses ordinary least squares regression to determine the slope of student performance change over time. RtI slope uses progress monitoring data during the intervention period. In their study of SLD eligibility decisions, student achievement scores were better predictors of SLD eligibility than RtI Scope. Their data revealed low achieving, poor, white students were more likely to be identified as SLD (Maki et al., 2020). These data could be interpreted to mean that school decision-making teams are over-relying on student achievement measures rather than using intervention effectiveness to determine SLD eligibility (Maki et al., 2020). As such, an analysis of whether demographic variables moderate intervention effects on macro-level student achievement measures is warranted.

Beyond the Pyramid

As school implementation of MTSS grows, areas in which multiple support tiers are offered increase. MTSS began with educational psychologists who wanted to use data-based problem-solving to improve student behavioral outcomes (Kratochwill & Bergen, 1978). Experts in early reading advocated for multiple support tiers to remediate struggling readers before disabilities developed (Schulte, 2016). In 2004, the IDEA was amended, so the response to intervention framework could be used to determine eligibility for special education services for LD students (SLD, 2019). Since 2004, the multi-tiered frameworks of interventions known as MTSS have expanded to include content beyond early reading, mathematics, and behavior.

Recent research explored the academic and behavioral outcomes of three tiers of social skills support. While the behavioral data were positive, and class time was preserved due to the supports, the three-year study's academic results were mixed (Albrecht et al., 2015). Similarly, a study of executive functioning interventions on student reading achievement found significant positive effects (Cartwright et al., 2002). In 2020 study examined the effects of three tiers of trauma interventions. Tier I was designed to teach students coping skills in the event they were exposed to trauma. Tier II interventions served students at known risk for experiencing trauma, providing services before the onset of traumatic events, and Tier III included intensive services for those who had experienced trauma (Fondren et al., 2020). Although each of the above studies is within the realm of behavior, each MTSS factor adds a plane to the MTSS pyramid presented in Figure 2.

Researchers have also added academic dimensions to the MTSS pyramid. In 2015 researchers studied the effects of an anxiety intervention on student achievement. The data indicated an increased likelihood of academic improvement (Nail et al., 2015). A report from 2018 describes Tier I instruction for emerging English learners, specifically identifying instructional practices beneficial for English language learning students. The authors then recommend Tier II and Tier III intervention practices for emerging bilingual students (Golloher et al., 2018). The results of a meta-analysis of tiered interventions for English language learning students found no significant difference between students' outcomes in the experimental and control groups (Torres, 2017). The author noted the disproportionate number of studies on Tier II interventions compared to Tier I, with 11 effect sizes reported for Tier I and 91 reported for Tier II. Tier III did not have enough effect sizes for the analysis (Torres, 2017). This current study is like Torres (2017) because it sought to understand the differential effects of tiered interventions.

At the other end of the achievement spectrum, Robertson and Pfeifer (2016) researched and created an implementation guide for tiered supports for gifted students. The authors posit that RtI for high achieving students would create a path that includes motivated and high achieving students who do not qualify for gifted services (Robertson & Pfeifer, 2016).

As more and more dimensions are added to the MTSS pyramid, it evolves from triangular to rectangular and then to octagonal. Each dimension of MTSS represents a plane on which a particular student's need can be pinpointed. A student might need Tier I for behavior, trauma, and gifted, Tier II for mathematics and language acquisition, and Tier III for reading. The student cannot exist as a point on a single plane, but rather the needs sit at the precise intersection of the multiple needs across dimensions and levels. In Figure 4, multi-tiered support systems expand the triangular representation by adding faces for each additional support area. The triangle begins to look more like a cone than a pyramid.

Summary

Multi-tiered systems of supports are not a program or curriculum that come in a neatly packaged box. MTSS is the framework of preventative interventions that include RtI and PBIS (Brown-Chidsey & Bickford, 2016). When Congress included response to intervention as a method for determining eligibility for certain ESE categories (SLD, 2019), one goal was to decrease the disproportionate number of Black students who were identified for ESE services (Burns et al., 2008; Fuchs et al., 2003; Kramarczuk Voulgarides et al., 2017). An additional goal was to end the wait-to-fail practices of the severe discrepancy model (Burns et al., 2008; Fuchs et al., 2003; Kramarczuk Voulgarides et al., 2017). Sixteen years later, one of the critical questions is who is benefitting from RtI?

Figure 4. MTSS Multi-Dimensional Cone of Supports.

A review of the literature showed several themes. As shown in Table 1, MTSS incorporates ESE, reading, mathematics, PBIS and is growing in scope. The ways schools implement MTSS impacts the effects on student outcomes and may have implications for ESE eligibility.

Table 1

Thematically Organized Review of the MTSS Literature

Study	Theme	Relevant Findings
Gillborn (2005)	Critical Theory	Education policy intended to reduce racism in the United States and the United Kingdom often has unintended consequences of racial inequity.
Giroux (1979)	Critical Theory	Critical Theory questions how the curricula and relationships in education reduce or reinforce existing power structures.
Ladson-Billings (1998)	Critical Theory	Instructional strategies and deficit language reinforce the belief that Black students are less than White students.
Sabnis et al. (2019)	Disproportionality of ESE Identification	Deficit discourse and student-centered attribution of difficulties indicate RtI may reinforce rather than rectify inequity in educational outcomes.
Gatlin & Wilson (2016)	Disproportionality of ESE Identification	A case study of Black students with disabilities who were successful through high school revealed three major themes related to their success: high expectations, adult support, and organizational systems.
Kramarczuk Voulgarides et al. (2017)	Disproportionality of ESE Identification	While the purpose of IDEA, RtI, and PBIS is to reduce the disproportionality of student outcomes, without consideration of culture and context, researchers risk reinforcing existing systemic racism in education.
Fish (2017)	Disproportionality of ESE Identification	In a study of teacher perceptions of male students, teachers were more likely to refer White boys for support aligned with SLD or gifted and more likely to refer Black boys for support aligned with behavioral disabilities.
Sullivan & Osher (2019)	Disproportionality of ESE Identification	The legal requirements and enforcement of policies intended to reduce ESE identification's disproportionality can directly conflict with Child Find requirements.
Darcy Mahoney (2020)	MTSS Expansion	A proposal for an early literacy intervention in partnership with public health organizations to provide interventions and support to the community.
Greenberg et al. (2017)	MTSS Expansion	Advocacy of MTSS frameworks applied to SEL with universal prevention tiers at both the school and community level.

Study	Theme	Relevant Findings
Marsh &Mather (2020)	MTSS Expansion	The MTSS framework can help connect students to the mental health services available through their school.
Fuchs et al. (2008)	Mathematics	A study of how Tier moderates mathematics intervention (tutoring) affects Tier I instruction found that validated instruction using the same strategies as tutoring had greater effects than Tier I instruction that was not validated.
National Center on Intensive Intervention	Mathematics	Research-based mathematics intervention should include explicit, systematic instruction and move through the concrete, representational, abstract continuum.
Weisenburgh-Snyder et al. (2015)	Mathematics	A small-scale study of 10 male students identified as eligible for ESE services in an intensive mathematics intervention (90 minutes each day) showed statistically significant general mathematics achievement improvements.
Gersten, Beckmann, et al., (2009)	Mathematics	The two mathematics intervention research areas with strong support were explicit, systematic instruction and support for solving word problems using common structures of word problems.
Fuchs et al. (1991)	Mathematics	Instructional adjustments in mathematics interventions based on progress monitoring assessments positively impacted student achievement when teachers could consult with experts on adjusting instruction.
VanDerHeyden & Codding (2015)	Mathematics	A mathematics intervention showed intervention was most effective for those at greater risk for mathematics difficulty than those at less risk.
DeFouw et al. (2019)	Mathematics	In a meta-analysis of mathematics interventions, 79% of studies failed to indicate the intervention's tier level, 31% of studies used curriculum-based measures such as fluency as their outcome variable rather than generalized mathematics achievement.
Deruaz et al. (2020)	Mathematics	A meta-analysis of research in mathematics learning difficulties indicates that although the research has expanded in the last ten years, there is still a lack of research to support students with mathematics learning difficulties.

Study	Theme	Relevant Findings
Bergstrom & Zhang (2016)	Mathematics	Whereas geometry interventions focused on basic concepts or geometric problem solving, research on geometry instruction for those not at risk focused on higher-level geometric reasoning skills.
Albrecht et al. (2015)	Positive Behavior Interventions and Supports	Behavioral results improved because of implementing three tiers of behavioral supports. Academic results were mixed.
Bradshaw et al. (2010)	Positive Behavior Interventions and Supports	Tier 1 PBIS training led to decreased ODR and suspensions. Student achievement outcomes were greater for SWPBIS schools but not significant.
Cohen et al. (2007)	Positive Behavior Interventions and Supports	Higher levels of Tier I PBIS implementation fidelity as measured by the Benchmarks of Quality correlate to decreased discipline referrals. The study measured the reliability and validity of the Benchmarks of Quality and found it to be a reliable and valid measure of SWPBIS implementation fidelity.
Debnam et al. (2012)	Positive Behavior Interventions and Supports	While schools' overall PBIS implementation fidelity was high, targeted interventions for behavior were not implemented with fidelity.
Gage et al. (2019)	Positive Behavior Interventions and Supports	Florida schools implementing SWPBIS with fidelity saw statistically significant decreases in OSS, but not in ISS, incidents involving law enforcement, or incidents involving drugs or alcohol. SWPBIS fidelity was associated with statistically significantly fewer incidences of OSS for Black students and students with disabilities.
Horner et al. (2015)	Positive Behavior Interventions and Supports	A compilation of empirical studies demonstrates that PBIS meets the criteria for an evidence-based intervention at all three tier levels.
Scott et al. (2019)	Positive Behavior Interventions and Supports	A study of MTSS fidelity in behavior, reading, and mathematics found decreased out-of-school suspensions. Interventions did not show effects on proficiency in the target area. However, the fidelity of implementation in reading and mathematics was associated with increased proficiency in language mechanics.
Sugai & Horner (2020)	Positive Behavior Interventions and Supports	School adoption of PBIS has increased steadily since 2000, and the median number of office discipline referrals has steadily decreased. However, implementation data

Study	Theme	Relevant Findings
		indicates fewer schools have Tier II and Tier III behavior systems in place.
Sugai & Horner (2009)	Positive Behavior Interventions and Supports	The scope of PBIS has expanded from supports for students with learning disabilities to supports and interventions for all students.
Sugai et al. (2000)	Positive Behavior Interventions and Supports	Effective PBIS schools have policies, structures, and routines to ensure the research-based practices for PBIS.
Elfner Childs et al. (2010)	Positive Behavior Interventions and Supports	Higher Tier I PBIS implementation fidelity levels as measured by Florida's self-assessment led to decreases in discipline referrals, school suspensions, and out-of-school suspensions.
Peshak George et al. (2018)	Positive Behavior Interventions and Supports	A qualitative study of key drivers that school district leaders associated with successful SWPBIS implementation in Florida. Findings indicated strong district coordinators and coaches with excellent "soft skills" were key to successful district-wide PBIS implementation.
Houchens et al. (2017)	Positive Behavior Interventions and Supports	A study of schools in Kentucky found that medium and high fidelity of implementation, as measured by the BOQ, were associated with increased student achievement.
Algozzine et al. (2011)	Positive Behavior Interventions and Supports	Teacher ratings of student behavior and academic competence were more strongly correlated than teacher ratings of student behavior and objective student performance.
Muscott et al. (2008)	Positive Behavior Interventions and Supports	SWPBIS implemented with the support of a statewide PBIS support network showed decreased office discipline referrals, decreased suspensions, increased mathematics achievement, and increased achievement in middle school reading.
Hagan-Burke et al. (2015)	Positive Behavior Interventions and Supports	A functional behavior analysis of students with behavioral disabilities indicated that changes to classroom academic demands reduced instances of unwanted behaviors.
Hurwitz et al. (2015)	Positive Behavior Interventions and Supports	An analysis of how individual behavior consultants impacted student outcomes showed that individual consultants account for statistically significant student outcomes variability.

Study	Theme	Relevant Findings
Nelson et al. (2002)	Positive Behavior Interventions and Supports	Researchers explored four specific interventions to use as secondary interventions in a three-tier system. Results showed statistically significant positive impacts on student behaviors and student achievement.
Schiller et al. (2020)	MTSS Implementation	A national study of state MTSS evaluation tools found MTSS expectations vary from state to state.
Charlton et al., 2018	MTSS Implementation	Critical helping factors for scaling up MTSS include cross-disciplinary leadership, professional development of differing modalities, consistent language, external partnering consultants, and funding sources.
Dulaney et al. (2013)	MTSS Implementation	There are three critical components for MTSS implementation at the district level; common language, a culture of collaboration, and building capacity at every level.
Berkeley (2009)	MTSS Implementation	One year after RtI became part of the IDEA, documentation across 50 states was analyzed to determine how states implemented RtI. States varied in their readiness and level of prescription to local districts.
Berkeley (2020)	MTSS Implementation	In a follow-up to the 2009 study, a review of state education agency websites found 39 states had statewide tiered intervention support models in place, and an additional 8 had guidance for implementation. Twenty-one states identified MTSS as their tiered intervention model.
Choi et al. (2019)	MTSS Implementation	Even when provided technical assistance for MTSS implementation, school leadership has a moderating effect on the quality of MTSS.
Cowan & Maxwell (2015)	MTSS implementation	Teachers believe RtI holds promise for helping struggling students; however, the required documentation and lack of teacher training are barriers to its effectiveness.
Swindelhurst et al. (2015)	MTSS Implementation	In a survey of principals in New England state, schools that reported fully implementing RtI did not indicate they were fully implementing all the core components of RtI.
Gage et al. (2015)	MTSS Implementation	Researchers found positive statistically significant effects for teachers who had better classroom management in a study of intervention effectiveness than those who had poor classroom management.

Study	Theme	Relevant Findings
Fuchs & Fuchs (2017)	MTSS Implementation	Rather than having three tiers of MTSS in addition to ESE services, the authors advocated for a two-tiered model in which Tier I is high-quality general instruction with differentiation, and Tier II includes ESE services.
Bradley et al. (2005)	ESE Eligibility	While there is no ideal RtI model, RtI for ESE identification may reduce the delay in identifying students in need of ESE services and focus attention on the instructional practices that support struggling students rather than a deficiency in the student.
Fletcher et al. (2004)	ESE Eligibility	RtI gives students the intervention they need when they struggle instead of the discrepancy model, which required students to wait until they are far behind to receive ESE services.
Fuchs et al. (2003)	ESE Eligibility	The discrepancy model for LD identification is problematic because it over-identifies some groups of children and under-identifies others. Based on early RtI implementation, additional research needs to be conducted to determine whether it is the right construct to replace the discrepancy model.
Painter & Alvarado (2008)	ESE Eligibility	The IDEA's inclusion of RtI for special education identified is a positive change from the discrepancy model.
Barrett & Newman (2018)	ESE Eligibility	A case study of MTSS and SLD identification and performance in a Midwest regional education service agency found the number of students identified as SLD decreased over the ten years MTSS was implemented. An achievement gap between SLD students and their non-ESE peers persisted in both mathematics and reading.
Karagiannis (2000)	ESE Eligibility	The soft disability labels, learning disables, speech or language disabled, emotional behavioral disabled, and mild mental retardation create a stigma that minimizes the likelihood of success rather than increasing achievement.
Holdnack & Weiss (2006)	ESE Eligibility	Neither the severe discrepancy model nor RtI can diagnose a learning disability. RtI demonstrates that students are having learning difficulties but cannot diagnosis why the difficulty is occurring.

Study	Theme	Relevant Findings
Burns et al. (2008)	ESE Eligibility	RtI holds promise for a more equitable diagnosis of the LD; however, more research is needed to determine its effectiveness, fidelity, and equity.
Togut & Nix (2012)	ESE Eligibility	The requirements of RtI for determining ESE eligibility put it at odds with the federal Child Find requirement.
Ciolfi & Ryan, 2011	ESE Eligibility	RtI may have the unintentional consequence of increasing the disproportionality in discipline. Students who receive ESE services have special protections against suspensions and expulsions; students in Tier II or Tier II of RtI do not have those protections.
Gersten et al. (2020)	Reading	Meta-analysis of the impacts of Tier II interventions compared to Tier I. The analysis found the effects to be significantly effective. Effects varied significantly by the purpose of the intervention, not by the characteristics of the intervention implementation.
Balu et al. (2015)	Reading	A large-scale study of the effect of interventions on students immediately below the intervention cut score found negative or no effects for reading in Kindergarten, first-grade, and second-grade.
Dale et al. (2018)	Reading	A Danish study of Tier II reading interventions found greater effects for lower-achieving students than higher-achieving students.
Austin et al. (2017)	Reading	A meta-analysis of 12 research findings indicates that while Tier III interventions do not close the achievement gap, students benefit from Tier III interventions.
Gersten, Compton et al. (2009)	Reading	Recommendations for implementing RtI in primary reading include; screening all students, core instruction with differentiation, more intense systematic, small group instruction for students at risk, progress monitoring to evaluate interventions, and more intensive interventions for those who continue to do not improve with Tier II interventions.
Nelson et al. (2018)	Reading	K-2 students exited from Tier II reading interventions due to meeting criteria did not maintain those effects. However, their effects were greater than those of students who were not. Maintenance declined in second more than first and first more than kindergarten.
Sanetti & Luh (2019)	Fidelity	The fidelity of implementing an intervention impacts the analysis of the students' responses. The determination of

Study	Theme	Relevant Findings
		responsiveness should vary based on whether the intervention was implemented with fidelity.
Stockslager (2016)	Fidelity	The Self-Assessment of MTSS Implementation fidelity measures how well MTSS is implemented rather than what aspects of MTSS are implemented.
Harlacher et al. (n.d.)	Fidelity	Tier II support should include 30 minutes of additional instruction 3-5 days per week in groups of 5-8 students for 8-15 weeks. Tier III interventions should last 45-120 minutes 5 days per week in groups of 1-3 students for a minimum of 20 weeks.
ALSuliman (2010)	Natural Setting	A small-scale study (11 students) of how RtI impacted student achievement. Students receiving Tier II interventions indicated a growth pattern, and students in Tier III interventions demonstrated a pattern of non-growth.
Valadez (2012)	Natural Setting	Instructional coaching impacted Tier I of RtI for English language learning students.
Samuleson (2010)	Natural Setting	Early reading intervention and progress monitoring for first-grade and second-grade students had no significant findings.
Seibel (2014)	Natural Setting	A study of the school-wide impact of reading interventions over six years found a positive correlation between the number of years the school had implemented MTSS and reading achievement.
Ward (2016)	Natural Setting	A study of the impact of PBIS on student academic outcomes for two years after an initial baseline year found a non-significant impact on mathematics achievement.
Cartwright et al. (2002)	Emerging Areas of MTSS	A study of executive functioning interventions on student reading achievement found significant positive effects.
Fondren et al. (2020)	Emerging Areas of MTSS	A study of trauma interventions within the MTSS framework.
Nail et al. (2015)	Emerging Areas of MTSS	A study of anxiety interventions’ effect on student achievement.
Golloher et al. (2018)	Emerging Areas of MTSS	Recommendations for supporting English language learning students within the MTSS framework.

Study	Theme	Relevant Findings
Torres (2017)	Emerging Areas of MTSS	A meta-analysis of tiered interventions for English language learners.
Robertson & Pfeifer (2016)	Emerging Areas of MTSS	RtI for high-achieving students creates a path that includes motivated and high-achieving students who do not qualify for gifted services.

Initial interest in RtI was born of a desire to decrease the over-identification of minority students as SLD or EBD (Sabnis et al., 2019). The individual components of MTSS tiered reading interventions, tiered mathematics interventions, tiered behavioral supports, ESE eligibility, the disproportionality of ESE identification, and the effects of differing fidelity of implementation have been the subject of many studies. The integration of PBIS and RtI supports and their effects on student achievement have not been rigorously studied, perhaps because the terms RtI and MTSS are often used synonymously. The present study endeavored to understand whether the tiered interventions of RtI and the broader MTSS framework had the desired effects on student outcomes and reduced inequity in ESE identification and student outcomes. While most of the studies reviewed explored individual pieces of MTSS, researchers have identified studies of MTSS as a holistic system in the natural setting as a gap in the research (Barrett & Newman, 2018; Fuchs & Fuchs, 2017). The proposed study seeks to contribute to the literature by examining MTSS interventions' effectiveness at each tiered level and across subject areas in one intermediate grade.

CHAPTER THREE: METHODOLOGY

Introduction

RtI and MTSS are often used interchangeably, with PBIS included. Frequently, RtI refers to the tiered academic supports. PBIS refers to a system of tiered behavioral supports, and MTSS refers to integrated systems of support for academics, behavior (Illinois Center for School Improvement, n.d.), and other areas. MTSS are complicated systems of hierarchical interventions across multiple areas; determining the effectiveness of these systems is also a complicated endeavor.

Although experimental research is the gold standard for determining cause and effect relationships (Fraenkel et al., 2015), examining MTSS using a causal-comparative design avoids the ethical considerations of denying a student intervention in the interest of science. The research questions indicated a causal-comparative design because the researcher did not randomly assign students to the treatment (Fraenkel et al., 2015). Understanding the differing effects of tiered interventions on student achievement suggested a quantitative design. The researcher sought to understand the extent to which the tier of intervention affects student achievement (Fraenkel et al., 2015). The dependent variables were changes in FSA ELA and FSA Mathematics percentiles from 2018 to 2019 for all fourth-grade students in one Florida district. This study utilized the change in scores rather than the 2019 score because the theoretical framework of MTSS assumes each increase in tiered supports indicates decreased levels of student achievement. Increasing tiers of interventions should increase the change rate; thus, the percentile change is a better indicator of interventions' effects. The independent variable was participation in a Tier II intervention, a Tier III intervention, or receiving Tier IV, ESE services during the fourth-grade (2018-2019) school year. The purposive sample was based on the students the researcher could access. The participants the researcher had access to are the 5,131 (Florida Department of Education, 2020) students enrolled in fourth grade in one Florida district during the 2018-2019 school year. The researcher collected FSA ELA scores, FSA Mathematics scores (third and fourth grades), and fourth-grade intervention participation data. Also, the researcher collected demographic data, including race, gender, English language learner status, and economically disadvantaged status.

Based on the research on MTSS, the number of students receiving Tier IV interventions and the number of students who received Tier III interventions was likely to be significantly less than the number of students who received Tier II interventions and the number of students receiving no interventions. The MTSS model utilized in Florida assumes 5% of students will need Tier III interventions in each area (reading, mathematics, and behavior), and 15% of students will need Tier II interventions in each area (Personnel Development Support Program, 2015b). In the 2018-2019 school year, 12.8% of the sample was reported as disabled in the target Florida district (Florida Department of Education, 2020). Of the 3,977 subjects, 3,876 were analyzed. The percent of students who received an intervention for reading or behavior differed from the conceptual recommendation.

This study reported descriptive statistics for demographic data for the 2018-2019 school year. The effects of each level of intervention on the percentile change were analyzed using an analysis of variance (ANOVA; Steinberg, 2011). The FSA ELA and FSA Mathematics percentile change from third to fourth grade served as the dependent variable.

Purpose of the Study

The purpose of this study was to contribute to the literature by investigating the effects of tiered MTSS interventions on student achievement in the intermediate grades in a natural school setting. In addition, this study investigated the differences in the effects of MTSS intervention tiers on student achievement in Grade 4. The study used post hoc data to measure student achievement, using the change in state assessment percentile on the FSA ELA and the FSA Mathematics. The current study collected post hoc FSA ELA and FSA Mathematics data and intervention assignment data for all students enrolled in fourth grade in one Florida district from August 2018 through the end of the 2018-2019 school year. The study answered the following questions:

1. What are the differences between intervention levels (Tier I, II, III, or IV) and student English language arts achievement (FSA ELA)?
2. What are the differences between intervention levels (Tier I, II, III, or IV) and mathematics achievement (FSA Mathematics scores)?
3. Do student characteristics moderate any differences between intervention levels (Tier I, II, II, or IV) and student achievement (FSA ELA and FSA Mathematics scores)?
   A. Gender
   B. Race
   C. ELL status
   D. Economically disadvantaged status

The study tested the following hypotheses.

1. H_1 There are differences between intervention levels and student English language arts achievement.
    a. H_0 There are no differences between intervention levels and student English language arts achievement.
2. H_2 There are differences between intervention levels and mathematics achievement.
    a. H_0 There are no differences between intervention levels and mathematics achievement.
3. H_3 Student characteristics moderate differences between intervention levels and student FSA ELA and mathematics achievement.
    a. H_0 Student characteristics do not moderate differences between intervention levels and student FSA ELA and FSA Mathematics achievement.

Population

The population for this study was a fourth-grade student class in one Florida district. In the 2018-2019 school year, the target school district had 3,977 students enrolled in the fourth grade. Fifty-two percent of students were male, 48% were female. The population's racial profile was 61% Hispanic, 23% White / Caucasian, 11% Black, 2% Asian, less than 1% Native American or Pacific Islander, and 2% Mixed race. In the target population, 38% of students qualified for services for English language learners. Although 21 of 24 elementary schools in the target district were identified as Title I, only 58% of students were certified as qualifying for free and reduced lunch. The discrepancy between the number of Title I schools and the percent of the population who qualify for free and reduced lunch is likely a factor of the federal Community Eligibility Program. The Community Eligibility Program allows whole schools to qualify for free lunch and breakfast based on data from other government assistance programs ("Community Eligibility Provision / National School Lunch," n.d.). Students who attend schools that qualify under the Community Eligibility Program are not required to verify their economically disadvantaged status.

The researcher chose this purposive sample based on their experience with MTSS implementation in the school district (Lunenburg & Irby, 2008). Before the 2018-2019 school year, the school district relied on data systems that tracked student interventions by level and type, including entry date and exit date. The MTSS model utilized in Florida assumes 5% of students will need Tier III interventions, and 15% of students will need Tier II interventions (Personnel Development Support Program, 2015b). In the 2018-2019 school year, 12.8% of students were identified as disabled in the target Florida district (Florida Department of Education, 2020). Per state reporting guidelines, this percentage excludes those students whose exceptionality includes: (a) gifted, (b) established conditions, (c) occupational therapy, (d) physical therapy, or (e) a combination of those four exceptionalities (Bureau of Accountability Reporting; Division of Accountability, Research, and Measurement, 2019). The number of students who received an intervention may be higher or lower than the conceptual recommendation.

Instrumentation

Using 2018 and 2019 state assessment scale scores from the Florida Standards Assessment for English language arts (FSA ELA) and the Florida Standards Assessment (FSA) for mathematics, this study utilized post hoc data to measure student achievement. No data were collected until UCF IRB approved the study. Only deidentified student data were included in the study. This study used intervention assignment data for all students enrolled in fourth grade in one Florida district in the 2018-2019 school year. The FSA ELA and FSA Mathematics are criterion-referenced tests designed to measure student achievement on the Language Arts Florida Standards and the Mathematics Florida Standards (Florida Department of Education, 2018b). The FSA ELA and FSA Mathematics assessments report scale scores and achievement levels (Florida Department of Education, 2018b). The proposed study utilized percentiles calculated from scale scores rather than achievement levels for analysis because the scale scores allowed for a more precise understanding of student achievement effects over time.

Reliability and Validity

The Florida Department of Education (2018a) published a report of the FSA ELA and FSA Mathematics reliability for two test formats: paper-based (PBT) and computer-based. Participants in the proposed study took a PBT in third grade and fourth grade. FSA ELA and FSA Mathematics report >0.50 reliability on all PBT and CBT for Grades 3 through 6 (Florida Department of Education, 2018b). The FSA ELA has multiple response types that are not equally distributed. The Florida Department of Education reports reliability using three different statistics: (a) Chronbach α, (b) stratified Chronbach α, and (c) Feldt-Raju (Florida Department of

Education, 2018b), each of which was greater than .85. Table 2 shows the statistics of the state reports for Grades 3 and 4 in 2018.

Table 2

Florida Standards Assessment Internal Reliability

	FSA ELA			FSA Mathematics		
	α	stratified α	Feldt-Raju	α	stratified α	Feldt-Raju
3rd Grade	.91	.91	.89	.94	.94	.93
4th Grade	.88	.88	.85	.95	.95	.93

The Florida Standards Assessment was designed to assess the Language Arts Florida Standards (Grades 3 through 10) and the Mathematics Florida Standards (Grades 3 through 8; Florida Department of Education, 2018b). The Florida Department of Education reported a correlational analysis between reporting category sub-scores. For the third-grade FSA ELA test, the reporting category correlations ranged from α = .51 to .77, with Language and Editing Tasks having the lowest correlation (α = .51; Florida Department of Education, 2018b). The deattenuated reporting category correlations for the FSA ELA ranged from .83 to .98. For Grade 4, the correlations ranged from α = .46 to .68, with the deattenuated correlations ranging from α = .87 to .99. Text-based writing had the lowest correlation in fourth grade (.46; Florida Department of Education, 2018b). In third-grade FSA Mathematics, the reporting category correlations ranged from α = .72 to .83, and in fourth grade, the correlation ranged from 0.74 to 0.83 (Florida Department of Education, 2018b). The deattenuated correlation for third-grade FSA Mathematics ranged from α = .90 to .96 and fourth grade from α = .95 to 0.99 (Florida

Department of Education, 2018b). The Florida Department of Education (2018a) also reported the results of a confirmatory factor analysis to demonstrate that the reporting category scores align with the assessment's theoretical structure. The report included the results of a second-order confirmatory factor analysis for three goodness of fit statistics: (a) the root mean square error of approximation (RMSEA), (b) Tucker-Lewis index (TLI), and (c) the comparative fit index (CFI; Florida Department of Education, 2018b). The root mean square error of approximation reports badness of fit. A score closer to zero indicates a better fit (Florida Department of Education, 2018b). In this study, all three statistics are a good fit for Grades 3–4 FSA ELA and FSA Mathematics (Florida Department of Education, 2018b).

Table 3

Florida Standards Assessment Tests of Fit

	RMSEA	TLI	CFI
Third-grade FSA ELA	.02	.98	.98
Fourth-grade FSA ELA	.02	.98	.98
Third-Grade FSA Mathematics	.03	.98	.98
Fourth-grade FSA Mathematics	.02	.98	.98

Note. The Florida Standards Assessments for ELA and mathematics are valid and reliable assessments of students' achievement on the Florida standards are therefore appropriate for this study.

Data Collection

Regarding MTSS in the analyzed district, some students received only core instruction, Tier I, some received Tier II supports, some received Tier III supports, and some received Tier IV ESE services. Each area (reading, mathematics, and behavior) starts with Tier I and progresses through the tiered levels.

Some students received a combination of interventions across and tiers. Students in the population were assigned a tier based on their highest reported level of intervention in each intervention category. For reading, those students who did not have Tier II or Tier III reading interventions or ESE services reported in the student information system during the 2018-2019 school year labeled Tier I. Those students reported as having Tier II reading interventions but not Tier III reading interventions and who did not receive ESE services were labeled Tier II. Those students who were reported as receiving Tier III reading interventions but not ESE services were labeled Tier III. Finally, those students who received ESE services were labeled Tier IV.

Some students received a combination of interventions at different tiers for different academic and behavioral areas. Students in the target population (2018-2019 school year) were assigned a tier based on their highest reported level of intervention in each intervention category. For reading, students who did not receive Tier II or Tier III reading interventions nor ESE services appeared in the student information system as assigned to Tier I. Students who reported Tier II reading interventions, but neither Tier III reading interventions nor ESE services were labeled Tier II. Students who received Tier III reading interventions but not ESE services were labeled Tier III. Finally, students who received ESE services were labeled Tier IV.

Students whose only exceptionality was gifted, established conditions, occupational therapy, physical therapy, or a combination of these exceptionalities were not included in Tier IV (Bureau of Accountability Reporting; Division of Accountability, Research, and Measurement, 2019). These students were excluded from Tier IV to align with Florida accountability guidelines. The process of coding students according to their highest level of intervention was repeated for mathematics interventions. Because the data collected did not specify whether exceptionalities were specific to reading or mathematics, Tier IV contained the same group of students for both reading and mathematics. This process was repeated for behavior interventions to identify students in Tiers I–III. Only students with the ESE code “J,” indicating an emotional behavior disability, were included in Tier IV for behavior (Appendix A).

The dependent variables were change in FSA ELA and FSA Mathematics percentiles from 2018 Grade 3) to 2019 (Grade 4). The independent variables consisted of participation in at least one of the following interventions in Grade 4 during the 2018-2019 school year: Tier II, Tier III, Tier IV, ESE services. In addition to FSA ELA scores, FSA Mathematics scores for specified years, and intervention participation in fourth grade, the researcher also collected demographic data, including: (a) race, (b) gender, (c) English language learner status, (d) economically disadvantaged status, and (e) time in the intervention.

After approval from the university Institutional Review Board (IRB), the researcher completed the following data collection steps:

1. Submit the Application to Conduct Research and Assurances to the school district (Appendix B and C);
2. Upon IRB approval and receipt of the school district's data, place data secure server to store it;
3. Code students into Tier I, Tier II, Tier III, or Tier IV for reading, mathematics, and behavior based on the highest reported intervention level;
4. Calculate percentile rank for all students who had an FSA ELA scale score in 2018. Calculate percentile rank for all students who had an FSA ELA scale score in 2019. Calculate the difference between 2019 and 2018 to determine a change in percentile as a growth measure. Repeat process with FSA Mathematics scale scores for 2018 and 2019;
5. Code student demographic data based on the Florida Department of Education reporting requirements (Bureau of Accountability Reporting; Division of Accountability, Research, and Measurement, 2019). Table 4 identifies the codes used; and
6. Analyze data using SPSS version 27. Meet minimum sample sizes for effect using G-Power analyses.

Table 4

Codes for Demographic Data Analysis

Variable	Categories and Codes
Highest Intervention Tier	Tier I Tier II Tier III Tier IV
Gender	Male = 1 Female = 0
Race	Asian / Pacific Islander = A Black / African American = B Native American / Indigenous = N Pacific Islander = P White / Non-Hispanic = W Mixed / Multi-racial = M
English Language Learner	LA LF LP LY LZ ZZ

Data Analysis

The following research questions guided this study that sought to understand the effects of MTSS intervention tiers on student achievement:

1. What are the differences between intervention levels (Tier I, II, III, or IV) and student English language arts achievement (FSA ELA)?

2. What are the differences between intervention levels (Tier I, II, III, or IV) and mathematics achievement (FSA Mathematics Scores)?
3. Do student characteristics moderate any differences between intervention levels (Tier I, II, III, or IV) and student achievement (FSA ELA and FSA Mathematics Scores)?
   A. Gender
   B. Race
   C. ELL status
   D. Economically disadvantaged status

The study tested the following hypotheses.

1. H_1 There are differences between intervention levels and student English language arts achievement.
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2. H_2 There are differences between intervention levels) and mathematics achievement.
   a. H_0 There are no differences between intervention levels) and mathematics achievement.
3. H_3 Student characteristics moderate differences between intervention levels and student FSA ELA and FSA Mathematics achievement.

a. H_0 Student characteristics do not moderate differences between intervention levels and student FSA ELA and FSA Mathematics achievement.

Research Questions 1 and 2 proposed a factorial ANOVA to analyze how increasing reading, mathematics, and behavior interventions affected student achievement. Student achievement was measured by the change in percentile on the FSA ELA and FSA Mathematics. Data analysis for both research questions was the same. The effects of each level of intervention on the percentile change were analyzed using an ANOVA because the study includes four categorical independent variables: Tier I, Tier II, Tier III, and Tier IV. Although not called Tier IV in Florida, other models use Tier IV to refer to those students needing ESE services because of inadequate responses to Tier I, II, and III (Burns & Yesseldyke, 2005). In the analysis phase, students who were documented as receiving ESE services were labeled Tier IV.

Each independent variable included the intervention's subject as a factor: reading, mathematics, and behavior. The first research question (Research Question 1) had one dependent variable for each intervention level (ELA Achievement), and Research Question 2 had one dependent variable for each intervention group (FSA Mathematics achievement). Because the study examined the effects of group membership on a continuous dependent variable, an ANOVA was selected as an appropriate statistical test (Steinberg, 2011).

Research Question 3 analyzed the effects of student characteristics on how interventions affect achievement. For Research Question 3, the independent variables were still categorical (intervention tier). The dependent variables were continuous (change in FSA and ELA mathematics percentiles); the student characteristics served as covariates. Research Question 3 required a two-way ANOVA analysis (Hahs-Vaughn, 2017). The data analysis for all research questions included reporting descriptive statistics. The study also reported descriptive statistics of the change in assessment scores for each tier and student characteristics for each intervention level.

Factors

Research Questions 1 and 2 shared a similar analysis design. In each case, there were four factors for each of the independent variables (Figure 5). Reading, mathematics, and behavior tiers were analyzed to determine the effects of intervention tiers on student achievement. The analysis included separate two-way ANOVAs for reading achievement and mathematics achievement, as measured by the change in FSA ELA and FSA Mathematics percentiles from 2018 to 2019. The purpose of the analysis was to determine whether interventions had effects outside of the interventions’ subject area.

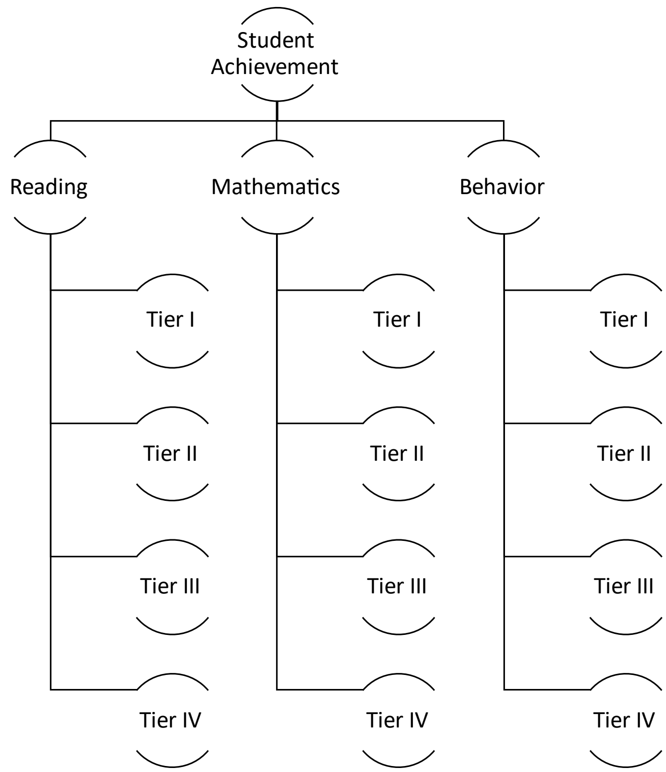


Figure 5. Design diagram for ANOVA for Research Questions 1 and 2.

Research Question 3 examined whether demographic factors affect student achievement. Figure 6 represents the multiple factorial ANOVA used to determine whether student demographics moderated any effects of tiered interventions on student achievement. Demographic categories were analyzed within each intervention category to determine whether they moderated any effects on student achievement. Each demographic category required a separate factorial ANOVA to determine the extent to which the demographics moderate any intervention effects. An analysis of the demographic or intervention combinations was beyond the scope of this study.

Statistical Assumptions

Once the data were collected, the researcher tested the data to determine whether the ANOVA assumptions were met. ANOVA assumptions included that the data were normally distributed, and the categories had equal variance (Steinberg, 2011). To test for normal distribution, the researcher used the Shapiro-Wilks test to determine normality, identified as skewness and kurtosis, between the absolute value of 2.0 and 7.0 (Hahs-Vaughn, 2017). A histogram visualizes the normality of distributions. Box’s M test was used to measure the homogeneity of variance (Hahs-Vaughn, 2017). The researcher used Levene’s test to determine whether the dependent variable had heterogenous variance (Hahs-Vaughn, 2017). When the assumption of homogeneity of variances was violated, the researcher used the Welch ANOVA statistic (Laerd Statistics, 2017). When multiple assumptions were violated, the Kruskal-Wallis *H* test was used to corroborate the ANOVA results.

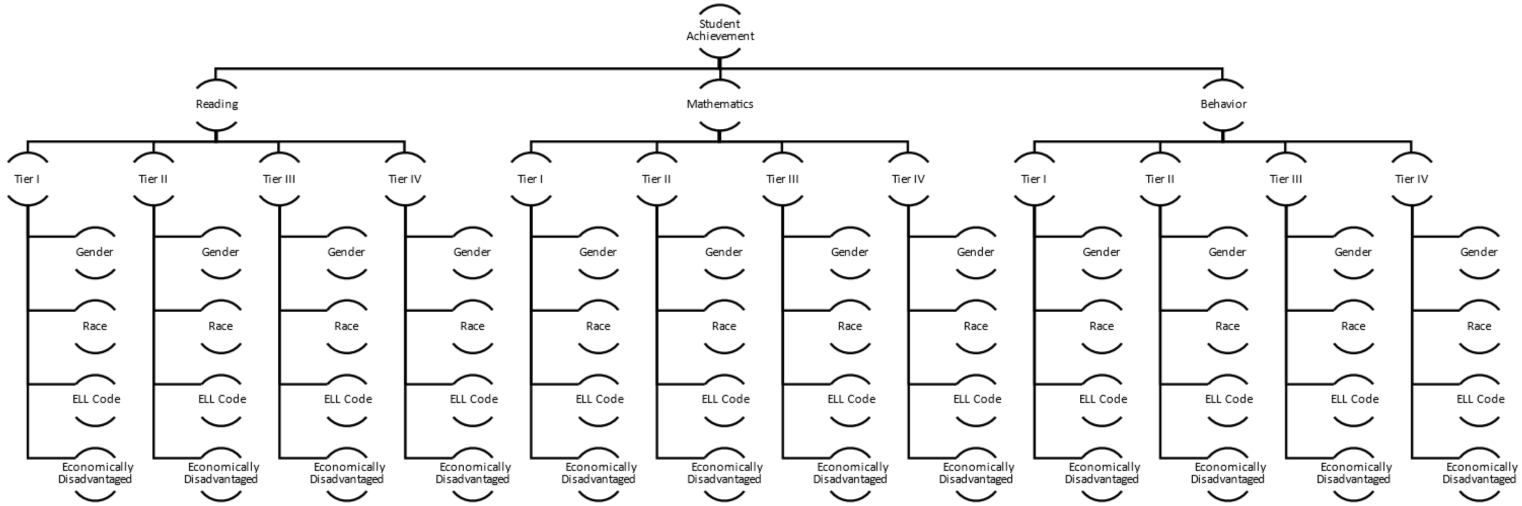


Figure 6. Design diagram for factorial ANOVA Research Question 3.

Post Hoc Tests

When the ANOVA found statistically significant effects, the researcher used the Tukey post hoc tests to determine where differences were statistically significant (Steinberg, 2011). The results of post hoc tests were reported and interpreted. Partial eta squared analysis determined the effect size of any statistically significant effects (Laerd, 2017). Table 5 includes a summary of the research questions, variables, and statistical tests.

Table 5

Research Question Matrix

	Research Questions	Data Source	Variable	Data Analysis
1	What are the differences between intervention levels (Tier I, II, III, or IV) and student achievement (FSA ELA and FSA Mathematics Scores) in the fourth grade?	Intervention documentation FSA ELA Scale Score	IVs: Characteristics (Categorical). Intervention levels (Categorical). DV: FSA scores (Continuous)	Descriptive Statistics ANOVA Post Hoc: Tukey, Games-Howell, Effect Size
2	What are the differences between intervention levels (Tier I, II, III, or IV) and mathematics achievement (FSA Mathematics Scores)?	Intervention documentation FSA Mathematics Scale Score	IVs: Characteristics (Categorical). Intervention levels (Categorical). DV: FSA Scores (Continuous)	Descriptive Statistics ANOVA Post Hoc: Tukey, Games-Howell, Effect Size
3	Do student characteristics moderate the differences between intervention levels (Tier I, II, III, or IV) and student achievement (FSA ELA and FSA Mathematics Score) in the fourth grade?	Student characteristics intervention levels	IV: Intervention levels (Categorical. ModV: Student Characteristics (Categorical). DV: FSA Scores (Continuous)	Descriptive Statistics two-way ANOVA Post Hoc: Main Effects, Effect Size

Limitations, Delimitations, and Assumptions

Limitations

Because this study explored MTSS in a natural school setting, the study may have been impacted by the following limitations:

1. The study could not verify the accuracy of the intervention documentation; this may have affected the results if students were documented as having received an intervention but did not receive it or it was not implemented as designed.
2. The researcher did not verify the fidelity of implementation for the reported interventions. Fidelity might have affected the results if interventions were not implemented as designed
3. The population of students was drawn from a single district in one state. Because states and counties vary in their MTSS implementation, the data may not be generalizable to other states and districts.
4. Outside of the MTSS interventions, many variables could have impacted student achievement, such as student mobility, Tier I instruction quality, and the intervention's quality.
5. Schools may set different criteria for placement in Tier II and Tier III, causing students in the same tier in different schools to have different skill levels, possibly impacting the central tendency measures used to analyze the data.

Delimitations

The current study only looked at one cohort of students in one Florida district. Students were grouped based on their most intensive level of intervention.

1. The current study did not account for interventions received before fourth grade. Previous researchers have examined the effectiveness of interventions in the primary grades (Balu et al., 2015; Nelson et al., 2018). An analysis of the cumulative effects of interventions was beyond the scope of this study.
2. The researcher did not consider the specific type of reading, mathematics, or behavior intervention implemented. As discussed in Chapter Two, there have been many research studies on the effectiveness of specific interventions. Because schools have choices regarding which intervention a student receives, not all Tier II interventions within a given subject area are the same. For these reasons, the specific intervention was not included.
3. Evaluating whether the intervention was appropriate for the student's educational needs was outside the scope of this study because the researcher analyzed quantitative student achievement data and intervention placement, including qualitative analysis.
4. Although the intervention tiers and the content areas were consistent throughout the target school district, schools have autonomy in facilitating tiers. Because of variation in interventionists, the specific person who provided the intervention was not considered.

5. This study did not consider intervention intensity. Mellard et al. (2010) identified multiple variables that can intensify interventions (e.g., dosage, group size, instructor's expertise, and curricular goals). While any variables above may have impacted student learning, the purpose of this study was to examine the effects of the framework of interventions rather than the specifics of each intervention group. As such, the examination of each factor was beyond the scope of the present study. The data included overall scale scores; it did not examine raw scores for individual reporting categories within FSA ELA and FSA Mathematics. Previous researchers have explored the effect of interventions on curriculum-based measures, such as oral reading fluency (Burn et al., 2002). Like Balu et al. (2015), the researcher sought to understand the effects of interventions on generalized achievement measures.
6. The researcher did not consider any accommodations for FSA ELA or FSA Mathematics tests required by Individual Education Plans or Section 504 requirements.
7. Only those receiving Tier IV ESE services who took the Florida Standards Assessment for both reading and mathematics were included in the study.
8. The Spring 2020 FSA administration was canceled due to COVID-19 school closures (FDOE Press Office, 2020). Because of the unique circumstances of the 2020 school year, this study compared data from 2018 and 2019 because those are the most recent years student FSA data were available prior to publication.

While each of the above delimitations may have influenced the results, they are outside this particular study's scope.

Assumptions

The researcher used historical data to assign subjects to the intervention level; thus, the current study made the following assumptions.

1. The data collected was accurate.
2. Interventions were implemented as designed.
3. Schools accurately documented intervention start dates, end dates, and categories in the student information system (SIS).
4. School leaders and teachers understood what MTSS is and the critical factors for MTSS success. Specifically, the school leadership provided the resources and training necessary for teachers to implement universal screening. Teachers and school staff provided three tiers of increasingly intense, research-based interventions. Students participated in systematic progress monitoring, and the team engaged in data-based decision-making.
5. The FSA ELA and FSA Mathematics have been used to measure Florida's student achievement since 2015 (Florida Department of Education, 2018c). The test is a valid and reliable measure of student achievement on the grade-level standards (Florida Department of Education, 2018b). This study assumed that interventions would impact performance on grade-level content. Therefore, FSA was an indicator of the effect of an intervention.

6. The goal of the interventions was to improve student learning outcomes for struggling students (Fuchs et al., 2010). As such, higher tiers of intervention should increase the rate of change for struggling students.

Summary

The study sought to extend the existing research by examining how increasing intervention levels within the MTSS framework affected student achievement in ELA and mathematics. The research questions conformed to a causal-comparative design (Fraenkel et al., 2015), with the intervention type and level as independent variables. The FSA percentile rank changes for ELA and mathematics from 2018 to 2019 were the dependent variables. The proposed study utilized the change in percentile rather than the fourth-grade scale score to avoid selection bias as student scale scores are inversely related to their FSA achievement. The study's purposive sample was the students enrolled in fourth grade in one Florida district in the 2018-2019 school year. FSA for ELA and Mathematics was used to measure the dependent variable. The FSA's reliability and validity measurements indicate it is a valid and reliable measure of student achievement in Florida. After IRB and school district approval, de-identified student data were collected and stored on a secure server. The research questions and design indicated using an ANOVA for Research Questions 1 and 2 and factorial ANOVAs for each demographic category in Research Question 3. The results of the SPSS analysis appear in the next chapter.

CHAPTER FOUR: RESULTS

Introduction

This causal-comparative study examined the effects of tiered interventions within the MTSS framework on one intermediate grade. Using quantitative analysis, the researcher explored how hierarchical tiers of academic or behavioral interventions affected general student achievement measures. The purpose of this study was to address a gap in the literature related to how increasingly intensive interventions differ in their effect on student achievement when enacted in an intermediate grade in a natural school setting. This chapter includes a description of the demographic characteristics of the populations and a data analysis results of the three research questions:

1. What are the differences between intervention levels (Tier I, II, III, or IV) and student English language arts achievement (FSA ELA)?
2. What are the differences between intervention levels (Tier I, II, III, or IV) and mathematics achievement (FSA Mathematics Scores)?
3. Do student characteristics moderate any differences between intervention levels (Tier I, II, III, or IV) and student achievement (FSA ELA and FSA Mathematics)?

The results of each research question are broken down by achievement area, then by the subject of the intervention: reading, mathematics, or behavior. Throughout this chapter, ESE services were referred to as Tier IV. Although not called Tier IV in Florida, other models use Tier IV to refer to those students needing ESE services because of inadequate responses to Tier I, II, and III (Burns & Yesseldyke, 2005). As ESE Services in Florida include accommodations and resources not available to general education students in Tier I, II, or III, these services constitute an increase in intervention intensity.

Population Demographics

The state of Florida requires all public-school students to participate in statewide standardized assessments (Gaitanis, 2017). A preponderance of students participates in the Florida Standards Assessment; however, some students with significant cognitive disabilities may participate in the Florida Standards Alternate Assessment instead of the Florida Standards Assessment (Gaitanis, 2017). Of the 3977 students enrolled in fourth grade in the target district in 2019, 101 students participated in the Florida Standards Alternate Assessment. Students receiving ESE services who took the alternative assessment were excluded from the analysis, reducing the percent of the population in Tier IV from 15% to 12%. Of the 3,876 students analyzed, 49% were female, 51% were male. When organizing students by *Every Student Succeeds Act* subgroup standards, the population's racial makeup was 2% Asian, 11% Black, 61% Hispanic, less than 1% Indian / Native American, 2% Mixed, less than 1% Pacific Islander, and 24% White. Fifty-eight percent of the students qualified as economically disadvantaged.

In 2018, the mean FSA ELA scale score for the target district was 299 (n = 3529); in 2019, it was 309 (n = 3788). The state minimum scale score for FSA ELA proficiency in fourth grade in 2019 was 311 (Bureau of K-12 Student Assessment, 2018). The mean scale score in mathematics in 2018 was 297 (n = 3546), and in 2019 the mean scale score was 311 (n = 3804). The minimum score for proficiency in fourth-grade mathematics in 2019 was 310 (Bureau of K-

12 Student Assessment, 2018; Bureau of K-12 Student Assessment, 2017). Descriptive statistics for FSA ELA are reported in Table 6.

Table 6

FSA ELA Scale Scores 2018 and 2019

Year	*n*	*M*	*SD*	Minimum scale score for proficiency	Scale Score Min	FSA ELA Scale Score Max
2018	3529	299.45	21.56	300	240	360
2019	3788	309.27	21.49	311	251	372

As shown in Table 7, the mean scale score in mathematics in 2018 was 297 (n = 3546), and in 2019 the mean scale score was 311 (n = 3804). The minimum score for proficiency in fourth-grade mathematics in 2019 was 310 (Bureau of K-12 Student Assessment, 2017, 2018).

Table 7

FSA Mathematics Scale Scores 2018 and 2019

Year	*n*	*M*	*SD*	Minimum scale score for proficiency	FSA ELA Scale Score Min	FSA ELA Scale Score Max
2018	3546	297.32	21.23	300	240	360
2019	3804	311.87	23.20	310	251	376

For various reasons, including student mobility and student absences, not all students in the study had data for FSA ELA and FSA Mathematics in 2018 and 2019. Missing data were removed listwise, and numbers are reported in each test.

The student population was divided into four groups based on their highest reported level of intervention in reading, mathematics, or behavior. Of the 3876 students, 12% (n = 477) were eligible for Tier IV, ESE services. Because ESE primary exceptionality codes do not indicate whether students received services for reading or mathematics, or both, the sample that represents Tier IV is the same in reading and mathematics.

Reading

For reading interventions, Tier I comprised 40% (*n* = 1555) of students who did not have documentation of Tier II or Tier III interventions in reading during the 2018-2019 school year. Twenty-four percent (*n* = 932) of students reported receiving Tier II interventions in the 2018-2019 school year but were not reported as receiving Tier III interventions during that time. Tier III comprised 24% (*n* = 911) of students reported receiving Tier III interventions during the 2018-2019 school year. The percent of the student population in Tiers II and III was larger than the percentage expected in the conceptual model for MTSS. Table 8 includes a breakdown of demographic characteristics by intervention level.

Table 8

Demographics Breakdown by Reading Intervention Tier

Tier	Gender		Race							English Language Learner	Economically Disadvantaged	Number of Years Retained	
	Male	Female	Asian	Black	Hispanic	Indian/ Native American	Mixed	Pacific Islander	White	Yes	Yes	1	2
I	45%	56%	2.6%	9.5%	54.9%	0.2%	3.2%	0.3%	29%	26%	47.7%	9	0
II	50%	51%	2.0%	10.9%	65.3%	0.3%	2.3%	0.1%	19%	39%	61.7%	61	0
III	57%	43%	0.5%	13.1%	66.7%	0.2%	1.4%	0.2%	18%	53%	65.1%	125	1
IV	66%	34%	0.6%	10.3%	62.3%	0.2%	2.3%	0.4%	24%	47%	71.1%	134	0

Students were assigned tiers based on their level of academic need (Schulte, 2016), leading to selection bias in the scale scores based on students' intervention tier. The expectation is that each intervention tier would have a lower average score than the subsequent level. The data indicate that this pattern holds for Tier I and Tier II but is less consistent in Tier III and Tier IV (Table 9). The mean ELA scale score for Tier I reading was higher than all other tiers in 2018 and 2019. The mean Tier II reading FSA ELA scale score was higher than Tiers III and IV in 2018 and 2019. Tier III reading had higher mean scale scores in ELA in 2018 but not in 2019.

Table 9

4th Grade FSA ELA Scale Score 2018 and 2019 Mean Scale Scores

Tier	N		Mean		SD		Skewness		Kurtosis	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
I	1425	1519	314.8	325.49	15.719	14.024	-0.3	-0.706	1.263	3.884
II	883	918	299.7	310.63	13.702	11.317	-0.346	0.145	0.837	1.932
III	778	897	282.51	289.59	16.437	16.654	-0.250	-0.382	-0.059	0.247
IV	443	454	279.34	291.15	19.888	20.248	0.229	-0.159	-0.041	-0.357

To account for selection bias and because the third-grade FSA has a different scale than the fourth-grade FSA, percentile ranks were calculated each year. The annual change in percentile was used as a metric to determine how interventions may have affected academic achievement as measured by the FSA ELA assessment. The percentile change showed variance based on intervention level. A review of the data in Table 10 indicates Tier I reading had the highest mean increase in scale score rank in ELA, followed by Tier IV, then Tier II. Tier III had a mean decrease in percentile rank, indicating that Tier III's mean percentile rank was lower in 2019 than in 2018. Mean percentile change is represented by the symbol MP_i, the standard deviation of the mean percentile is represented by $SD\ P_i$.

Table 10

Change in FSA ELA Percentile by Reading Intervention Tier

Tier	***n***	MP_i	$SD\ P_i$	**Skewness**	**Kurtosis**
I	1406	2.88	16.19	0.315	1.431
II	872	0.42	19.34	0.122	-0.181
III	767	-1.75	17.24	-0.086	1.275
IV	426	1.94	16.68	0.244	1.500

Because other researchers (Kiss & Christ, 2019) have explored the link between mathematics achievement and reading achievement, this study also compared effects across intervention subject areas. Table 11 shows the patterns for relative performance on FSA ELA for students in mathematics interventions in 2018 and 2019.

Table 11

FSA ELA Scale Scores by Mathematics Intervention

Tier	*n*		*M*		*SD*		Skewness		Kurtosis	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
I	2235	2422	307.04	316.56	19.06	19.12	-.385	-.699	.516	1.122
II	567	596	292.24	301.90	17.38	18.10	-.514	.138	.328	.704
III	284	316	285.56	293.36	17.90	17.14	-.165	-.492	-.113	.113
IV	443	454	279.34	291.15	19.89	20.25	.229	-.159	.041	-.357

The mean changes in FSA ELA percentile rank by mathematics intervention tier followed the same pattern as the FSA Mathematics changes. However, the Tier III and Tier IV range is less for FSA ELA than FSA Mathematics (Table 12).

Table 12

Mean Change in FSA ELA Percentile by Mathematics Intervention

Tier	*n*	*M* P_i%	*SD* P_i%	Skewness	Kurtosis
I	2208	1.45	17.37	.150	0.910
II	558	0.68	18.24	-.514	0.704
III	279	-1.84	16.84	-.241	0.705
IV	426	1.94	16.68	.244	1.500

Mathematics

As indicated in Chapter Three, students were re-coded according to their highest reported intervention in mathematics. Tier I represented 63.6% (*n* = 2466) of students, Tier II represented 15.7% (*n* = 610) of students, Tier III represented 8.3% (*n* = 322), and Tier IV represented 12.3% (*n* = 477) of students who were eligible for ESE services. The proportions of the population in Tiers I, II, and III for math are relatively close to those proposed in the conceptual model for MTSS. Table 13 provides a breakdown of demographic characteristics by intervention level. Given the small number of students in some demographic categories, some of those categories had zero students at the more intensive levels of mathematics intervention. As mathematics interventions increased in intensity, the demographic data showed that the percent of the population that was male, Black, Hispanic, English language learner, and economically disadvantaged increased.

Table 13

Demographics Breakdown by Mathematics Intervention

Tier	Gender		Race							English Language Learner	Economically Disadvantaged	Years Retained	
	Male	**Female**	**Asian**	**Black**	**Hispanic**	**Indian/ Native American**	**Mixed**	**Pacific Islander**	**White**	**Yes**	**Yes**	**1**	**2**
I	49%	51%	2.4%	9.2%	59.8%	0.3%	2.5%	0.3%	25.5%	34.3%	53%	110	1
II	52%	48%	0.7%	13.9%	64.9%	0%	2.6%	0%	17.9%	42.5%	64%	58	0
III	48%	52%	0.3%	18%	62.1%	0.3%	1.6%	0%	17.7%	42.9%	66%	27	1
IV	66%	34%	0.6%	10.3%	62.3%	0.2%	2.3%	0.4%	23.9%	46.8%	71%	134	0

Statistical data of FSA Mathematics scale scores appear in Table 14. In 2018, students in increasingly intensive mathematics tiers scored lower than those in less intensive tiers. In 2019, Tier III had the lowest mean score amongst the tiers. The mean score for Tier IV was higher than Tier III but lower than Tiers I and II.

Table 14

4th Grade FSA Mathematics Scale Score 2018 and 2019 Mean Scale Scores

Tier	*n*		*M*		*SD*		Skewness		Kurtosis	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
I	2245	2426	305.65	320.84	17.98	19.93	0.025	-0.223	0.913	0.700
II	570	599	289.02	302.27	15.95	17.51	-0.284	-0.316	0.997	1.385
III	286	318	279.96	288.41	15.52	15.22	-0.525	-0.508	0.533	0.438
IV	445	461	277.07	293.30	20.94	22.99	-0.084	-0.113	-0.422	-0.474

The change in percentile rank showed variance based on intervention level. Tier IV reading had the highest mean increase in scale score percentile rank in mathematics, followed by Tier I, then Tier II. Tier III had a mean decrease in percentile rank in mathematics (Table 15).

Table 15

FSA Mathematics Change in Percentile by Mathematics Intervention Tier

Tier	*n*	*M* P_i%	*SD* P_i%	Skewness	Kurtosis
I	2219	1.1	16.72	.287	0.967
II	563	0.69	16.28	.167	0.483
III	283	-4.59	15.05	-.566	1.557
IV	434	4.31	16.31	.788	1.965

The extent to which ELA interventions may have impacted mathematics achievement was also analyzed. Performance patterns held for FSA Mathematics scale score means across all reading tiers in 2018 and 2019. As one would expect, increased intensity in reading interventions was associated with lower mean scaled scores in mathematics (Table 16).

Table 16

4th Grade FSA Mathematics Scale Score 2018 and 2019 Mean Scale Scores

Tier	*n*		*M*		*SD*		Skewness		Kurtosis	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
I	1429	1522	310.65	326.79	17.081	18.428	0.132	-0.190	1.016	0.696
II	884	918	297.62	311.68	14.72	16.088	0.032	0.163	1.019	1.016
III	788	903	284.25	296.40	16.87	19.32	-0.303	-0.177	0.369	0.391
IV	445	461	277.07	293.30	20.936	22.993	-0.084	-0.113	-0.422	-0.474

The change in percentile ranks indicated variance based on intervention level, similar to the changes in percentile rank by mathematics intervention. Tier IV reading had the highest mean increase in scale score percentile in mathematics, followed by Tier I, then Tier III. Tier II had a mean percentile decrease. Whereas mathematics interventions showed a negative change in mathematics percentile at Tier III, students receiving Tier III reading interventions saw a mean increase in mathematics percentile rank. In contrast, those in Tier II reading interventions saw a small mean decrease in mathematics percentile rank (Table 17).

Table 17

FSA Mathematics Change in Percentile by Reading Intervention Tier

Tier	*n*	*M* P_i	*SD* P_i	Skewness	Kurtosis
I	1411	1.27	16.01	.244	1.430
II	873	-0.84	17.22	.086	0.131
III	781	0.60	16.76	.377	0.087
IV	434	4.31	16.31	.788	1.965

Behavior

Behavior interventions were analyzed to determine the effect on both FSA ELA and FSA Mathematics percentile ranks change. Tier I contained 94% (n = 3645) of students, Tier II contained 4.9% (n =191) of students, Tier III contained 0.4% (n = 16), Tier IV contained 0.6% (n = 23) of the population of students. The percentage of Tier II and III students was considerably less than that proposed in the conceptual MTSS framework. Table 18 includes a breakdown of demographic characteristics by intervention level. Given the relatively small number of students in particular race categories, some demographic categories had zero students at higher intervention levels.

Table 18

Demographics Breakdown by Behavior Intervention Tier

	Gender		Race							English Language Learner	Economically Disadvantaged	Number Retained	
Tier	**Male**	**Female**	**Asian**	**Black**	**Hispanic**	**Indian/ Native American**	**Mixed**	**Pacific Islander**	**White**	**Yes**	**Yes**	**1**	**2**
I	50%	50%	1.8%	10%	62%	0.2%	2.3%	0.2%	23.7%	38%	57%	290	0
II	73%	27%	0%	19%	53%	0%	4.7%	0.5%	21.5%	31%	70%	32	1
III	88%	13%	6.3%	25%	50%	0%	12.5%	0%	6.3%	19%	63%	4	0
IV	83%	17%	0%	26%	57%	0%	0%	0%	17.4%	48%	70%	3	0

For behavior, Tier I included higher mean scores than all other tiers in 2018 and 2019. Although Tier II and Tier IV had very similar mean scores in 2018, Tier II had a higher mean score in 2019 than Tier IV. Tier III had a higher mean score in 2018 and 2019 than Tier II or Tier IV. Interestingly, Tier IV had a larger change in the variance of percentile than the other intervention levels. While Tiers I, II, and III showed less than one scale score point change in the standard deviations between 2018 and 2019, Tier IV changed from 24.10 scale score points within one standard deviation in 2018 to 16.67 scale score points. More interestingly, the number of Tier IV students for behavior did not change, so the decrease in variance is not likely due to a change in the Tier IV population.

Table 19

4th Grade FSA ELA Scale Score 2018 and 2019 Mean Scale Scores by Behavior Intervention Tier

Tier	***n***		***M***		***SD***		**Skewness**		**Kurtosis**	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
I	3316	3573	300.02	309.9	21.44	21.35	-0.300	-0.498	0.002	0.275
II	176	180	290.43	298.60	21.34	21.32	0.095	-0.233	0.177	-0.226
III	15	13	293.00	305.38	23.57	23.61	0.346	0.226	-1.520	-1.225
IV	22	22	290.82	296.95	24.10	16.67	0.480	0.038	-0.944	-1.132

Table 20 reveals that the percentile change varied by intervention level. Regarding behavior interventions, Tier III had the greatest mean change in percentile, while Tiers II and IV reported negative changes in mean FSA ELA percentile.

Table 20

Change in FSA ELA Percentile by Behavior Intervention Tier

Tier	N	$M\ P_i\%$	$SD\ P_i\%$	Skewness	Kurtosis
I	3270	1.28	17.14	0.160	0.873
II	168	-1.49	21.02	0.027	0.373
III	12	9.78	19.19	1.425	2.788
IV	21	-7.70	21.74	-0.738	1.220

In Table 21, the patterns in math scale scores for behavior tiers are similar to ELA patterns. Tier I showed the highest mean scale score in 2018 and 2019, followed by Tier III, then Tier II, and finally Tier IV.

Table 21

4th Grade FSA Mathematics Scale Score 2018 and 2019 Mean Scale Scores

Tier	*n*		*M*		*SD*		Skewness		Kurtosis	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
I	3331	3582	297.98	312.53	21.05	23.06	-0.200	-0.238	0.562	0.257
II	177	183	287.62	300.90	21.46	22.58	0.163	0.093	0.573	-0.188
III	15	16	291.00	311.56	20.23	21.81	-0.209	-0.527	-0.374	-0.649
IV	23	23	280.48	296.96	21.97	25.89	0.000	0.569	-0.386	0.180

The change in percentile for mathematics displayed variance based on intervention level (Table 22). Tier III had the greatest mean change in percentile rank in mathematics, followed by Tier IV, then Tier I, and finally Tier II.

Table 22

Change in FSA Mathematics Percentile by Behavior Intervention Tier

Tier	***n***	***M*** P_i**%**	***SD*** P_i**%**	**Skewness**	**Kurtosis**
I	3289	0.92	16.56	0.262	1.018
II	172	0.71	16.33	0.193	2.176
III	15	11.93	24.50	1.519	1.987
IV	23	2.42	14.49	0.105	-0.109

Across intervention subject areas, a G*Power analysis (Appendix D) showed that the population size was large enough, > 1724, to identify small effects.

Assumptions

The ANOVA is an omnibus test of differences between means between multiple groups (Steinberg, 2011). ANOVA has six assumptions (Laerd, 2017). The first three assumptions were satisfied by the study design: continuous dependent variable, one independent categorical variable with two or more groups, and independence of observations. The remaining statistical assumptions were tested and reported for changes to percentile rank for each intervention subject area: reading, mathematics, and behavior.

For reading tiers, an analysis of box plots revealed there were outliers at every intervention level. Also, these outliers were genuinely unusual values; therefore, the data points remained, and the analysis continued. Change in percentile rank was only normally distributed for Tier II ($p = .281$); none of the other tiers were normally distributed as indicated by Shapiro-Wilk's test ($p < .0005$). The assumption of homogeneity of variance was violated for Levene's test of equality of variances ($p < .0005$).

The assumptions were also tested for the change in percentile ranks for mathematics tiers. Box plots revealed there were outliers at every intervention level. These outliers were genuinely unusual values, and data points were retained for analysis as with reading interventions. Change in percentile rank was only normally distributed for Tier II ($p = .050$). Tiers I, III, and IV were not normally distributed as assessed by Shapiro-Wilk's test ($p < .05$). The assumption of homogeneity of variance was violated for Levene's test of equality of variances. ($p <.05$) for FSA ELA percentile change but not for FSA Mathematics percentile change.

Box plots for behavior tiers were less straightforward. Tier I had several outliers both above and below the mean. Tier II had three outliers, and Tier III had one outlier. Tier IV had no outliers. Given the small number of students in Tiers III and IV for behavior, the lack of outliers compared to Tier I was unexpected. Because the outliers resulted from genuinely unusual values, the data points were retained, and the analysis proceeded. As assessed by Shapiro-Wilk's test, change in percentile rank was normally distributed for Tier II ($p = .240$), Tier III ($p = .110$), and Tier IV ($p = .487$). Tier I was not normally distributed ($p < .0005$). Like mathematics interventions, the assumption of homogeneity of variance was violated for Levene's test of equality of variances. ($p = .004$) for FSA ELA but not for FSA Mathematics. Because the

ANOVA is responsive to outliers and violations of normality, the analysis continued using the Welch ANOVA to account for the violation of homogeneity of variances (Laerd Statistics, 2017). When the assumption of violation of homogeneity of variances was valid, the ANOVA statistic and Tukey post hoc test were used to determine statistically significant differences (Steinberg, 2011).

Research Question 1

Research Question 1 asked, "What Are the Differences Between Intervention Levels (Tier I, II, III, or IV) and Student English Language Arts Achievement (FSA ELA)?" Each intervention type was analyzed separately to explore how reading, mathematics, and behavior interventions might have impacted change in FSA ELA achievement.

Reading Interventions

As previously indicated, the data failed to meet the statistical assumptions, although the research design did meet the statistical assumptions of an ANOVA. The analysis continued because the ANOVA is robust to violations. As shown in Table 23, there were differences in FSA ELA percentile change between intervention tiers.

Table 23

Table of Mean and Median FSA ELA Percentile Change by Reading Intervention Tier

Tier	n	$Mdn\ P_i\%$	$M\ P_i\%$	$SD\ P_i\%$
I	1406	1.70	2.88*	16.19
II	872	0.50	0.42	19.34
III	767	-0.90	-1.75*	17.24
IV	426	0.50	1.94	16.68

*Indicates statistical significance.

The ELA percentile change was statistically significant for different reading intervention tiers, $F(3, 1416) = 13.234$, $p < .0005$, partial $\eta^2 = .011$ (a small effect). The Games-Howell post hoc test was used to interpret the ANOVA results (Laerd, 2017). The percentile change in Tier I was statistically significant when compared to the mean percentile change in Tier II (2.46 percentile points 95% CI 0.44 percentile points to 4.47 percentile points, $p = .010$) and the mean percentile change in Tier III (4.63 percentile points 95% CI 2.68 percentile points to 6.57 percentile points, $p < .0005$). In Tier IV, there was a mean percentile change of 1.94; this change was statistically significantly different from Tier III (3.69 percentile points 95% CI 1.06 percentile points to 6.31 percentile points, $p = .002$).

Because the assumptions of the ANOVA were not met, a Kruskal-Wallis *H* test was conducted to corroborate the differences in percentile rank changes in ELA between reading tiers. Based on a visual inspection of Figure 7, percentile changes' distributions were similar because most scores fall ± 50 percentile points. Median percentile changes were statistically significant between groups ($H(3) = 34.265$, $p < .0005$).

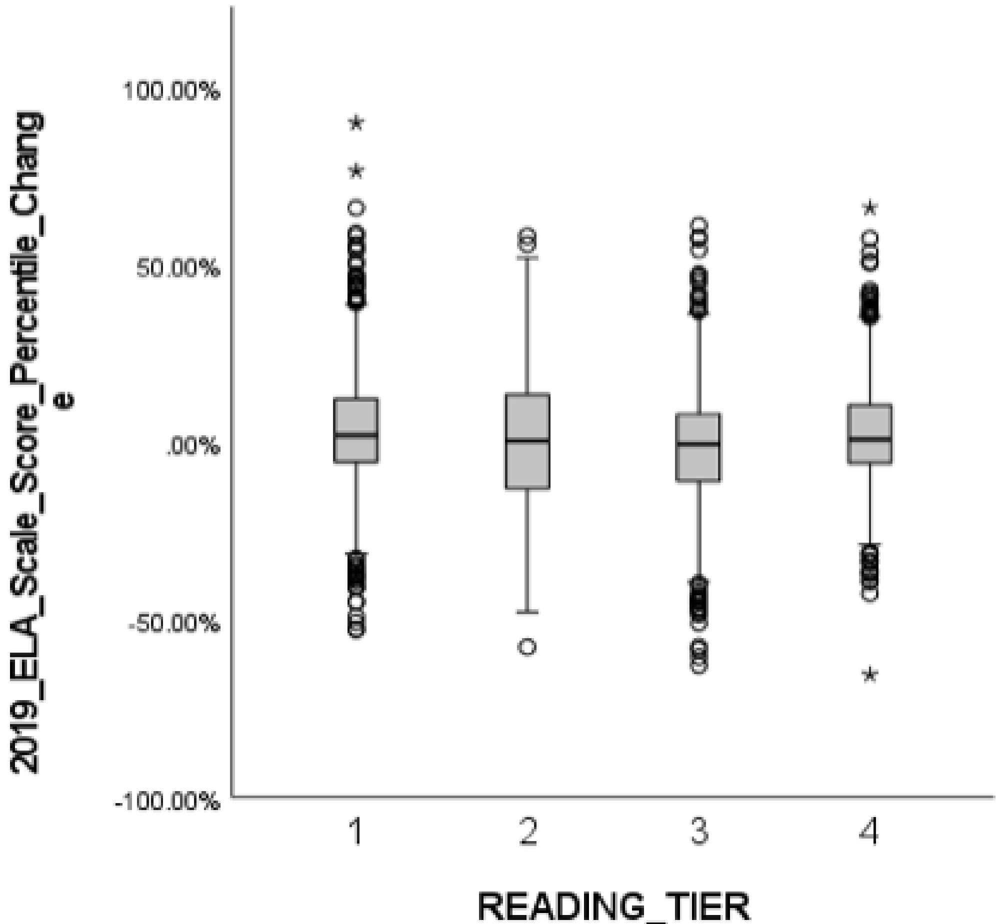


Figure 7. Box Plot of ELA Percentile Change by Reading Tier.

Pairwise comparisons of reading tiers were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. A post hoc analysis of the data showed statistically significant differences across medians between Tier III (-0.90) and Tier IV (0.50) (*p* = 010), Tier III and Tier I (1.70, *p* < .0005), and Tier II (0.05) and Tier I (*p* = .005). These statistically significant differences were like those found with the Game-Howell post hoc tests for the Welch ANOVA.

Mathematics Interventions

An analysis of the differences between mean FSA ELA percentile change based on mathematics intervention tier indicated some smaller differences than reading interventions. The differences in mean percentile change between tiers (Table 24) were similar to the pattern of the reading interventions.

Table 24

Table of Mean and Median FSA ELA Percentile Change by Mathematics Tier

Tier	*n*	Mdn P_i%	M P_i%	SD P_i%
I	2208	1.00	1.45	17.37
II	558	0.10	0.68	18.24
III	279	-1.00	-1.84*	16.84
IV	426	0.50	1.94	16.68

*Indicates statistical significance.

The mean ELA percentile change between mathematics tiers was significantly different [Welch's $F(3, 813.329) = 3.590$, $p = 0.013$, partial $\eta^2 = .003$; a small effect]. Using the Games-Howell post-hoc test, the mean FSA ELA percentile change compared by mathematics tiers showed significant differences between Tiers I and III (3.29 percentile points; 95% CI 0.52 percentile points to 6.06 percentile points, $p = 0.012$) and between Tiers III and IV (-3.78 95% CI -7.11 percentile points to -0.45 percentile points, $p = .019$). Because the ANOVA assumptions were not met, a Kruskal-Wallis H test was run to confirm the differences in percentile rank changes in FSA ELA between mathematics tiers. Based on a visual inspection of Figure 8, percentile rank changes' distributions were similar because median percentiles were approximately zero across tiers. Median percentile rank changes were statistically significant between groups [$H(3) = 8.772$, $p < .032$]. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. Post hoc data analysis showed statistically significant differences between Tier III (*Mdn* = -1.0%) and Tier I (*Mdn* = 1.0%), $p = .038$. The ANOVA post hoc analysis found Tier III to be statistically significantly different from Tier IV; the Kruskal-Wallis post hoc test did not find Tier III and Tier IV to be statistically significantly different.

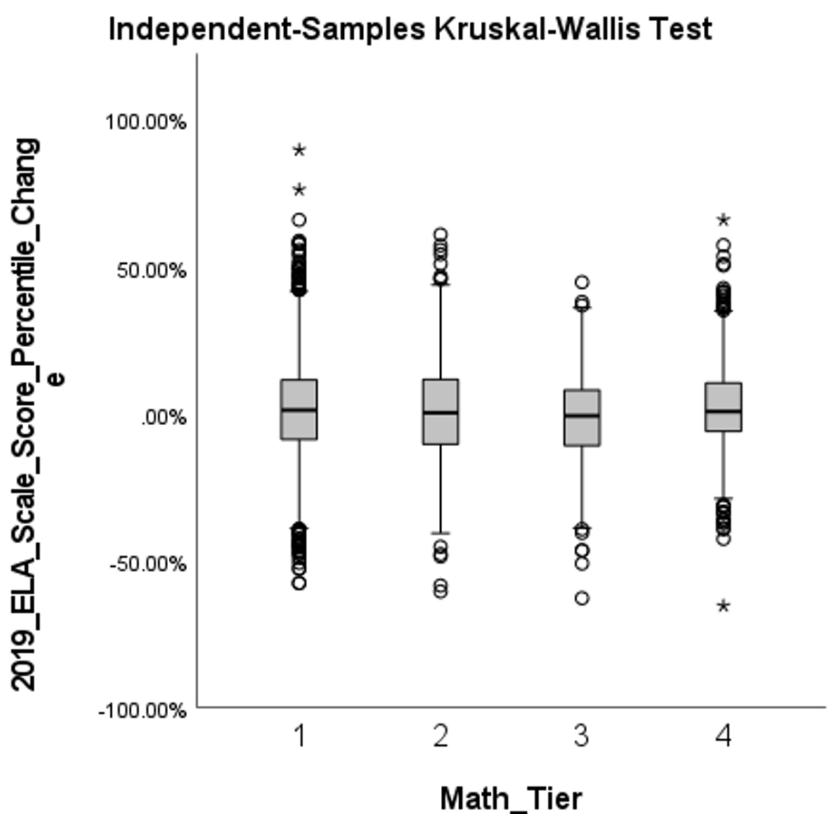


Figure 8. Box Plot of ELA Percentile Change by Mathematics Tier.

Behavior Interventions

The difference in mean percentile change in FSA ELA was also analyzed by behavior intervention tier. Although there was a sizable range in the change in percentile (Table 25), the ELA percentile change for behavior tiers was not statistically significant [Welch's F(3, 34.336) = 2.807, p = .054, partial η^2 = .004; a small effect].

Table 25

Table of Mean and Median FSA ELA Percentile Change by Behavior Tier

Tier	n	$Mdn\ P_i$	$M\ P_i$	$SD\ P_i$
I	3270	0.70	1.28	17.14
II	168	-0.90	-1.49	21.02
III	12	6.25	9.78	19.19
IV	21	-2.80	-7.70	21.74

Analysis of Games-Howell post hoc tests did not show statistically significant differences between groups. This lack of statistical significance was likely because of the smaller population sizes in Tiers III and IV.

Because the ANOVA assumptions were not met, a Kruskal-Wallis H test was run to determine if there were differences in percentile rank changes in ELA between reading tiers. Based on a visual inspection of Figure 9, the distributions of percentile rank changes were not similar. Median percentile rank changes were statistically significant between groups [H(3) = 8.892, p = .031]. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. The post hoc analysis showed statistically significant differences between medians for Tier III (Mdn percentile points change = 6.25) and Tier IV (Mdn percentile points change = -2.80, p = .027).

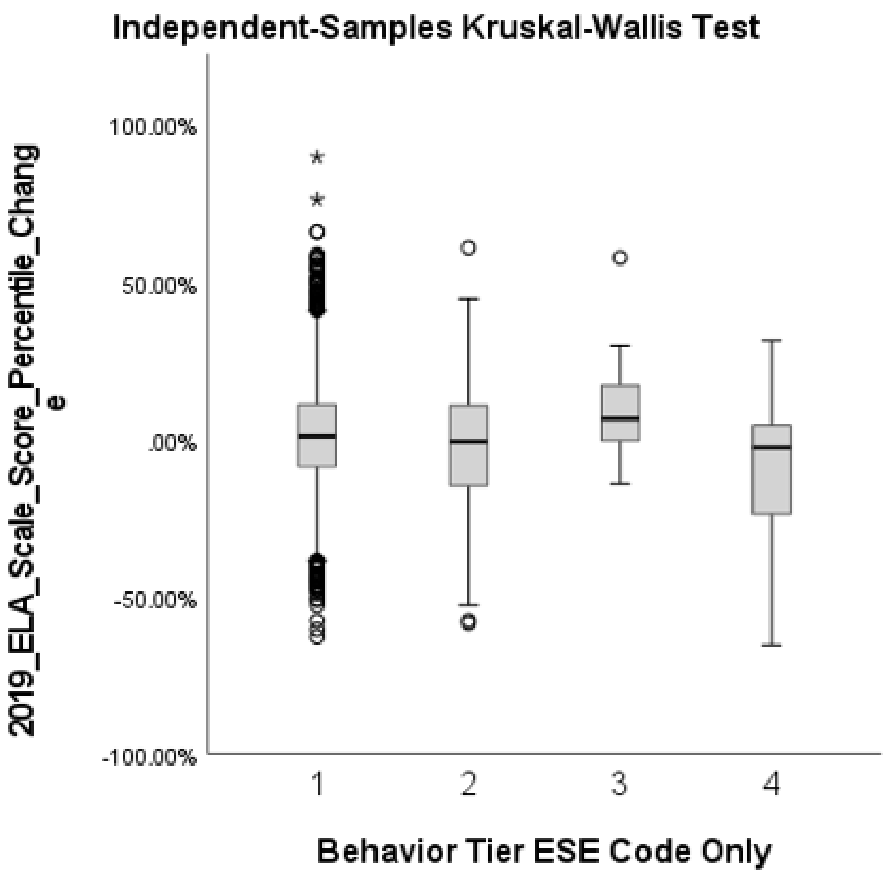


Figure 9. Box Plot of FSA ELA Percentile Change by Behavior Tier.

The analysis revealed different changes in percentile for reading and mathematics interventions. Although Tier I continued to show a positive change in percentile, Tier III for behavior showed the greatest positive change. Unlike reading and mathematics interventions, Tier II and Tier IV for behavior showed a mean negative change in FSA ELA percentile; Tier IV results revealed a statistically significant decrease compared to Tier III.

Section Summary

The hypothesis for Research Question 1 was:

H_1 There are differences between intervention levels and student English language arts achievement.

H_0 There are no differences between intervention levels and student English language arts achievement.

The null hypothesis is rejected because there were statistically significant differences between intervention tiers for reading, mathematics, and behavior. Table 26 includes a summary of the effects of tiered interventions on FSA ELA percentile. Tier III was statistically significantly different for both reading and mathematics Tier III intervention students.

Table 26

Mean Change in FSA ELA Percentile from 2018 to 2019 by Intervention Tier

Intervention Tier	Reading Interventions Mean Percentile Change	Math Interventions Mean Percentile Change	Behavior Interventions Mean Percentile Change
I	2.88*	1.45	1.28
II	0.42	0.68	-1.49
III	-1.75*	-1.84*	9.78
IV	1.94	1.94	-7.70

*Indicates statistical significance.

The Tier III negative change in FSA ELA percentile from 2018 to 2019 is potentially problematic since increasingly intensive interventions aim to increase the rate of change for struggling students. Similarly, the statistically significant differences for behavior interventions were between the large positive change in median percentile rank in Tier III and the large negative median percentile rank change in Tier IV. The implications of the negative changes will be explored further in Chapter Five.

Research Question 2

The analysis for Research Question 2 sought to answer "What Are the Differences Between Intervention Levels (Tier I, II, III, or IV) and Student mathematics Achievement (FSA Mathematics)?" Each intervention subject: reading, mathematics, and behavior was analyzed separately to determine how interventions might have impacted FSA Mathematics achievement.

Reading Interventions

The change in FSA Mathematics percentile rank was analyzed by reading tier to determine differences between tiers. As with the analysis of FSA ELA achievement, the analysis for FSA Mathematics continued with the Welch ANOVA to account for the violation in the homogeneity of variances. The mean change in FSA Mathematics percentile did vary by reading intervention tier (Table 27).

Table 27

Table of Mean and Median FSA Mathematics Percentile Change by Reading Tier

Tier	*n*	*Mdn* P_i%	*M* P_i%	*SD* P_i%
I	1411	0.10	1.27*	16.01
II	873	-1.40	-0.84	17.22
III	781	-0.40	0.60	16.76
IV	434	2.15	4.31*	16.31

*Indicates statistical significance.

The FSA Mathematics percentile change by reading tiers was statistically significant [$F(3, 1444.256) = 9.566$, $p < .0005$, partial $\eta^2 = .008$; a small effect]. The Games-Howell post hoc test analysis showed the following differences were statistically significant: Tier I and Tier II [2.11 percentile points (95% CI: 0.25 percentile points to 3.96 percentile points), $p = .019$], Tier I and Tier IV [-3.05 percentile points (95% CI -5.34 percentile points to -0.75 percentile points), $p = .004$], Tier II and Tier IV [-5.15 percentile points (95% CI -7.66 percentile points to -2.64 percentile points), $p < .0005$], and Tier III and Tier IV [-3.72 percentile points (95% CI -6.26 percentile points to -1.18 percentile points), $p = .001$]. Because the ANOVA assumptions were not met, a Kruskal-Wallis *H* test was conducted to determine if there were differences in percentile rank changes in mathematics between reading tiers. Based on a visual inspection of Figure 10, percentile changes' distributions were similar because the medians fall at approximately zero across tiers.

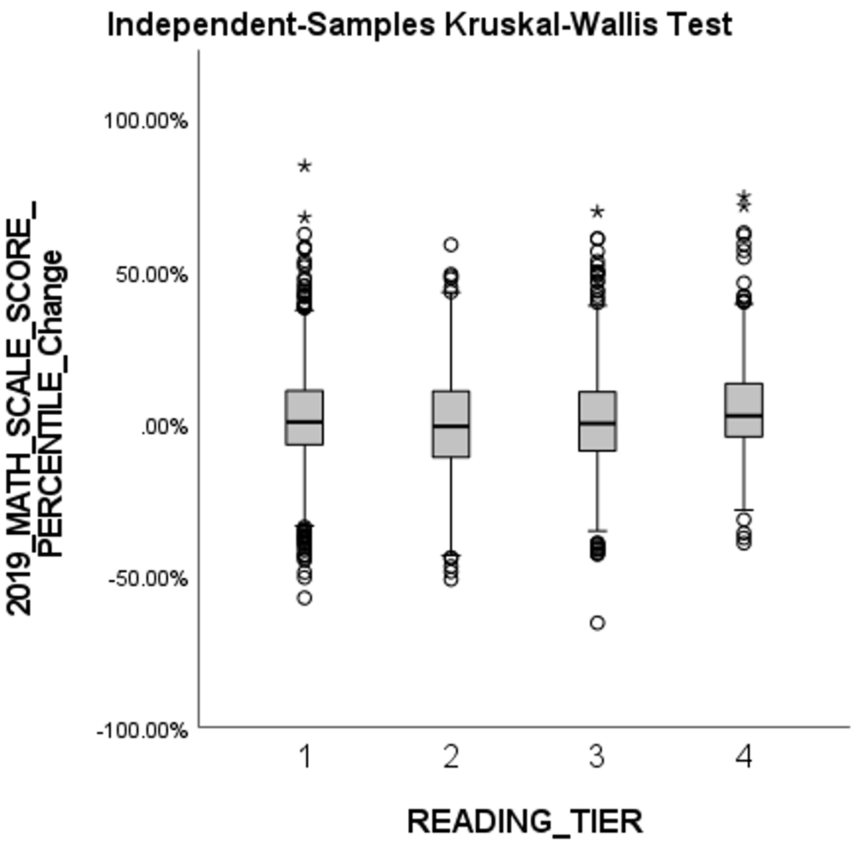


Figure 10. Box Plot of FSA Mathematics Percentile Change By Reading Tier.

Median percentile rank changes were statistically significant between groups [$H(3) = 26.623$, $p < .0005$]. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. The review of post hoc test results showed statistically significant differences in medians between Tier II and Tier I ($p = .003$), Tier II and Tier IV ($p < .0005$), Tier III and Tier IV ($p < .0005$), and Tier I and Tier IV ($p = .003$). Tier IV reading interventions were associated with statistically significant increases in FSA Mathematics percentile, while Tier II reading interventions were associated with statistically significant decreases in FSA Mathematics percentile. The Kruskal-Wallis test found the same statistically significant differences as the ANOVA.

Mathematics Interventions

Mathematics intervention tiers were analyzed to determine whether they were associated with changes in FSA Mathematics percentile. Change in FSA Mathematics percentile did show homogeneity of variance as assessed by Levene's test of equality of variances (p = .335) by mathematics intervention tiers. Because there was homogeneity of variance, the ANOVA statistic was reported, and the Tukey HSD post hoc analysis was used. Tier IV had the greatest change, followed by Tier I, then Tier II. Tier III showed a mean decrease in percentile change (Table 28).

Table 28

Table of Mean and Median Mathematics Percentile Change by Mathematics Tier

Tier	*n*	Mdn P_i%	M P_i%	SD P_i%
I	2219	0.00	1.10	16.73
II	563	-0.10	0.69	16.28
III	283	-2.40	-4.59*	15.05
IV	434	2.15	4.31*	16.31

*Indicates statistical significance.

Changes in mathematics percentile were statistically significant for different mathematics intervention levels [$F(3, 3467) = 3.402$, $p = .017$, partial $\eta^2 = .014$; a small effect]. Tukey HSD post hoc test analysis showed the difference between Tier I and Tier III of 5.69 percentile points (95% CI, 3.02 percentile points to 8.36 percentile points) was statistically significant ($p < .0005$). Tier IV and Tier I showed a difference of 3.22 percentile points (95% CI, .099 percentile points to 5.44 percentile points), which was statistically significant ($p = .001$). Tier II and Tier III results revealed a difference of 5.28 percentile points (95% CI, 2.19 percentile points to 8.37 percentile points) that was statistically significant ($p < .0005$). Tier IV and Tier III also showed a statistically significant difference of 8.91 percentile points [(95% CI, 5.67 percentile points to 12.14 percentile points), $p < .0005$].

Because all the ANOVA assumptions were not met, a Kruskal-Wallis *H* test was run to corroborate the differences in percentile rank changes in FSA Mathematics between mathematics tiers. Based on a visual inspection of Figure 11, percentile changes' distributions were similar; the medians fall at approximately zero across tiers.

Median percentile changes were statistically significant between groups [$H(3) = 40.563$, $p < .0005$]. Pairwise comparisons were performed using Dunn’s (1964) procedure with a Bonferroni correction for multiple comparisons. The post hoc test analysis revealed statistically significant medians between Tier III and Tier II ($p = .027$), Tier III and Tier I ($p = .002$), and Tier III and Tier IV ($p < .0005$). The analysis of the Kruskal-Wallis post hoc test confirmed the results of the ANOVA.

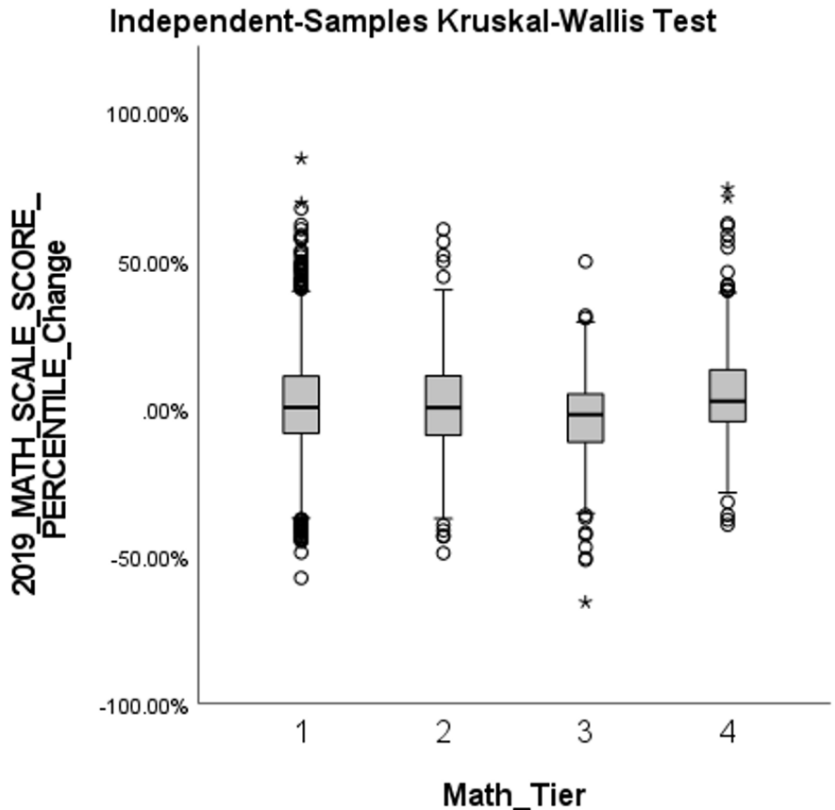


Figure 11. Box Plot of FSA Mathematics Percentile Change by Mathematics Tier.

Behavior

The relationship between behavior intervention tiers and FSA Mathematics achievement was analyzed to determine differences in percentile change between tiers. As with mathematics interventions, the assumption of homogeneity of variance was not violated for Levene's test of equality of variances (p = .335). Because the assumption was not violated, the ANOVA statistic and Tukey post hoc test were used to analyze the data.

The FSA Mathematics percentile change was not significant [$F(3,3495) = 2.266$, $p = 0.079$ partial $\eta^2 = .002$; a small effect]. Table 29 displays a sizable difference between means, particularly Tier III; however, Tier III's standard deviation was much larger than all other tiers.

Table 29

Table of Mean and Median FSA Mathematics Percentile Change by Behavior Tier

Tier	***n***	**Mdn P_i%**	**M P_i%**	**SD P_i%**
I	3289	0.0	0.92	16.56%
II	172	-0.90	0.71	16.33%
III	15	6.25	11.93	24.50%
IV	23	-2.80	2.42	14.49%

*Indicates statistical significance.

Although the *F* statistic was not statistically significant, some pairwise comparisons approached significance. The difference between Tier III and Tier I [11.00 percentile points (95% CI -0.02 percentile points to 22.03 percentile points)] approached statistical significance ($p = .05$). The difference between Tier III and Tier II [11.22 percentile points (95% CI -0.25 percentile points to 22.68 percentile points), $p = .058$] also approached statistical significance.

Because the ANOVA assumptions were not met, a Kruskal-Wallis *H* test was conducted to confirm the results regarding percentile changes in FSA Mathematics between behavior tiers. Based on a visual inspection of Figure 12, changes in percentile rank distributions were similar because interquartile ranges fell ± 25%. Median percentile rank changes were not statistically significant between groups ($H(3) = 3.089$, $p < .378$.) The *H* test confirmed the results of the ANOVA.

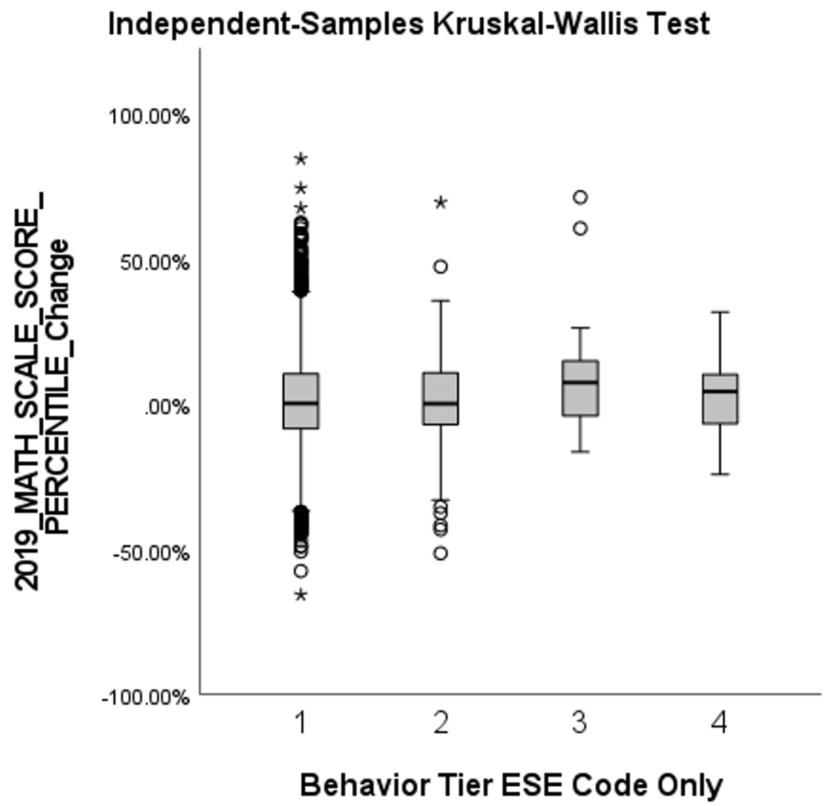


Figure 12. Box Plot of FSA Mathematics Percentile Change by Behavior Tier.

Although there were no statistically significant differences in FSA Mathematics percentile rank change between behavior tiers, the results indicate that Tier III behavior students may be improving their mathematics skills faster than Tier I. Tier III demonstrated a higher mean change than Tiers I, II, and IV. Tiers II and IV showed lower mean and median percentile changes than the mean and median percentile changes in Tier I.

Section Summary

The hypothesis for Research Question 2 was:

H_2 There are differences between intervention levels and mathematics achievement.

H_0 There are no differences between intervention levels and mathematics achievement.

The data showed statistically significant differences in FSA Mathematics percentile changes from 2018 to 2019 for reading interventions, mathematics interventions, and behavior interventions. Based on the analysis, the null hypothesis is rejected. Table 30 summarizes the mean changes in FSA Mathematics percentile by intervention subject and tier.

Table 30

Mean Change in Mathematics Percentile from 2018 to 2019

Intervention Tier	Reading Interventions Mean Percentile Change	Math Interventions Mean Percentile Change	Behavior Interventions Mean Percentile Change
I	1.27	1.10	0.92
II	-0.84*	0.69	0.71
III	0.60	-4.59*	11.93*
IV	4.31*	4.31*	2.42

*Indicates statistical significance.

As with Research Question 1, statistically significant differences resulted from a negative mean change in FSA Mathematics percentile. The results are potentially problematic because the goal of MTSS is to increase the rate of change. It is important to note that the Tier IV student population was the same for reading intervention and mathematics interventions but not for behavior interventions. Encouragingly, the Tier IV reading and mathematics group showed statistically significant positive differences, indicating that Tier IV students receiving ESE services may be improving more quickly than their peers.

Research Question 3

To answer Research Question three: "Do Student Characteristics Moderate Any Differences Between Intervention Levels (Tiers I, II, III, or IV) and Student Achievement (FSA ELA and FSA Mathematics Scores)?", this study explored the extent to which demographic variables moderated any differences between intervention tiers. The independent variables were reported intervention tiers for the 2018-2019 school year. The dependent variables were the change in FSA ELA or FSA Mathematics percentile rank from 2018 to 2019. The demographic moderators included: (a) gender, (b) race, (c) English language learner status, and (d) economically disadvantaged status. The categorical independent variables, categorical demographic factors, and scaled independent variables indicated a factorial ANOVA analysis was the appropriate statistical test (Hahs-Vaughn, 2017). The data were analyzed to determine whether they met the statistical assumptions of a factorial ANOVA. ANOVA Assumptions were tested for all intervention subjects: mathematics, reading, and behavior. As with Research Questions 1 and 2, the data were found to have outliers that were reviewed, determined to be genuinely unusual variables, and retained for analysis. As such, the outliers remained in the data set. Data were not normally distributed across tiers, as assessed by Shapiro-Wilk's test ($p > .05$). The assumption of homogeneity of variance was violated as assessed by Levene's test for equality of variance ($p < .0005$). Because the factorial ANOVA is responsive to violations, the analysis continued for gender and behavior interventions' impact on reading achievement.

Gender

ELA Achievement

There was a statistically significant interaction between gender and reading intervention level on change in ELA percentile [$F(3, 3463) = 3.933$, $p = .008$, partial $\eta^2 = .003$; a small effect]. The mean change in ELA percentile varied by gender and intervention tier (Table 31).

Table 31

Change in FSA ELA Percentile Rank by Reading Tier by Gender

Tier	Gender	*n*	M P_i%	SD P_i%	LL P_i%	UL P_i%
I	Female	781	2.89	15.91	1.682	4.104
	Male	625	2.86	16.53	1.504	4.212
II	Female	438	2.01*	19.49	0.389	3.623
	Male	434	-1.18*	19.07	-2.803	0.446
III	Female	331	1.20*	16.51	-0.661	3.059
	Male	436	-3.99*	17.47	-5.607	-2.366
IV	Female	146	3.40	18.39	0.599	6.201
	Male	280	1.18	15.69	-0.845	3.200

*Indicates statistical significance.

A factorial analysis of main effects showed the difference between females and males in Tier II [3.18 percentile points change (95% CI .892 percentile points to 5.477 percentile points)] was statistically significant ($p = .006$). The difference between females and males in Tier III [5.19 percentile points change (95% CI 2.718 percentile points to 7.653 percentile points)] was also statistically significant ($p < .0005$). Finally, the differences between means by tier for females were not statistically significant ($p > .05$).

There was a statistically significant interaction between intervention level and gender regarding change in ELA percentile for male students [$F(3, 3463) = 14.561$ $p < .0005$, partial η^2

= .012; a small effect]. For male students, Tier I was statistically significantly different from Tier II [4.04% (95% CI 1.190 to 6.884), $p = .001$] and Tier III [6.85% (95% CI 4.001 to 9.688) $p < .0005$]. Tier IV was statistically significantly different from Tier III [5.16% (95% CI 1.675 to 8.654), $p = .001$]. These effects followed the same pattern as the effects of interventions on the whole population.

Scores for students in Tier I reading showed a change in FSA ELA percentile that was almost identical for males and females. In Tier II, the proportion of males to females was nearly equal; females demonstrated a mean positive mean change in FSA ELA percentile, while males displayed a mean negative change. The mean change in FSA ELA percentile for the total population, however, was positive. For students in Tier III interventions, the mean population change in FSA ELA percentile was negative. Categorized by gender, Tier III contained almost 100 more males than females. Males showed a statistically significant mean decrease in FSA ELA percentile, while the females showed a mean increase in FSA ELA percentile.

The researcher analyzed data to determine whether gender moderated the effects of behavioral interventions on FSA ELA percentile change. As displayed in Table 32, only two females appear in Tier III for behavior; thus, Tier III could not be compared by gender. This analysis indicates that more intensive reading interventions may be more effective for females than for males.

Table 32

Mean Change in FSA ELA Percentile by Behavior Tier by Gender

Tier	Gender	*n*	M P_i%	SD P_i%	LL P_i%	UL P_i%
I	Female	1649	2.43	17.28	1.591	3.266
	Male	1621	0.12	16.95	-0.729	0.961
II	Female	41	-0.132	17.35	-5.444	5.181
	Male	127	-1.93	22.11	-4.946	1.091
III	Female	2	13.20	23.05	-10.852	37.252
	Male	10	9.10	19.69	-1.657	19.857
IV	Female	4	1.450	2.51	-15.558	18.458
	Male	17	-9.86	23.74	-18.109	-1.609

*Indicates statistical significance.

There was not a statistically significant interaction between gender and behavior intervention level on change in ELA percentile [$F(3,3463) = .305$, $p = .822$ partial $\eta^2 = .000$; a small effect]. There was no statistically significant main effect for gender [$F(1,3463) = 1.343$, $p = .247$, partial $\eta^2 < .0005$; a small effect]. The lack of statistical significance may be attributed to the low number of students, particularly females in Tiers III and IV, for behavior.

Mathematics Achievement

The researcher analyzed data to determine whether gender moderated the effects of mathematics interventions on FSA Mathematics percentile change. Differences in FSA

Mathematics percentile change were remarkably similar for Tiers II and III when categorized by gender (Table 33).

Table 33

Mean Change in FSA Mathematics Percentile by Behavior Tier by Gender

Tier	Gender	*n*	M P_i	SD P_i	LL P_i	UL P_i
I	Female	1143	1.37	16.48	0.419	2.330
	Male	1076	0.80	16.99	-0.183	2.564
II	Female	270	0.60	16.66	-1.369	2.564
	Male	293	0.77	15.94	-1.117	2.659
III	Female	149	-4.60	16.08	-7.246	-1.952
	Male	134	-4.59	16.84	-7.376	-1.793
IV	Female	149	3.59	16.84	0.944	6.238
	Male	285	4.69	16.04	2.778	6.606

*Indicates statistical significance.

There was no statistically significant interaction between gender and mathematics intervention level on change in FSA Mathematics percentile [$F(3, 3491) = .326$, $p = .807$, partial $\eta^2 = .000$; a small effect]. There was no statistically significant main effect for gender [$F(1, 3491) = .057$, $p = .812$, partial $\eta^2 < .0005$; a small effect]. Because the size of the gender groups in Tiers I, II, and III were roughly equivalent, and little variance emerged in either the change in percentile or the standard deviation, the data provide strong evidence that FSA Mathematics percentile change was not affected by gender.

Data were also analyzed to determine whether gender moderated the effects of behavioral interventions on mathematics achievement. Table 34 displays the mean change in FSA Mathematics percentile change by behavior tier.

Table 34

Mean Change in FSA Mathematics Percentile Change by Behavior Tier

Tier	Gender	*n*	M P_i	SD P_i	LL P_i	UL P_i
I	Female	1661	0.87	16.57	0.72	1.667
	Male	1628	0.98	16.56	0.173	1.784
II	Female	44	1.93	14.98	-2.966	6.835
	Male	128	0.29	16.80	-2.582	3.165
III	Female	2	27.15	62.01	4.165	50.135
	Male	13	9.58	18.31	0.569	18.600
IV	Female	4	-0.23	10.41	-16.478	16.028
	Male	19	2.98	15.38	-4.478	10.436

The researcher determined that there was no statistically significant interaction between gender and behavior intervention level on change in mathematics percentile [$F(3, 3491) = .808$, $p = .489$, partial $\eta^2 = .001$; a small effect]. There was no statistically significant main effect for gender [$F(1, 3491) = 1.009$, $p = .315$, partial $\eta^2 = .000$; a small effect]. The lack of statistical significance was likely due to the small number of students, particularly female students, in Tiers III and IV for behavior.

Race

ELA Achievement

The researcher analyzed the data to determine whether race moderated the effects of reading interventions on FSA ELA percentile change. Because of their particularly small sample sizes, Asian, Indian / Native American, and Pacific Islander were combined into one “Other” category. Table 35 shows there was some variability in FSA ELA percentile change by race.

Also, data analysis revealed that there was no statistically significant interaction between race and reading tier for FSA ELA percentile change [$F(12, 3451) = 1.536$, $p = .104$, $\eta^2 = .005$]. All races showed mean increases in FSA ELA percentile for Tier I. The overall population mean change in FSA ELA percentile for Tier II was 0.42. The mean change in percentile by race varied much more for Tier II students. Black and mixed-race students showed a negative mean change in FSA ELA percentile, while White and Hispanic students showed small mean increases in FSA ELA percentile change. Tier III showed negative mean changes in FSA ELA percentile for all races, and Tier IV showed positive mean changes in FSA ELA percentile across races.

Table 35

Mean Change in FSA ELA Percentile Change by Reading Tier by Race

Tier	Race	*N*	*M* P_i%	*SEM* P_i%	*LL* P_i%	*UL* P_i%
I	Black	130	3.70	1.516	0.730	6.674
	Hispanic	767	3.80	0.624	2.571	5.021
	Mixed	41	1.14	2.70	-4.151	6.434
	White	423	1.17	0.840	-0.477	2.818
	Other	45	2.45	2.58	-2.605	7.498
II	Black	94	-1.681	1.783	-5.176	1.814
	Hispanic	576	0.44	0.720	-0.968	1.855
	Mixed	21	-7.30	3.77	-14.694	0.094
	White	161	1.22	1.36	-1.46	3.885
	Other	20	11.36	3.87	3.78	18.937
III	Black	101	-2.23	1.72	-5.597	1.147
	Hispanic	499	-0.69	0.77	-2.202	0.832
	Mixed	12	-8.41	5.00	-18.19	1.374
	White	148	-4.38	1.42	-7.17	-1.60
	Other	7	-3.63	6.53	-16.436	9.179
IV	Black	42	2.05	2.67	-3.179	7.279
	Hispanic	268	1.46	1.06	-0.612	3.528
	Mixed	9	4.33	5.76	-6.962	15.629
	White	102	2.62	1.71	-0.740	5.970
	Other	5	8.74	7.73	-6.414	23.894

Regarding the question of whether race moderated the effects of behavior interventions on reading achievement, there was no statistically significant interaction between race and behavior tier for change in FSA ELA percentile rank [$F(10, 3453) = 1.773$, $p = .060$, partial $\eta^2 = .005$; a small effect]. There were some differences between FSA ELA percentile change across races; however, those differences were not statistically significant because of the small population in Tiers III and IV.

Mathematics Achievement

Mathematics interventions were analyzed by race to determine whether race moderated the differences in change in FSA Mathematics percentile rank. There was not a statistically significant interaction between race and mathematics tier regarding change in FSA Mathematics percentile rank [$F(12, 3479) = 0.428$, $p = 0.953$, partial $\eta^2 = .001$, a small effect]. Except for mixed-race students in Tier I, whose mean change in FSA Mathematics percentile was -3.42 ± 18.46, students in all other racial groups showed greater FSA Mathematics percentile change in Tier I than in Tier I II. Every race demonstrated a mean negative change in FSA Mathematics percentile for Tier III students. Finally, students in every racial group showed a positive mean change in FSA Mathematics percentile for Tier IV, indicating that Tier IV ESE services were associated with positive mathematics achievement changes regardless of race.

Additional data analysis examined whether the effects of behavior interventions might be moderated by race. There was no statistically significant interaction between race and behavior tier for change in FSA Mathematics percentile rank [$F(10, 3481) = 1.416$, $p = 0.166$, partial $\eta^2 = .004$; a small effect]. As stated previously, this lack of statistical significance may result from the small proportion of the population in Tiers II, III, and IV behavior interventions.

English Language Learner Status

English language learners are assigned codes in the Student Information System based on their English language assessment (Home Language Survey) that occurs during the enrollment process. As reported in Chapter Three, English language learners were analyzed by their specific ELL code rather than whether they fit within the broader category of ELL.

ELA Achievement

FSA ELA percentile change and ELL code were analyzed to determine whether ELL code moderated the effects of reading interventions. There was a statistically significant interaction between ELL status and reading intervention level regarding change in ELA percentile [$F(12, 3451) = 5.808$, $p < .0005$, partial $\eta^2 = .020$; a small effect].

In Tier I, LY students were statistically significantly higher than LA students [18.56 percentile points (95% CI 0.0 percentile points to 37.11 percentile points), $p = .05$], LF students [14.27 percentile points (95% CI 8.67 percentile points to 19.87% tile), $p < .0005$], and ZZ [14.761 (95% CI 9.86 percentile points to 19.66 percentile points) $p < .0005$] students.

LY students in Tier II also showed mean statistical increases significantly higher than LF students [13.81 percentile points (95% CI 8.58 percentile points to 19.04 percentile points) $p < .0005$] and ZZ students [10.33 percentile points (95% CI 6.25 percentile points to 14.41 percentile points), $p < .0005$].

In Tier III, LF students' mean percentile change was significantly lower than LY students [-14.05 percentile points (95% CI -21.60 percentile points to -6.5 percentile points), $p < .0005$],

LZ students [-33.76 percentile points (95% CI -58.55 percentile points to -8.98 percentile points), $p = .001$], and ZZ students [-10.92 percentile points (95% CI -18.40 percentile points to -3.43 percentile points), $p < .0005$]. The Tier III difference between LZ students and LA students [38.23% (95% CI 1.94% to 74.51%)] was statistically significant ($p = .031$). Tier IV had no statistically significant differences in means.

Table 36 includes the percentile change in FSA ELA for each ELL code:

Table 36

Change in FSA ELA Percentile by Reading Tier by ELL Code

Tier	ELL Status	*n*	*M* $P_i\%$	*SD* $P_i\%$	*LL* $P_i\%$	*UL* $P_i\%$
I	LA	7	2.07	10.88	-14.604	10.461
	LF	238	2.21	15.66	0.064	4.363
	LY	103	16.48*	21.15	13.216	19.751
	LZ	1	14.50		-18.659	47.659
	ZZ	1057	1.72	15.16	0.703	2.743
II	LA	7	-8.93	21.86	-21.461	3.604
	LF	151	-4.52	16.83	-7.220	-1.823
	LY	182	9.29*	18.69	6.833	11.749
	LZ	7	-4.61	13.72	-17.147	7.919
	ZZ	525	-1.04	19.34	-2.488	0.406
III	LA	3	-17.9*	24.51	-37.044	1.244
	LF	45	-13.44*	19.90	-18.379	-8.493
	LY	331	0.61	13.08	-1.211	2.434
	LZ	4	20.33	33.83	3.746	36.904
	ZZ	384	2.52	19.00	-4.210	-0.825
IV	LA	12	6.08	18.24	-3.489	15.655
	LF	64	-0.33	16.83	-4.471	3.818
	LY	129	2.81	15.26	-0.113	5.726
	LZ	8	6.75	15.29	-4.973	18.473
	ZZ	213	1.68	17.44	-0.591	3.953

*Indicates statistical significance.

Students labeled LY are in their first two years of English language learner support (Florida Department of Education, 2019). The 2018 assessment may have been their first assessment in English. As such, the significant growth of LY students from 2018 to 2019 may have resulted from increased English language proficiency rather than an indication that interventions are significantly more effective for LY students. Since data on English language proficiency was not collected, the role of English language acquisition cannot be confirmed. The mean negative change in percentile of LF and LA students in Tier III was quite large, indicating the need to explore further how interventions affect students who have been exited from ELL services.

The researcher conducted additional data analysis to determine whether ELL status moderated the effects of behavior interventions on ELA achievement. There was a statistically significant interaction between ELL status and behavior tier for change in ELA percentile [$F(10, 3453) = 2.199$, $p = .015$, partial $\eta^2 = .006$; a small effect]. No significant interaction effects were found between ELL codes and ELL code was not found to be a statistically significant factor [$F(4, 3453) = 1.456$, $p = 0.213$, partial $\eta^2 = .002$; a small effect]. The lack of statistically significant pairwise comparisons may have been a function of the small proportion of Tier III and Tier IV's population for behavior.

<u>Mathematics Achievement</u>

Data were analyzed to determine whether ELL status moderated the effects of mathematics interventions on mathematics achievement. There was a statistically significant interaction between ELL status and math tier for change in math percentile [$F(10, 3481) = 2.551$,

$p = .005$, partial $\eta^2 = .007$; a small effect]. Results reported in Table 37 indicate there were differences in overall change between FSA Mathematics percentile by ELL code.

Table 37

Table of Mean Change in FSA Mathematics Percentile by ELL Code

ELL Code	n	$M\ P_i\%$	$SEM\ P_i\%$	$LL\ P_i\%$	$UL\ P_i\%$
LA	29	-2.08	4.78	-11.45	7.30
LF	501	1.08	1.18	-1.24	3.39
LY	751	3.17*	0.67	1.85	4.48
LZ	20	-1.25	3.72	-8.55	6.05
ZZ	2198	-0.72	0.49	-1.68	0.23

There was a statistically significant difference between FSA Mathematics percentile change and ELL status [$F(4, 3481) = 5.669$, $p < .0005$, partial $\eta^2 = .006$; a small effect]. The difference between LY and ZZ [3.89 percentile points (95% CI -11.07 percentile points to 10.02 percentile points)] was statistically significant ($p < .0005$). Like FSA ELA, the difference between LY students and ZZ students may be a function of improved English proficiency more than the efficacy of instruction or intervention having a more positive effect on them.

Data were analyzed to determine whether ELL status moderated the effects of behavior interventions on mathematics achievement. There was no statistically significant interaction between ELL status and behavior tier for change in math percentile [$F(10, 3481) = 1.584$, $p = .105$, partial $\eta^2 = .005$; a small effect]. There was no statistically significant difference in Math percentile change between ELL status [$F(4, 3481) = 1.268$, $p = .280$, partial $\eta^2 = .001$; a small effect]. Any effects of behavior interventions may result from the low number of students in Tiers II, III, and IV in behavior interventions.

Economically Disadvantaged

ELA Achievement

Analysis of whether economically disadvantaged status moderated the effects of reading interventions on ELA achievement showed no statistically interaction effects [$F(3, 3461) = .448$, $p = .718$, partial $\eta^2 < .0005$; a small effect]. There was no statistically significant difference in FSA ELA percentile change by economically disadvantaged status [$F(1, 3463) = 0.012$, $p = .913$, partial $\eta^2 = .0001$; a small effect].

Behavior interventions showed no statistically significant interaction between economically disadvantaged status and behavior tier for change in ELA percentile change [$F(3, 3463) = 1.021$, $p = .382$, partial $\eta^2 = .001$; a small effect]. There was also no statistically significant difference in FSA ELA percentile change regarding economically disadvantaged status [$F(1, 3463) = 1.646$, $p = .200$, partial $\eta^2 < .0005$; a small effect]. This study found no evidence that economically disadvantaged status moderated the effects of reading or behavior interventions on student achievement.

Mathematics Achievement

Changes in FSA Mathematics percentile were analyzed by economically disadvantaged status to determine whether economically disadvantaged status moderated the effects of mathematics interventions on mathematics achievement. There was no statistically significant interaction between economically disadvantaged status and mathematics tier for change in mathematics percentile change [$F(3, 3491) = .860$, $p = .461$, partial $\eta^2 = .001$; a small effect]. There was no statistically significant difference in math percentile change by economically disadvantaged status [$F(1, 3491) = .033$, $p = .856$, partial $\eta^2 < .0005$; a small effect].

Data were analyzed to determine whether economically disadvantaged status moderated the effects of mathematics interventions on mathematics achievement. There was no statistically significant interaction between economically disadvantaged status and behavior tier for change in mathematics percentile change [$F(3, 3491) = 1.056$, $p = .366$, partial $\eta^2 = .001$; a small effect]. There was no statistically significant difference between math percentile change and economically disadvantaged status [$F(1, 3491) = 1.304$, $p = .254$, partial $\eta^2 < .0005$; a small effect]. Results indicated that economically disadvantaged status did not moderate the effects of mathematics or behavior interventions on student achievement. Economically disadvantaged students may be underrepresented in the data due to the Community Eligibility Program, which provides free school meals but does not require students to apply for free or reduced-price meals ("Community Eligibility," n.d.). Thus, the lack of statistical significance for economically disadvantaged status should be interpreted cautiously.

Section Summary

The analysis of data utilized in this study showed mixed results regarding how demographics moderate the effects of intervention tiers. Although the results were mixed, gender and ELL code showed statistically significant interaction effects, so the null hypothesis is rejected. Table 38 summarizes the effects of demographic variables on percentile change for FSA ELA and FSA Mathematics.

Table 38

Summary of Demographic Variables Effects on Mean Change in FSA ELA and FSA Mathematics Percentile

Demographic Categories	Reading Interventions Mean Percentile Change	Math Interventions Mean Percentile Change	Behavior Interventions Mean Percentile Change
Gender*	Higher effects for females in Tier III.	No statistically significant effects.	No statistically significant effects.
Race	No statistically significant effects.	No statistically significant effects.	No statistically significant effects.
ELL Code*	LY students showed greater positive effects. LF and LA students showed statistically significant negative effects.	LY students showed greater positive effects.	Statistically significant differences in FSA ELA percentile change for the interaction, but no statistically significant pairwise comparisons. No statistically significant effects for FSA Mathematics percentile change.
Economically Disadvantaged	No statistically significant effects.	No statistically significant effects.	No statistically significant effects.

Regarding gender, results revealed statistically significantly higher outcomes for females in Tier II and Tier III for reading. The analysis did not show that race moderated the effects of intervention tier on student achievement. There were statistically significant differences between ELL categories and within ELL categories between intervention tiers. Data analysis did not reveal statistically significant differences in intervention effects based on economically disadvantaged status.

Chapter Summary

Overall, students showed a positive change in percentile rank in Tier I, regardless of the subject area. Tier II was mixed. Table 39 summarizes the effects of intervention tier and FSA percentile.

Table 39

Summary of Mean Change in FSA Percentile

Mean Change in FSA ELA Percentile			
Intervention Tier	**Reading Interventions Mean Percentile Change**	**Math Interventions Mean Percentile Change**	**Behavior Interventions Mean Percentile Change**
I	2.88*	1.45	1.28
II	0.42	0.68	-1.49
III	-1.75*	-1.84*	9.78
IV	1.94	1.94	-7.70
Mean Change in FSA Mathematics Percentile			
Intervention Tier	**Reading Interventions Mean Percentile Change**	**Math Interventions Mean Percentile Change**	**Behavior Interventions Mean Percentile Change**
I	1.27	1.10	0.92
II	-0.84*	0.69	0.71
III	0.6	-4.59*	11.93*
IV	4.31*	4.31*	2.42

Tier II reading and mathematics students showed a small positive change in FSA ELA percentile. However, this change was less than the percentile change for Tier I. Tier II mathematics students showed a small positive mean change in FSA Mathematics percentile but a negative mean change in FSA ELA percentile. Whether the discrepancy between FSA Mathematics and FSA ELA change is an unintended consequence of Tier II mathematics interventions is unknown. Tier III students in reading and mathematics showed negative changes in FSA ELA percentile. Interestingly, although Tier III mathematics students showed a decrease in FSA Mathematics percentile, Tier III reading students showed a mean increase in FSA Mathematics percentile. The conflicting results may indicate that, while Tier III mathematics interventions are not showing evidence of increasing the rate of student achievement change, Tier III reading interventions have an unintentional positive effect on mathematics achievement. Data were also analyzed using to Kruskal-Wallis test because the data did not meet the statistical assumptions of an ANOVA. The Kruskal-Wallis results corroborated the ANOVA results.

The mixed results from this study are similar to other large-scale studies of generalized achievement effects (Balu et al., 2015; Gage et al., 2017; Nelson et al., 2018; Scott et al., 2019). Based on the results, MTSS does not appear to increase Tier II and Tier III students' rate of change in academic achievement compared to Tier I. On the other hand, Tier IV does appear to provide evidence that it is associated with an increased rate of change. The implications of these mixed results will be explored further in Chapter Five.

CHAPTER FIVE: DISCUSSION

Introduction

Chapter Four reported the results of the analysis of student achievement data related to tiered interventions. Chapter Five includes a summary of the study, a discussion of each research question's findings, implications for practice, recommendations for future research, and conclusions. The discussion includes an examination of the findings for each research question. The purpose of the later sections is to illuminate and synthesize the connections between this research and the existing literature on MTSS. The chapter concludes with suggestions for further research to help educational researchers and leaders better understand the discrepant results in MTSS research.

Summary of the Study

The purpose of this study was to address a gap in the literature by investigating the effects of MTSS interventions on student achievement in a natural school setting. The study focused on investigating the possible differences in the effects of the MTSS intervention tiers on student achievement in fourth grade by using post hoc data to measure student achievement on the FSA ELAS and FSA Mathematics. The study is relevant to researchers and school leaders because MTSS has expanded since 2004 when it was included in the *Education for All Handicapped Children Act* (EAHCA). To date, the most important study of MTSS in the natural school setting was a Department of Education study of the overall effectiveness of RtI (Balu, 2015). Thus far, the body of literature on MTSS includes studies on how the system affects student achievement.

The epistemological framework through which the researcher examined MTSS effects was the critical framework. The critical researcher asks the question: who benefits from MTSS (Butin, 2010)? Capra's (1996) *Web of Life, living systems theory,* provides a framework to understand the need to examine the patterns of MTSS from a high level, based on the interaction of the pattern of a system with the processes and structures that influence how it functions (Capra, 1996). MTSS is the same three-tiered pattern regardless of the subject, school, or Florida district. Had the data showed more intensive interventions were associated with positive change in student achievement, the impacts of the processes and structures would be less concerning for future researchers. Because the study is a long-range view of MTSS, the characteristics of the intervention tiers were not considered. The researcher did not collect data on the specific intervention program or its fidelity. Also, the extent to which factors related to fidelity and intervention quality impacted student achievement was not explored.

This quantitative study used a causal-comparative design to analyze post hoc data, including all fourth-grade students in one Florida district in the 2018-2019 school year. Three research questions guided this study: (a) exploration of the effects of tiered interventions on ELA achievement, (b) exploration of the effects of tiered interventions on mathematics achievement, and (c) analysis of the extent to which demographic characteristics might moderate any achievement effects. The dependent variable was the change in FSA ELA and FSA Mathematics percentile from 2018 to 2019. This study utilized the change in score percentile rather than the 2019 score because increasing tiers of interventions should increase the change rate; thus, the percentile change was a better indicator of interventions' effects. Students were assigned to four intervention levels based on their highest reported level of intervention in reading or mathematics during the 2018-2019 school year.

Students receiving ESE services were coded as Tier IV, a fourth-level intervention. Coding was applied according to intervention subject (mathematics, reading, and behavior) so a student could be coded for Tier I reading, Tier II mathematics, and Tier III behavior. The researcher analyzed the effects of each level of intervention on the percentile change by using an ANOVA. A factorial ANOVA was used to determine whether demographic variables including gender, race, ELL status, or economically disadvantaged status moderated intervention effects. The ANOVA was the appropriate statistical test because the study included more than one categorical independent variable and one continuous dependent variable.

Discussion of Findings

Research Question 1

What Are the Differences Between Intervention Levels (Tier I, II, III, or Tier IV) and Student English Language Arts Achievement (FSA ELA)? A foundational assumption of MTSS is effective Tier I instruction, such that 80% of students are successful with general education (Brown-Chidsey-Bickford, 2016; Gresham & Little, 2012; Nelson et al., 2018). There is some evidence that the effectiveness of Tier I may not be high enough; the mean FSA ELA score in the target district fell just below the state minimum scale score for proficiency, thereby negatively impacting the higher tiers. On the other hand, students in Tier I show mean increases in percentile from 2018-2019. The group mean was higher than the minimum scale score in 2019 than in 2018, indicating Tier I instruction improved student outcomes for Tier I students. These improvements in Tier I may explain why previous studies found statistically significant increases when they compared school-wide proficiency from year to year (Fisher & Fry, 2013; Gage et al., 2017; Grapin et al., 2019). School-wide implementation of MTSS may positively impact overall achievement by increasing achievement in Tier I without necessarily improving achievement in Tiers II and III.

The overall pattern of FSA ELA scale scores in 2018 followed the expected pattern of MTSS. Tier I scored highest, followed by Tier II, Tier III, and Tier IV, indicating that the students in each level of intervention were likely placed based on evidence of lack of performance. In 2019, Tier I had the highest mean growth, followed by Tier II. Tier III was slightly lower than Tier IV. Tier IV students started fourth grade with lower mean achievement than their Tier III peers and ended the year with higher mean achievement.

Figure 13 displays the intersection of the mean FSA ELA scale score and mean change in FSA ELA percentile along a continuum. Quadrant I of Figure 13 represents proficient intervention groups and indicates a positive change in FSA ELA percentile. Quadrant II represents intervention groups that were not proficient but showed positive change in percentile. Quadrant III shows the intervention groups below proficiency with negative change in FSA ELA percentile. Ideally, Tier I groups would be in Quadrant I; Tiers II, III, and IV would be found in Quadrant II.

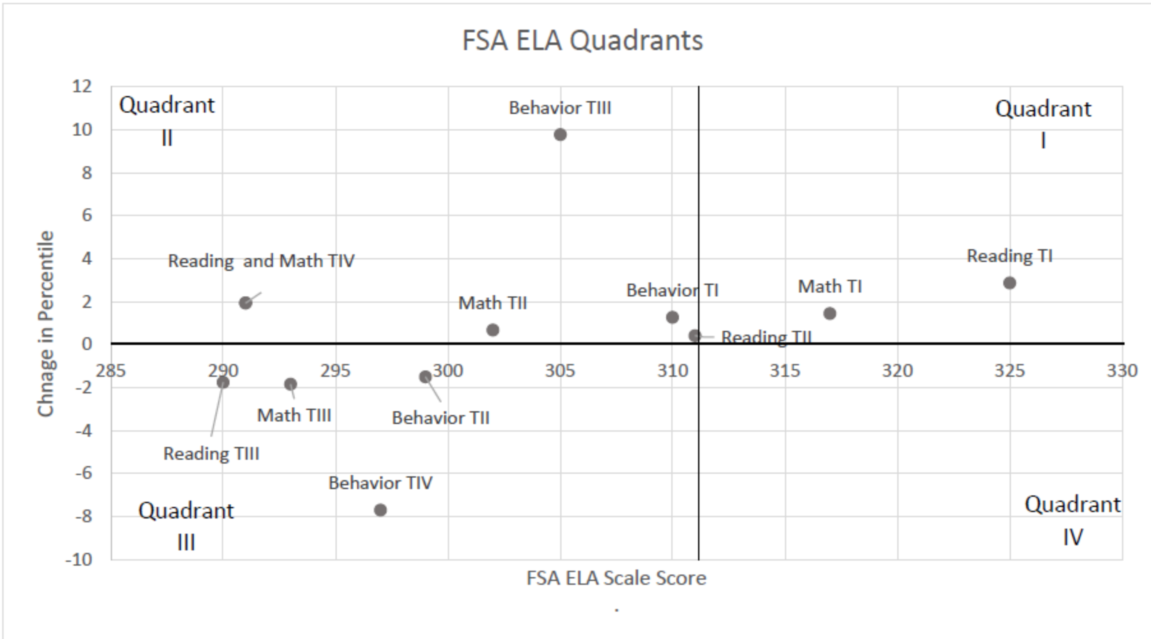


Figure 13. FSA ELA Percentile Change and Scale Score Quadrants.

Tier II reading interventions showed a mean scale score at the 311 scale score proficiency level. Perhaps Tier III behavior students were receiving interventions more tailored to their specific needs, so the intervention led to significant academic improvements. Table 40 contains a summary of the interventions by quadrant and includes the change in FSA ELA percentile.

Table 40

Quadrant Analysis of Intervention Effects on FSA ELA

Change in FSA ELA Percentile

Quadrant II Below proficient achievement Positive change in percentile • Reading TII (0.42) • Math TII (0.68) • Behavior TIII (9.78) • Reading and Math TIV (1.94)	Quadrant I Proficient achievement Positive change in percentile • Reading TI (2.88) • Math TI (1.45)
Quadrant III Below proficient achievement Negative change in percentile • Behavior TII (-1.49) • Behavior TIV (-7.7) • Math TIII (-1.84) • Reading TIII (-1.75)	Quadrant IV Proficient achievement Negative change in percentile No intervention tiers in this quadrant

Proficiency
Minimum FSA ELA Scale Score for Proficiency 311

An analysis of the data from Research Question 1 showed statistically significantly different FSA ELA percentile change results. Therefore, the null hypothesis for Research Question 1 was rejected. Tier II interventions and Tier III academic interventions were likely to close students' learning gaps. By contrast, improved reading scores corresponded to Tier IV reading and mathematics interventions and Tier III behavior interventions. The results of the present study are similar to the results of the Balu et al. (2015), in that academic interventions in addition to Tier I, but not including ESE services, were not found to have statistically significant positive effects on student achievement when measured on a standardized achievement test. One of the criticisms of the Balu et al. study involved its use of a cut score rather than documentation of participation in an intervention (Fuchs & Fuchs, 2017). The present study included students in intervention tiers based on data reported in the student information system but did not independently verify the validity or fidelity of implementing those interventions. Unlike the Balu et al. study, the present study separated Tier IV students to explore how their supports might affect achievement differently.

Tier II reading interventions showed a small positive change; this change was statistically significant (less than Tier I). The purpose of Tier II is to increase the rate of change such that students can close the learning gap (Weisenburg-Snyder et al., 2015). The outcomes of this study are different from the outcomes of Gersten et al.'s (2020) meta-analysis of Tier II interventions. The difference in outcomes may be a result of any number of factors. First, Gersten et al.'s meta-analysis included studies of primary grade interventions, whereas this study examined effects in an intermediate grade. Because the body of literature on early reading skills (i.e., phonics, phonemic awareness, and oral reading fluency) is more robust than the body of literature on vocabulary and comprehension interventions. The difference in grade levels examined may explain the differing results.

The analysis yielded interesting findings related to Tier IV. RtI was initially included in ESE eligibility decisions as a potential solution to the disproportionate number of historically marginalized students qualifying for ESE services (Ciolfi & Ryan, 2011; Fuchs et al., 2003; Painter & Alvorado, 2008; Togut & Nix, 2012). However, the results of this study provide evidence that in this population, students in Tier IV showed growth that was statistically significantly different from Tier III. The results indicate that a student for this population may potentially have improved achievement outcomes if they qualify for Tier IV ESE services than if they only receive Tier III interventions.

The aspects of Tier IV ESE services that may have impacted the disparity in achievement were beyond the scope of this study. The study did not analyze whether specific ESE labels showed differences in change in percentile for reading, as suggested by Fish (2017), nor did it analyze what types of Tier IV ESE services had different effects. Data were not collected on whether students in Tier I, II, or III had 504 plans that might have allowed them testing accommodations similar to students in Tier IV. It is unknown which of the Tier IV ESE services and accommodations were related to the increase in student achievement. Conclusions about specific Tier IV ESE services could not be determined from the data collected.

Students in mathematics interventions showed remarkably similar achievement patterns on FSA ELA as those students in reading interventions. The data may indicate that students with low achievement in mathematics also have low achievement in reading. Kiss and Christ (2019) found that indications of reading difficulties were not an accurate predictor of math difficulties in the early grades. As such, the similarities in percentile change may not be directly attributable to generally low achievement across mathematics and reading. Conversely, as Kiss and Christ (2019) explored the relationship in early grades, perhaps ELA difficulties are a stronger predictor of mathematics difficulties in later grades.

Behavior intervention data led to very interesting results, particularly when compared to reading and mathematics interventions. Tier III behavior students showed a mean positive change in FSA ELA percentile, whereas Tier IV students showed a mean negative change in FSA ELA percentile. Hagan-Burke et al. (2015) found that functional behavior analyses that included changes in classroom instruction practices led to improved student outcomes. Hurwitz et al. (2015) found that behavior consultants accounted for statistically significant variability in outcomes. These studies indicate that perhaps Tier III behavior interventions were more successful because there were so few students. Specifically, perhaps school teams could truly problem-solve for Tier III behavior intervention because there were so few students. By contrast, the volume of students in reading interventions would have created a barrier to a robust problem-solving approach and instead forced the school teams into a standard protocol approach, even with Tier III interventions.

Research Question 2

What Are the Differences Between Intervention Levels (Tier I, II, III, or Tier IV) and Student Mathematics Achievement (FSA Mathematics)? Analysis of the FSA Mathematics change in percentile did show statistically significant differences by intervention tier, so the null hypothesis was rejected. As with FSA ELA, Tier IV showed statistically significant positive mean changes, while Tier II reading students and Tier III math students showed negative FSA Mathematics percentile changes. The specific cause of the surprising findings is unknown. Perhaps Tier II reading students are missing opportunities for support in mathematics. Given the small amount of research on mathematics interventions compared to reading, perhaps school teams do not have enough information to accurately select and implement mathematics interventions. Figure 14 displays the effects of intervention tiers along a continuum of FSA Mathematics scale scores. If MTSS interventions were functioning as theorized, lower scale scores would be associated with higher tiers of intervention and more significant increases in percentile.

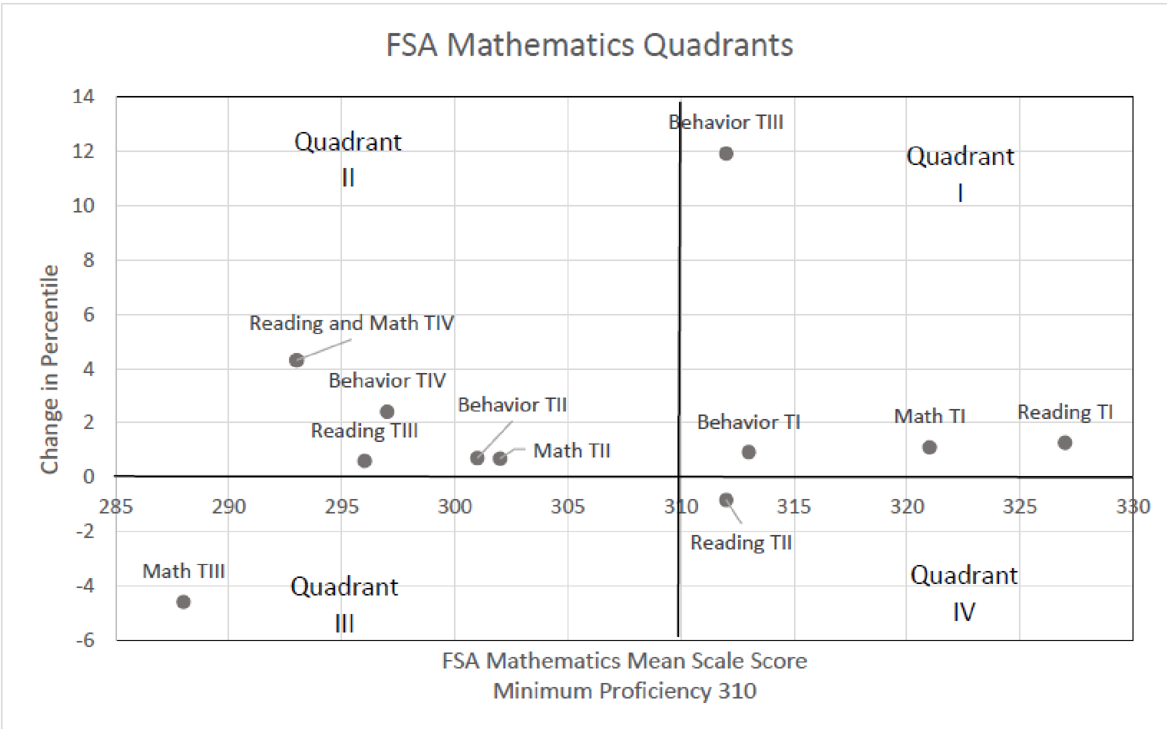


Figure 14. FSA Mathematics Percentile Change and Scale Score Quadrants.

Like FSA ELA, students in Tier III behavior interventions showed statistically significant positive change compared to their peers. It is also interesting that Tier III students' behavior showed a mean mathematics scale score at proficient. Yet, those students also showed the most significant positive change in the FSA Mathematics percentile of any intervention group. This finding is important because, in Florida, elementary school students who are proficient in mathematics are placed into accelerated math classes. For these 12 students, their behavior interventions may increase the likelihood of being placed in accelerated mathematics in middle school. A correlation between behavior supports, and mathematics achievement has been documented in other research studies but is limited (Choi et al., 2017). The general assumption in PBIS literature is that behavior interventions improve student achievement because students are in class more often. Based on this assumption, PBIS studies typically report changes in out-of-school suspension rates along with office discipline referrals (Elfner Childs et al., 2010; Freeman et al., 2016; Gage et al., 2017, 2019; Scott et al., 2019). Studies of schoolwide behavior interventions and their academic effects (e.g., Albrecht et al., 2015; Bradshaw et al., 2010; Houchens et al., 2017; Muscott et al., 2008; and Scott et al., 2019) typically lump all students together to analyze the effects on over-all proficiency. Perhaps if those studies had explored the relationship between Schoolwide Positive Interventions and Supports (SWPBIS) implementation fidelity, student achievement, and intervention level, the effects might have varied as well.

The findings for Research Question 2 are summarized in Figure 15. Intervention groups were placed into quadrants representing the group mean proficiency related to the group mean change in FSA Mathematics percentile. As expected, Tier I interventions fell in Quadrant I. Tier II reading interventions falling in Quadrant IV provide further evidence that Tier II reading intervention implementation in the natural school setting is an area in need of further research.

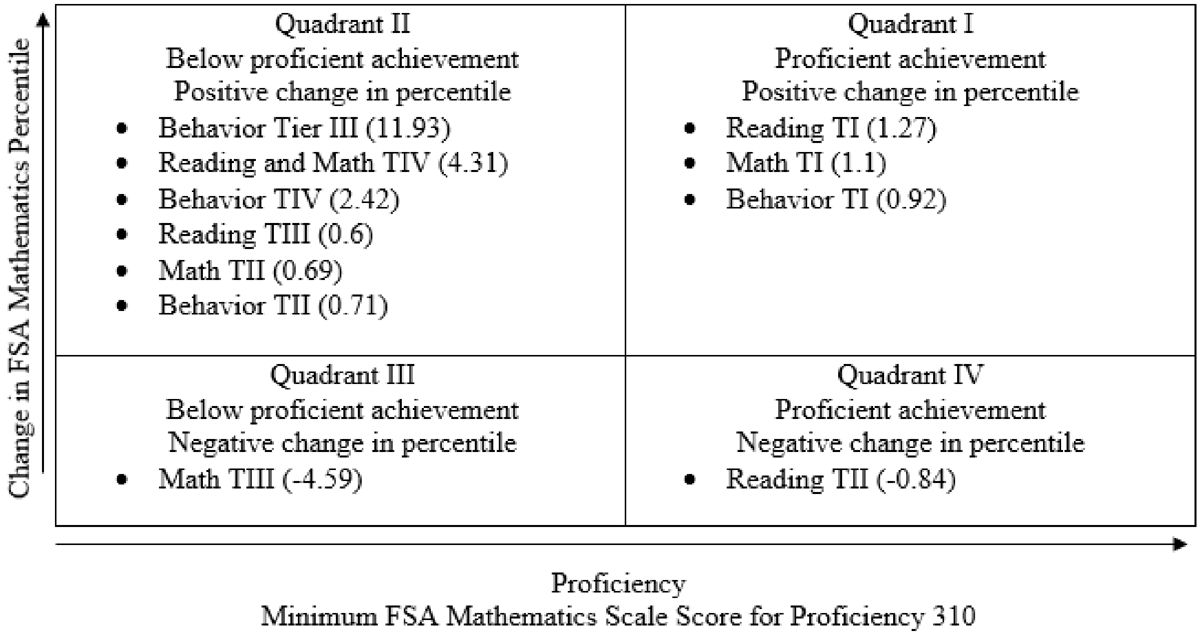


Figure 15. Quadrant Analysis of Intervention Effects on FSA Mathematics.

While the results within the analysis showed statistically significant differences between mathematics tiers, those differences did not provide evidence that students in higher tiers of intervention are responding to interventions by increasing their rate of change on the FSA Mathematics. Although the data collected is insufficient to determine why students in interventions did not grow as expected, the findings indicate a need to study MTSS effects further.

Research Question 3

Research Question 3 used multiple factorial ANOVA to examine the question, Do Student Characteristics Moderate Any Differences Between Intervention Levels (Tier I, II, III, or

Tier IV) and Student Achievement (FSA ELA and FSA Mathematics Scores)? One of the goals of RtI and MTSS is to reduce the disproportional number of minority students who receive ESE services (King Thorius & Maxey, 2014; Sabnis et al., 2019). For that reason, it is essential to examine the racial and socio-economic make-up of the intervention tiers. In the current study's population, specific demographic sub-categories are over-represented in particular tiers. Students who are male, Black, Hispanic, or economically disadvantaged are overrepresented in Tiers II, III, and IV of reading and behavior interventions. Students who are female, Asian, mixed-race, native English speakers, and not economically disadvantaged are over-represented in Tier I for reading and behavior. In this study, the researcher could not determine how culturally-biased beliefs and assumptions play a role in the assignment of interventions because of the limitations of the data.

Race

Despite the racial disproportionality in tiered interventions, there were no statistically significant differences between racial groups. The patterns of percentile change were remarkably similar across racial groups. The lack of significance was consistent across reading, mathematics, and behavior intervention for both FSA ELA, FSA Mathematics. The results are simultaneously encouraging and discouraging. The results were encouraging because changes in performance do not vary significantly by race, meaning Tier II and Tier III interventions are not less effective for non-White students. The results are discouraging because the lack of difference in scores also indicated that Tier II and Tier III interventions are not significantly more helpful for non-White students. According to Giroux (1979), the lack of difference may be due to existing power structures being so entrenched that they permeate intervention implementation. This thinking is similar to Sabnis et al. (2019), who posited that as long as teachers and school personnel attributed student learning gaps to student-centered factors, systems of interventions were likely to reinforce rather than improve inequitable outcomes. Along the same lines, a small-scale study of Black students receiving ESE services who succeeded in high school found high expectations, adult support, and personal organizational systems to be critical drivers of their success (Gatlin & Wilson, 2016). Perhaps students receiving Tier IV ESE Services benefit from relational adult support (e.g., high expectations and assistance with personal organization). Students in intervention Tiers II and III did not receive this type of support.

While the change in percentile by behavior intervention tier was not significant, there are important findings in the racial make-up of the behavior tiers. The percent of White students in Tier IV for reading and math was almost identical to the proportion of the overall population; Black students were slightly underrepresented in Tier IV for reading and mathematics. By contrast, Black students were over-represented in Tier IV for behavior interventions, while White students were underrepresented in Tier IV for behavior. These results were similar to the results of Fish (2017), who found that White students were more likely to receive a referral for SLD, while Black students were more likely to be referred for EBD. This disproportionality is critical because reading and mathematics Tier IV students showed a positive change in FSA ELA and FSA Mathematics.

In contrast, Tier IV for behavior showed a large, though not significant, negative change in FSA ELA. Critical theory asks, “Who benefits?” Students benefit from MTSS when their rate of change increases. Based on the present study's findings and the lack of significantly different increases in percentile, tiered interventions may not create the more equitable education system that researchers and policymakers had hoped.

Gender

Gender did prove to be a statistically significant moderator of percentile change. The analysis showed that female students showed statistically significant differences in the change in FSA ELA percentile. Specifically, female students in Tiers II, III, and IV showed positive changes in percentile, while their male counterparts showed negative changes in percentile. At Tier I, the change was almost identical. Statistically significant differences were unique to reading interventions and FSA ELA scores in Tier III. In addition to showing a negative change in Tiers II and III, male students were also over-represented in Tier III. Tier I effects are similar to Hattie's (2009) findings that gender has little difference in achievement. However, the data from the higher tiers does not support that conclusion. Whether the differences in achievement were a result of the intervention design is not known. Because of these results, future researchers should replicate this study to determine if this is a pattern unique to this population or an indication of a systemic issue that benefits female students over male students.

By contrast, mathematics interventions showed male and female students were evenly represented in Tiers I, II, and III. Tier IV showed more male students than female students; however, that does not reflect ESE services specific to mathematics; instead, it reflected students receiving Tier IV ESE services for academics. Therefore, the researcher could not determine whether the disproportionate gender patterns in Tier IV are related to reading, mathematics, or both. The gender disproportionality was even more significant for behavior interventions where male students were overrepresented in Tiers II, III, and IV. The fact that males were disproportionately represented in Tier III and IV is particularly troubling since Tier IV showed a negative change in percentile.

English Language Learners

Students who are English language learners showed statistically significant differences. The majority of those differences were LY students over other ELL groups. Because LY students were significantly different regardless of intervention level, the change was not likely due to effects from interventions. As discussed previously, LY students are in their first two years of support as English language learners (Florida Department of Education, 2019). Most likely, LY students' 2018 scores reflected their limited English proficiency, and the significant positive change in 2019 resulted from natural language acquisition over the year. By contrast, LF students who have exited the initial two years of support (Florida Department of Education, 2019) showed a statistically significant negative change in FSA ELA percentile. An LF student in the fourth grade is likely in their third or fourth year of learning the English language, so perhaps their scores are related to their limited English proficiency in first, second, or third grades, impacting their fourth-grade success. More specifically, perhaps those students have specific learning gaps related to English language learning that are not being addressed in their current tier of support. Because data were not collected on how interventions were implemented, no conclusions can be drawn for why results for LF students are negative. The negative change for LF students reveals a need to understand better how lack of English proficiency in primary grades impacts reading ability in intermediate grades.

Economically Disadvantaged

The FSA ELA and FSA Mathematics data analysis did not show statistically significant differences between students identified as economically disadvantaged and those not identified as economically disadvantaged. These findings should be interpreted cautiously since all economically disadvantaged students may not be identified as such. The Community Eligibility Provision of the National School Lunch Program (2021) allows whole schools to qualify for free breakfast and lunch based on the amount of the zoned school population that qualifies for government assistance. Because of the Community Eligibility Provision, individual students are not required to prove a financial need for free and reduced lunches, a common identifier for economically disadvantaged status. The lack of statistical significance should not be interpreted to mean students respond to interventions equally regardless of economic status; instead, it should be interpreted as an area needing further research.

Summary

Research Question 3 was driven by the Critical Race Theory question, “Who benefits?” The analysis of how demographic variables moderated intervention effects showed that the primary demographic subgroups who benefited from MTSS were females receiving Tier II and Tier III interventions for reading. This difference was the most statistically significant finding related to student demographic. While the analysis of race as a moderating variable did not yield statistically significant results, an important finding is that White students were over-represented in Tier IV for reading and mathematics, where the overall change in percentile was positive. On the other hand, Black students were overrepresented in Tier IV for behavior and Tier III for reading, which showed FSA ELA percentile changes were significantly negative. In short, Black students a smaller part of the more successful intervention tiers and were a larger part of the more successful intervention tiers.

English language learners showed significant differences in percentile change for FSA ELA and FSA Mathematics. The differences in mathematics and many of the differences in English language arts were likely due to natural acquisition of the English language during students' first two years in English-speaking schools. There were, however, significant findings for students in Tier III for reading who had been exited from ELL supports but had not yet demonstrated English proficiency. Evidence suggests that students who are limited in their English proficiency benefit, but those who have progressed beyond limited English proficiency are not benefitting from MTSS interventions. Further research is needed to confirm these findings and better understand why some students struggle with their language acquisition and achievement after their initial two years of support.

Finally, there were no significant findings for the interaction of economically disadvantaged status and intervention tier. Like other historically underperforming groups, economically disadvantaged students were over-represented in higher intervention tiers. As with other student demographic groups, the over-representation is cause for concern because the data did not show that students in Tiers II and III for reading or mathematics improved at a greater rate than their peers in Tier I. Evidence does not indicate that students who are economically disadvantaged are benefitting from MTSS. On the other hand, students in Tier IV showed positive change greater than that of Tier I, which offers hope for the effectiveness of Tier IV ESE services to close the learning gap for some students. Figure 16 summarizes the findings of the research questions.

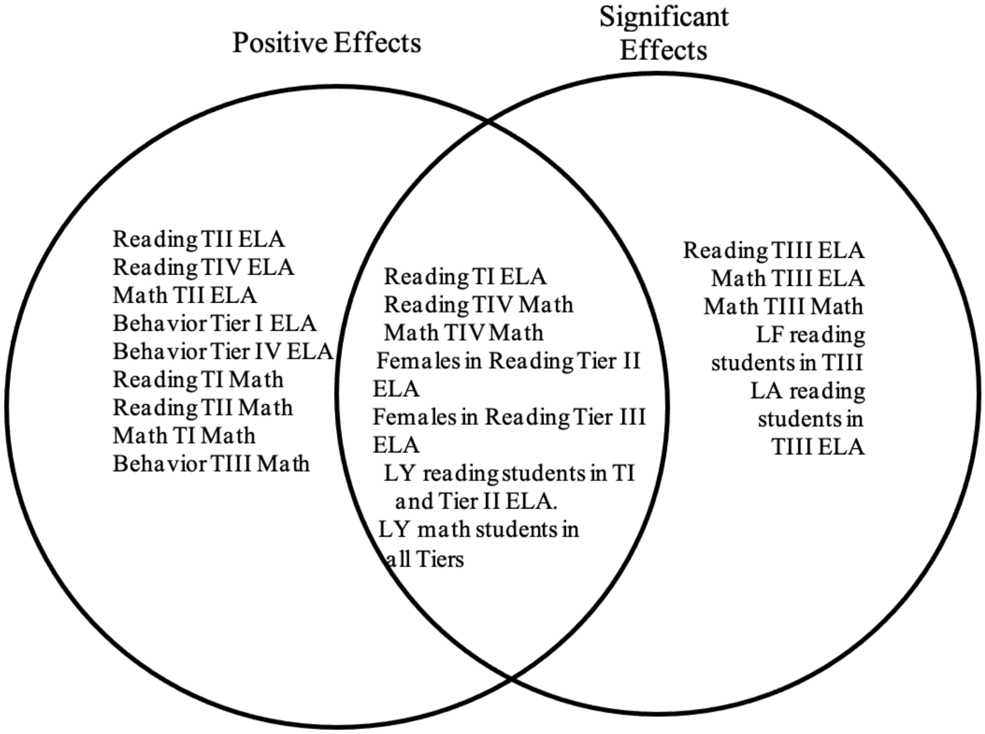


Figure 16. Venn Diagram of Positive and Significant Intervention Effects, with Positive Significant Effects in the Overlapping Area.

Limitations

The limitations of the study design led to limitations in the conclusions that can be drawn. Verifying the accuracy of the intervention documentation was outside the scope of the study, so results should be interpreted somewhat cautiously. Future researchers should include verifying the documentation in their research.

The researcher did not verify the fidelity of implementation for the reported interventions. Fidelity might affect the results if interventions were not implemented as designed. Because fidelity analysis was beyond the scope of the study, the researchers cannot conclude how implementation fidelity may have affected student achievement.

Although the population for the study was large (almost 4,000 students), the population of students came from a single grade level in one district in one state. Since their MTSS implementation and the student demographics vary by district and state, the results are not generalizable outside of the target district or other grade levels.

Data collected on Tier IV ESE services did not include whether students received ESE services for reading, mathematics, or both. Students who only qualify for services in one academic area may have been identified as receiving Tier IV ESE services for reading and mathematics. For this reason, the results of students who receive Tier IV ESE services may include students who receive services but not in the specific academic area. For example, a student may receive ESE services in reading only for SLD but was included in Tier IV for mathematics in this analysis. The data collected included the exceptionality, SLD, but did not include any information on specific services. Additionally, because data on services were not included, no conclusions could be drawn regarding whether specific services were associated with positive changes in percentile.

Many variables outside of the MTSS interventions may impact student achievement, such as student mobility, Tier I instruction quality, and the intervention's quality. In each case, gaps in the data limit the conclusions the researcher can draw that might explain the differences in achievement. Due to the limitations, the results should be interpreted cautiously.

Schools may set different criteria for placement in Tier II and Tier III, causing students in the same tier in different schools to have different skill levels. Differences in placement criteria may account for some of the generally unusual values of outliers; however, that cannot be determined because placement criteria were not collected.

Implications for Practice

MTSS has grown from being a problem-solving model for educators to find solutions to individual student behaviors to a service delivery model that includes multiple levels of interventions across multiple subjects with the promise of making every student succeed (Brown-Chidsey & Bickford, 2017). Unlike the results here, a recent meta-analysis of studies of reading interventions that meet *What Works Clearinghouse* guidelines showed significant positive effects on students' early reading (Gersten et al., 2020). Yet large-scale implementation studies show mixed effects (Albrecht et al., 2015; Balu et al., 2015; Bradshaw et al., 2010). Like Fuchs and Fuchs (2017) indicated in their response to the Balu et al. (2015) study, perhaps the target district was selecting and assigning students to reading or mathematics interventions based on assessment cut scores rather than a team-based assessment of the students' strengths and needs.

Lack of true problem solving may have limited the effectiveness of those interventions. The current study should not be interpreted as an indictment of MTSS as a service delivery system; rather, it provides further evidence of the need to understand the gap between experimental research and natural school implementation research. The implications of this research are essential for education policy leaders, state education agencies, and local education leaders.

Implications for Policy

Education policy leaders need to consider this and all MTSS research when creating state policies relating to MTSS. Based on the findings in this research, legal requirements to reduce the disproportionality of minority students labeled SLD or LD may be having an unintended negative consequence by allowing those students to languish in Tier III rather than improve their learning with the supports of Tier IV. The analysis results support the concerns of other researchers that RtI may reinforce existing educational inequalities (Kramarczuk & Voulgarides, 2017; Ladson-Billings, 1998; Sabnis et al., 2019).

Policy leaders need to dive into and encourage further research into exactly who benefits from interventions before writing policies that require participation in particular interventions based on cut-scores. A foundational assumption of MTSS is that Tier I instruction is effective for 80% of students (Gresham & Little, 2012; Nelson et al., 2018). Well-intentioned policies requiring all students below a particular percentile receive Tier III services may create a strain on Tier III that stretches schools' resources. The requirements may make interventions less effective. One of Fuchs and Fuchs's (2017) criticism of the Balu et al. (2015) study was that their cut score, the 40th percentile, was too high, possibly leading to ineffective interventions. The prevention model assumes that most will receive the help they need at lower levels of intervention, and fewer people will need the most intensive supports. Policies that require intervention participation may tax the resources of the intensive interventions, thereby making them less effective.

MTSS requires schools to implement research-based interventions (Florida Department of Education, 2018a). Educational leaders should hold themselves to the same research-based requirement when writing educational policies.

State education agencies need to consider this research when evaluating the effectiveness of MTSS in their states. School's MTSS implementation is measured by self-reported scales, student achievement measures, and subgroups' performance. State education agencies who wish to understand the effects of MTSS need to create systems by which they can monitor how students in specific tiers are performing. There is no way to know whether the results of this study are unique to the population, the district, or the state. If such a database existed, state MTSS leaders and policymakers could determine to what extent the results here were unique. Additionally, researchers and district leaders could determine where MTSS results increase the rate of change for students. Analysis of MTSS intervention data across the state would allow the Florida Department of Education to provide districts clear research-based policies and procedures for implementing MTSS.

This research should signal leaders in other districts to ask the same questions. If Tier II and Tier III academic interventions do not have the intended positive effect on this population, perhaps those interventions do not have the desired effect on their population either. Similarly, given the positive effects of Tier III behavior interventions, other districts' leaders should conduct analyses to determine whether Tier III is equally effective for their students. Perhaps because there are fewer students in Tier III for behavior, MTSS problem-solving teams can engage in the discussion and data analysis necessary to match the intervention to the student's need. Perhaps they cannot engage in the same quality of problem-solving for reading and mathematics because the volume of students is too great.

Finally, the target district should continue to dig into the available data to determine what is and what is not working in their MTSS. The results did not indicate that MTSS in the target district had the desired effect on the target population. However, the target population was one cohort of students. Perhaps this cohort of students was unique. Perhaps during the 2018-2019 school year, policies, such as the designation of schools in need of improvement, were enacted that put a microscope on improving ESE services (Florida Department of Education, 2018a). These types of policy changes could have limited resources for Tier II and Tier III interventions. It is also possible that differences between the third-grade and fourth-grade FSA ELA or FSA mathematic affected struggling students differently. Ideally, comparing the same cohort using data from 2020 would provide a deeper understanding of this study's results. Unfortunately, due to the COVID-19 pandemic, students did not take the FSA ELA and FSA Mathematics in 2020, making that data unavailable.

For educational researchers, this study points to the need for replication research. Without replication studies, educators cannot know whether this research is indicative of a problem with MTSS in the specific population or MTSS as a model for improving academic outcomes. Further, MTSS researchers need to establish some coherent understanding of the academic goals of MTSS interventions. MTSS researchers need to determine if the goal is to have an immediate effect measured by micro-assessment data or to have long-term effects measured by macro-assessments. If the goal is to affect both, then research needs to be done to determine which factors are present when MTSS affects both proximal and distal achievement measures and when it does not.

Recommendations for Future Research

Future research on MTSS needs to explore the gap between randomized control trials and natural school settings. The present study looked only at macro-assessments, whereas studies of specific interventions tend to look at micro-assessment or meta-assessment results (Gersten et al., 2020). Because federal programs such as the *Every Student Succeeds Act* (2015), and state evaluation systems use state standardized test data to measure schools. Research on the effectiveness of interventions should include data on state achievement tests. Educational leaders have to use research-based interventions for MTSS; however, researchers do not investigate the effects of intervention programs for Tier II versus Tier III. Because of the lack of research, school leaders may be using interventions that have positively impacted students in Tier II but not students in Tier III. Further, the divergent results between academics and behavior interventions suggest a need to better understand the effects of standard protocol approaches compared to individualized problem-solving. Similarly, given a large number of students in academic interventions compared to behavior interventions, future researchers may want to explore whether large numbers of students in a particular tier of intervention lead to assignments to interventions that are not a good fit based on students' needs.

The current study included several limitations: the accuracy of intervention documentation, implementation fidelity, criteria for placement in Tier II and Tier III, and school-level variables (e.g., schedule of intervention implementation). Future researchers could improve this study by identifying the population, then tracking the interventions during the school year. This approach would allow the researcher to verify that interventions were input correctly, collect data on implementation, such as how often interventions occurred, what intervention materials were used, and progress monitoring data. In addition, collecting and verifying data on the specifics of MTSS implementation would allow future researchers to understand better some of the findings in the current study, including:

- Why females showed a greater change in percentile than males,
- Whether economic disadvantaged status moderates intervention effects in areas without community eligibility.
- Why LF students showed a negative change in percentile.
- The commonalities of outlying students who showed a positive change in their percentile score within one intervention tier.

Researchers may want to compare the change in achievement the year before the intervention to determine whether interventions, while not increasing the rate of change, were mitigating the rate of learning loss. The researcher could not collect accurate data on the amount of time students were in an intervention level; future researchers may want to investigate this variable (time in intervention level) in future research. Finally, future researchers should also explore whether students in Tier IV for academics showed greater change due to their additional services or testing accommodations.

Conclusions

The present study sought to address a gap in the literature by studying the effects of tiered intervention systems on student achievement in the natural school setting. The population for the study was one cohort of fourth-grade students in a Central Florida school district. Students were coded into Tier I, II, or III based on their highest reported level of intervention during the 2018-2019 school year. Students receiving ESE Services were coded into Tier IV because, in Florida, students who qualify for ESE Services have accommodations and supports that are not available to the general population. The quantitative analysis was an ANOVA of the change in FSA ELA and FSA Mathematics percentile from 2018 to 2019.

The analysis found students in Tier III for reading and mathematics interventions showed mean changes in the percentile that were significantly negative. In contrast, students in Tier I and Tier IV showed significant positive change. Behavior interventions showed different effects than academic interventions. Students in Tier III demonstrated significant improvement for FSA Mathematics and a large but not significant change for FSA ELA. The number of students in Tier III and Tier IV behavior interventions was low, so one must interpret these results with caution. While the study results revealed that gender and English language learner status moderate the effects of interventions, race and economic status did not moderate intervention effects.

The findings do not indicate that MTSS is a failure; instead, the findings further prove a gap between the research on interventions and how those interventions impact student achievement in the natural school setting. Living systems theory posits three levels of living organisms; process, pattern, and structure. When researchers isolate interventions, they look only at the process of the intervention. When schools enact an intervention, the patterns of the school culture and the structures of the school and district change how those interventions impact students. The present study points to a need to understand better what aspects of culture impact the effectiveness of MTSS. The Critical Race Theory literature points to teachers' underlying assumptions about race, class, and student achievement as a barrier to the effectiveness of blanket policies that try to address inequity (Ladson-Billings, 1998). Perhaps teachers have unconscious beliefs about their students that are impacting the effectiveness of interventions. On the other hand, the structural efforts to reduce the number of historically marginalized students labeled ESE may contribute to those students languishing in Tier II or III rather than being evaluated for Tier IV ESE services.

Implementation guides for MTSS lead educational leaders to believe MTSS is a simple triangle of supports. In reality, various supports, services, and variables combine to form a complicated web of supports. Researchers and educators need to work together to understand better how the structures and patterns of MTSS interact to impact student achievement.

The research questions for this study asked whether tiered interventions impacted students' achievement. The answer was yes, the intervention has an impact. The impact, however, did not match the theoretical construct of MTSS as a service delivery model. Students in Tier II and Tier III did not show evidence that they were increasing their rate of change relative to their Tier I peers. The findings are similar to other high-level analyses of MTSS effects, such as Balu and colleagues (2015), Muscott and colleagues (2008), and Scott and colleagues (2019) but are very different from the results of studies of effects of specific interventions (ALSuliman, 2010; Austin et al., 2017; Bergstrom & Zhang, 2016; Cartwright et al., 2002; Dale et al., 2018; DeFouw et al., 2019; Gersten et al., 2020; VanDerHeyden & Codding, 2015; Weisenburgh-Snyder et al., 2015). The present study results underscore the need to dig deeper into the data, patterns, structures, and processes of MTSS to understand better how MTSS changes student achievement.

The bulk of research on MTSS has centered on the question, “Do interventions improve student achievement?” These studies provide pretty clear answers: yes, interventions appear to improve student outcomes (ALSuliman, 2010; Austin et al., 2017; Bergstrom & Zhang, 2016; Cartwright et al., 2002; Dale et al., 2018; DeFouw et al., 2019; Gersten et al., 2020; VanDerHeyden & Codding, 2015; Weisenburgh-Snyder et al., 2015). The present study adds to the small but growing body of literature in which researchers seek to understand where, when, and for whom does MTSS improve student achievement (Balu et al., 2015; Gage et al., 2015; Muscott et al., 2008; Nelson et al., 2018; Scott et al., 2019). This area of MTSS research does not report clear yes and no answers and often leads to more questions. As Lloyd Alexander wrote in their 1964 novel *The Book of Three*, “In some cases…we learn more by looking for the answer and not finding it than we do from learning the answer itself” (p. 7).

APPENDIX A: FLORIDA EXCEPTIONAL STUDENT EDUCATION CODES

FLORIDA DEPARTMENT OF EDUCATION
DOE INFORMATION DATABASE REQUIREMENTS VOLUME I:
AUTOMATED STUDENT INFORMATION SYSTEM
AUTOMATED STUDENT DATA ELEMENTS

Year: 2019-20

Data Element Number: **118400**

Data Element Name: **Exceptionality**

A code to identify each exceptionality including the primary exceptionality and all other exceptionalities (including related services) for any student enrolled in or eligible for enrollment in the public schools of a district who requires special instruction or related services to take full advantage of or respond to educational programs and opportunities because of a physical, mental, emotional, social or learning exceptionality. The codes to be used are:

Code	Definition/Example
C	Orthopedically Impaired
D	Occupational Therapy
E	Physical Therapy
F	Speech Impaired
G	Language Impaired
H	Deaf or Hard of Hearing
I	Visually Impaired
J	Emotional/Behavioral Disability
K	Specific Learning Disabled
L	Gifted
M	Hospital/Homebound
O	Dual-Sensory Impaired
P	Autism Spectrum Disorder
S	Traumatic Brain Injured
T	Developmentally Delayed
U	Established Conditions

Data Element Number: **118400**

Data Element Name: **Exceptionality**

V	Other Health Impaired
W	Intellectual Disability
Z	Not Applicable

Historical Notes:

1995-96 Code R was collapsed into Code H
2007-08 Code Q was collapsed into Code J [s. 1003.01(3)(a), Florida Statutes]
2008-09 Codes A, B, and N were collapsed into Code W [s. 1003.01(3)(a), Florida Statutes]

Length: 1

Data Type: Alphabetic

Year Implemented: 9798

State Standard: Yes

Use Types:

State Reporting: No

Local Accountability: Yes

FASTER: Yes

Migrant Tracking: No

Required Grades: PK-12

Programs Required:

Exceptional Student Education

Formats Required:

None

Surveys Required:

None

Appendixes:

None

Description of Changes:

7/1/2017	Definition	**Replaced 'child or youth' with 'student.'**
7/1/2016	Definition	**Updated definition to include "related services."**
10/18/2011	Codes	This is not a revision, but a correction resulting from an error made during the conversion process to the new data element format. **Code 'W' was omitted from the 2011-12 element that should have carried forward from 2010-11. Thus, code 'W' is being added back** to the list of exceptionalities.
8/4/2011	Surveys Required	Removed Exceptionality from all Surveys required.
8/4/2011	Formats Required	Removed Exceptionality from all formats required.
8/4/2011	Use Type	Removed State Reporting from Use Type.

Page 2 of 3

(Florida Department of Education, 2020)

APPENDIX B: DEIDENTIFIED PERMISSION FROM CENTRAL FLORIDA SCHOOL DISTRICT TO CONDUCT RESEARCH

November 18, 2020

[redacted]

Dear Ms. Strange:

This letter is to inform you that we have received your request to conduct research in our School District. Based on the description of the research you intend to conduct, I am pleased to inform you that you may proceed with your work as you have outlined. Please be advised that this approval is based on the understanding that a school's participation is completely voluntary and left to the discretion of each building administrator. Please also be advised that the district office will not be able to assist you with any aspect of your research (e.g. sending emails, obtaining data, locating students, providing addresses, etc.).

Finally, be reminded that all information obtained for the purpose of your research must be dealt with in the strictest of confidentiality. At no time is it acceptable to release any student or staff identifiable information. Upon completion of your research, please provide our office with a copy of your results.

I wish you the best of luck in your future endeavors. If I can be further assistance, please do not hesitate to contact me.

Sincerely,

[redacted]

[redacted]

Research, Evaluation & Accountability

APPENDIX C: UCF INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

UCF

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

NOT HUMAN RESEARCH DETERMINATION

December 9, 2020

Dear Hope Strange:

On 12/9/2020, the IRB reviewed the following protocol:

Type of Review:	Initial Study
Title of Study:	A CAUSAL-COMPARATIVE EXAMINATION OF THE DIFFERENTIAL EFFECTS OF TIERED INTERVENTIONS WITHIN THE MTSS FRAMEWORK IN ONE INTERMEDIATE GRADE
Investigator:	Hope Strange
IRB ID:	STUDY00002440
Funding:	None
Grant ID:	None
Documents Reviewed:	• Disseration Data Column Headings (Version 2).xlsx, Category: Other; • Hope Strange, Category: IRB Protocol; • Hope Strange Osceola Research Project Request.docx, Category: Other; • Strange Research Notification Letter.pdf, Category: Other;

The IRB determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.

IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving human in which the organization is engaged, please submit a new request to the IRB for a determination. You can create a modification by clicking **Create Modification / CR** within the study.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

UNIVERSITY OF CENTRAL FLORIDA

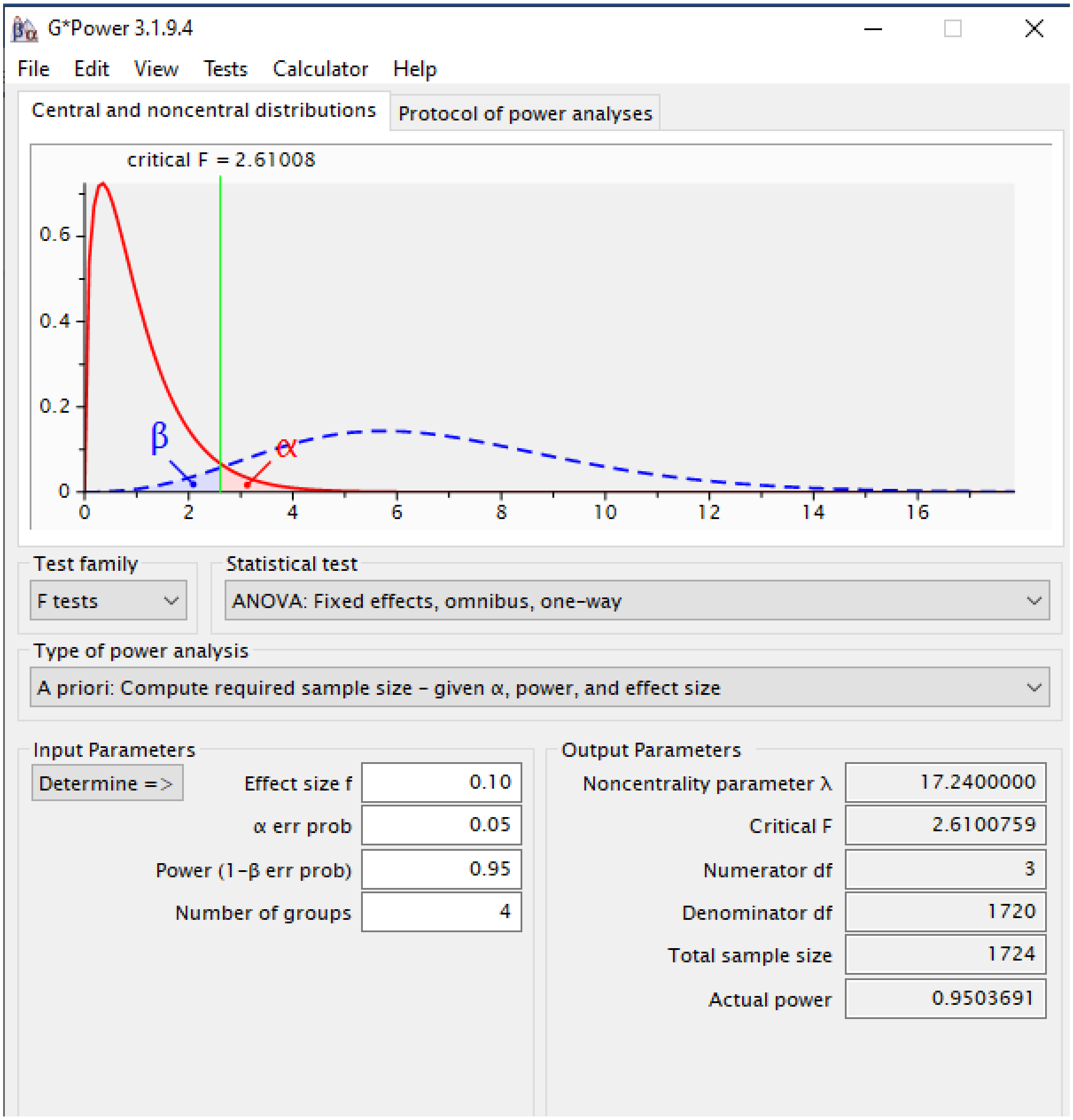
Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

Renea Carver

Renea Carver
Designated Reviewer

APPENDIX D: G POWER ANALYSIS

Small Effect Size



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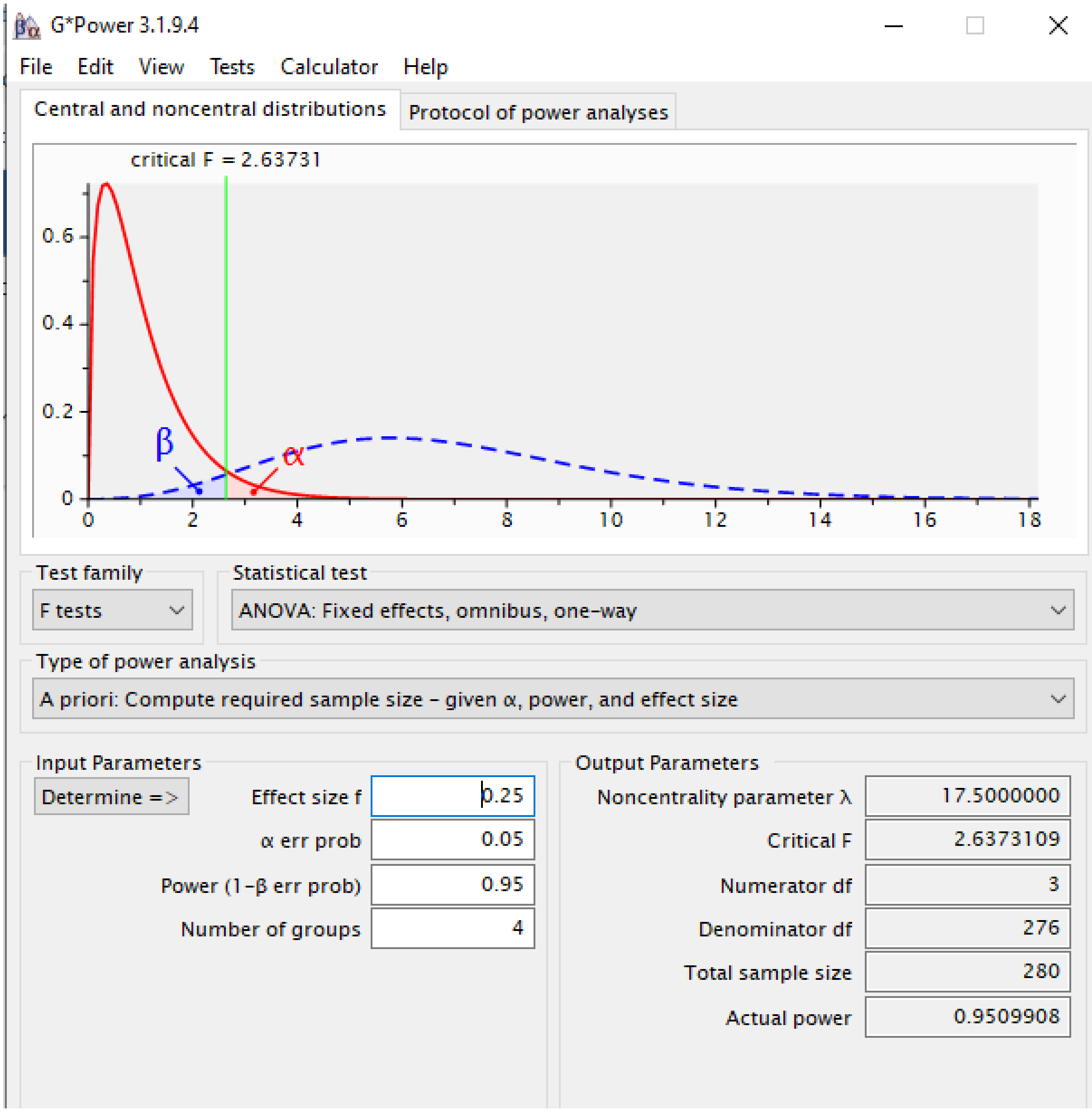
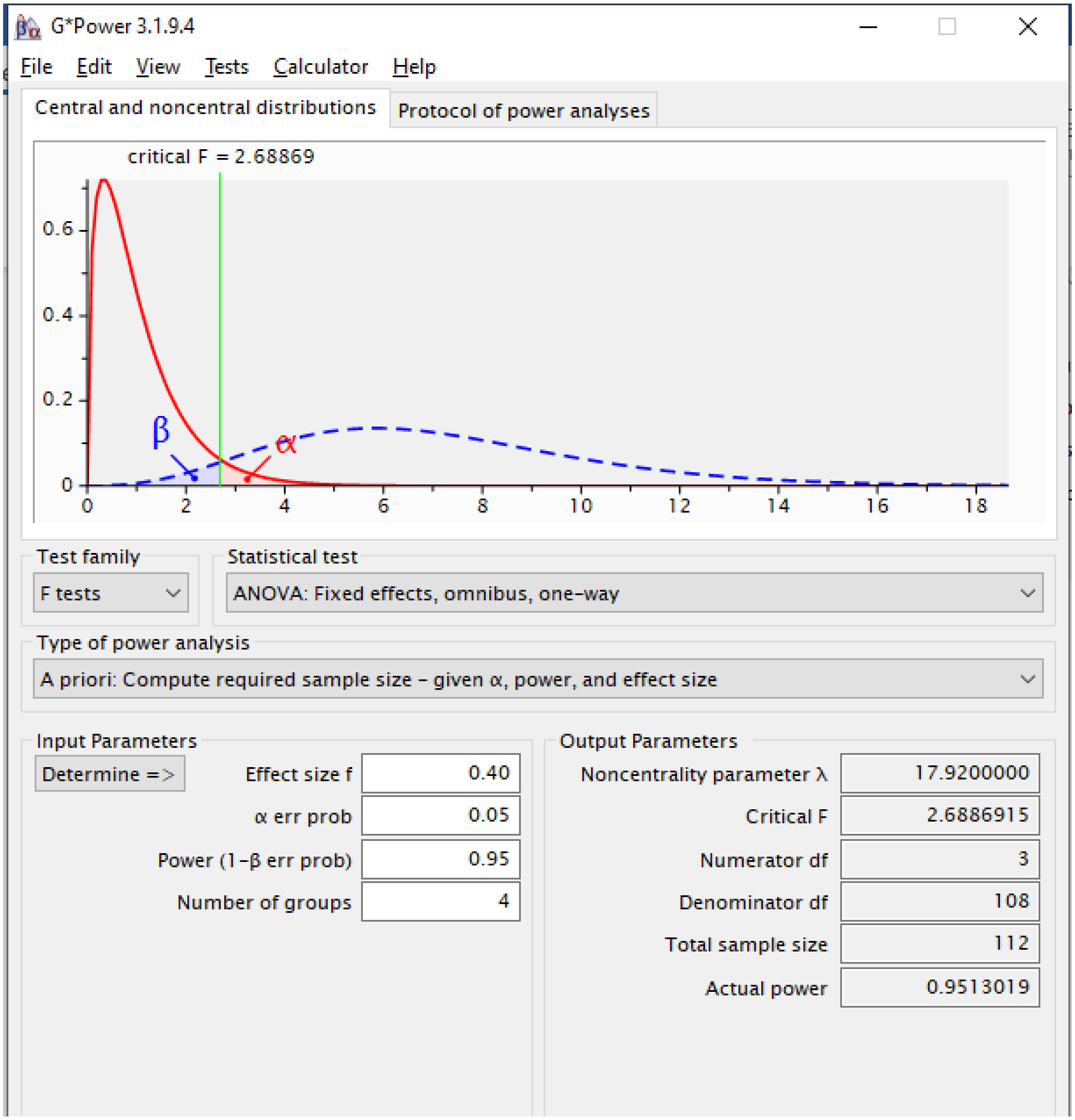


Large Effect Size



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