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Outcomes of a School-Wide Mathematics Intervention

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This is to certify that the doctoral study by

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and that any and all revisions required by
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Walden University
2020

Abstract

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by

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MA, State University of New York at Buffalo, 2008

BS, University of New Mexico, 1998

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

In response to students' poor algebra achievement, Midtown High School, a pseudonym, implemented a school-wide math intervention and enrichment program during the 2014-2015 school year. The purpose of this mixed-methods study was to assess the influence of the intervention on Algebra I and Algebra II end-of-course (EOC) exam achievement scores as well as explore math teachers' perspectives of the intervention program. The theoretical foundation was constructivism. A consensus sample using archival data from all 419 high school students taking Algebra before the intervention 2013-2014 and after the intervention 2014-2015 and 2015-2016 were used with teacher interviews for triangulation. ANOVA results indicated a significant difference between the treatment and comparison groups, $F(1,403) = 12.91$, $p = .00$. As related to Algebra I, the intervention group performed significantly lower than the comparison group ($M = 40.99$ and $M = 52.26$, respectively). There were no significant differences found for Algebra II EOC scores for either the 2014-2015 or 2015-2016 school years. Qualitatively, the most notable theme was inadequate implementation fidelity of the intervention program, which helped explain the lower Algebra I performance of the treatment group. Based on these results, a policy recommendation was developed for the school to create and implement a systematic process for measuring academic intervention implementation fidelity, to include creating a leadership team and the introduction of a systematic process for improving measurement fidelity. Following policy recommendations could lead to social change by improving high school mathematics achievement, thereby improving high school graduation rates and increasing postsecondary opportunities.

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Section 1: The Problem

The Local Problem

In response to concerns regarding school-wide math outcomes on state Algebra I and Algebra II End of Course (EOC) exams, Midtown High School (MHS), a pseudonym for an urban high school in Tennessee (TN), developed and implemented a school-wide math intervention and enrichment program during the 2014-2015 school year (Jefferson, 2013). However, the effectiveness of the program on student performance after implementation was unknown as a whole as well as by specific subgroups, including gender, students served by special education, ethnicity, and economically disadvantaged students. TN underperformed in mathematics based on both the National Assessment of Educational Progress (NAEP) and the American College Testing (ACT) assessment. Also, TN underperformed on proficiency rates on their EOC exam scores. Furthermore, MHS underperformed in comparison to other TN high schools (Broderick, 2016; Tennessee Department of Education [TDOE], n.d.-a; U.S. Department of Education [USDOE], 2013).

TN public schools participate in the NAEP assessments, and only 17% of 12th graders from TN scored at the proficient level or higher in mathematics on the NAEP assessments (USDOE, 2013). Also, TN requires all students to take the ACT in their 11th grade year (ACT, 2015). In 2015, 30% of students in TN met the national benchmark in mathematics as measured by the ACT while 42% of students nationally met the national benchmark (Broderick, 2016). Additionally, TN requires all high school students receiving a high school diploma to complete four years of mathematics, to include one year of each of the following: (a) Algebra I, (b) Geometry, and (c) Algebra II or (a) Integrated Math I, (b) Integrated Math II, and (c) Integrated Math III (TDOE, n.d.-a). The Integrated Math course series integrates algebra, geometry, statistics, and trigonometry as appropriate into each of the courses for more holistic and relevant math instruction (TDOE, n.d.-a). Currently, both Algebra I and Algebra II require an EOC exam developed by the state, which is worth 25% of student second-semester grades in those courses (TDOE, n.d.-a). EOC assessment scores are the State of Tennessee's summative assessment scores and used for decision-making at the state, district, and school level (TDOE, n.d.-a).

On average, in TN, 63.4% of students scored proficient or higher on the Algebra I EOC in 2014, while only 47.9% of students scored proficient or higher on the Algebra II EOC (TDOE, n.d.-a). MHS fell below that state average, with 47.2% of students scoring proficient or higher on the Algebra I EOC in 2014 and 39.9% of students scoring proficient or higher on the Algebra II EOC, as detailed in Table 1 (TDOE, n.d.-a). The leadership at MHS sought to focus on student growth in mathematics, as measured by the Tennessee Value-Added Assessment System (TVAAS), which is based on EOC scores and used by the state to measure growth (assistant principal, personal communication, May 15, 2015). Proficiency levels for MHS are delineated in Table 1.

An examination of Algebra I proficiency trends indicated MHS had a higher percentage of students scoring Below Basic than both the district and the state and a much lower percentage of students scoring Advanced than the state in both 2013 and 2014 (TDOE, n.d.-a). An examination of Algebra II proficiency trends yielded similar results; MHS had a higher percentage of students scoring Below Basic than both the district and the state and a lower percentage of students scoring Advanced than the district in both 2013 and 2014 (TDOE, n.d.-a). Comparisons between MHS, their district, and the state of Tennessee are shown in Figures 1 and 2.

Table 1

Algebra I and Algebra II EOC Percentage Trends for MHS

Class/Year	Below Basic	Basic	Proficient	Advanced
Algebra I 2012	33.0	46.4	16.7	3.9
Algebra I 2013	23.4	23.0	35.7	17.9
Algebra I 2014	23.8	29.0	31.8	15.4
Algebra II 2013	52.4	30.8	13.8	3.0
Algebra II 2014	19.7	40.4	31.1	8.8

Note: (TDOE, n.d.-a)

A school mathematics leader expressed concerns about poor math preparation in earlier grades, citing poor assessment scores on the Tennessee Comprehensive Assessment Program (TCAP) by entering freshmen, as a contributing factor to poor high school math achievement overall (MHS Mathematics Department head, personal communication, January 5, 2015). Other factors contributing to low student achievement included poor Algebra I EOC scores for upper-level students and a lack of student motivation for success in high school mathematics (MHS Mathematics Department head, personal communication, January 5, 2015; TDOE, n.d.-a). In 2014-2015, MHS implemented a school-wide intervention and enrichment program, designed by school staff to address student under-preparedness and lack of motivation, for mathematics achievement (Jefferson, 2013). The school's goal, according to school leadership (assistant principal, personal communication, May 15, 2015), was to improve student math proficiency (i.e., Below Basic, Basic, Proficient, and Advanced) on math EOC exams. Interventions have been shown to improve secondary school achievement in reading and mathematics (Cortes, Goodman, & Nomi, 2014; Regional Education Laboratory West [RELW], 2015; Sarfo, Eshun, Elen, & Adentwi, 2014; Vaughn & Fletcher, 2012; Vaughn & Swanson, 2015). Additionally, school-wide interventions have been shown to be effective for raising overall student performance (Cortes et al., 2014; RELW, 2015; Sarfo et al., 2014; Vaughn & Fletcher, 2012).

The school-wide intervention developed by MHS used a tiered approach based on the previous year's end of year state math assessment data (Jefferson, 2013). Students scoring basic or higher on the previous year's state math assessment received enrichment designed to hone problem solving skills while teaching relevance (MHS Mathematics Department head, personal communication, January 5, 2015). Moderately struggling students received additional course instruction aimed at re-teaching specific topics and skills (MHS Mathematics Department head, personal communication, January 5, 2015). Severely struggling students and students with disabilities participated in computer-based skills intervention (MHS Mathematics Department head, personal communication, January 5, 2015). All students participated in the intervention for one hour each week (MHS Mathematics Department head, personal communication, January 5, 2015). Additionally, there was a school motto that was shared school-wide each morning and afternoon, and a school problem of the week that all students worked in their math classes. The students also discussed these problems in other classes, if the math problems were relevant to those classes (MHS Mathematics Department head, personal communication, January 5, 2015).

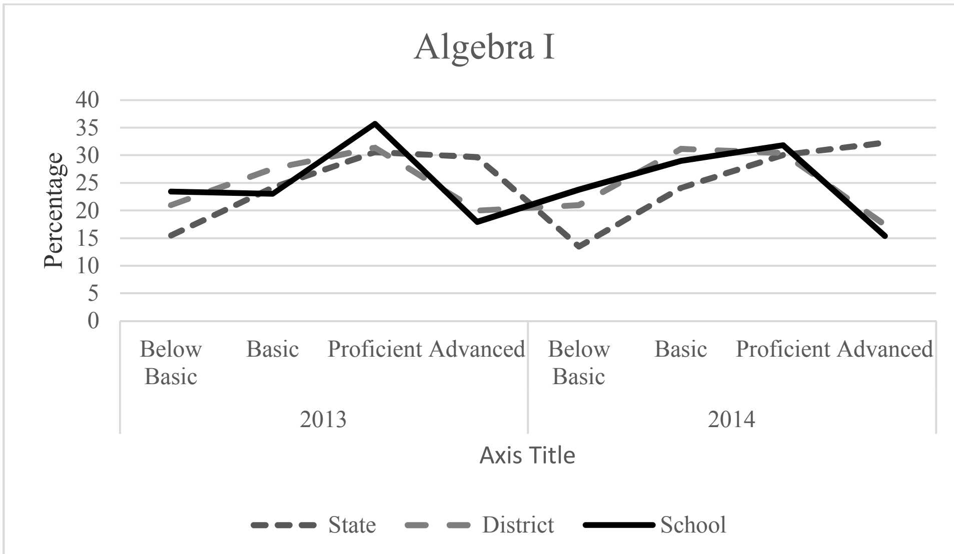

Figure 1: Algebra I EOC proficiency trend comparisons for TN, Midtown District, and MHS. (TDOE, n.d.-a)

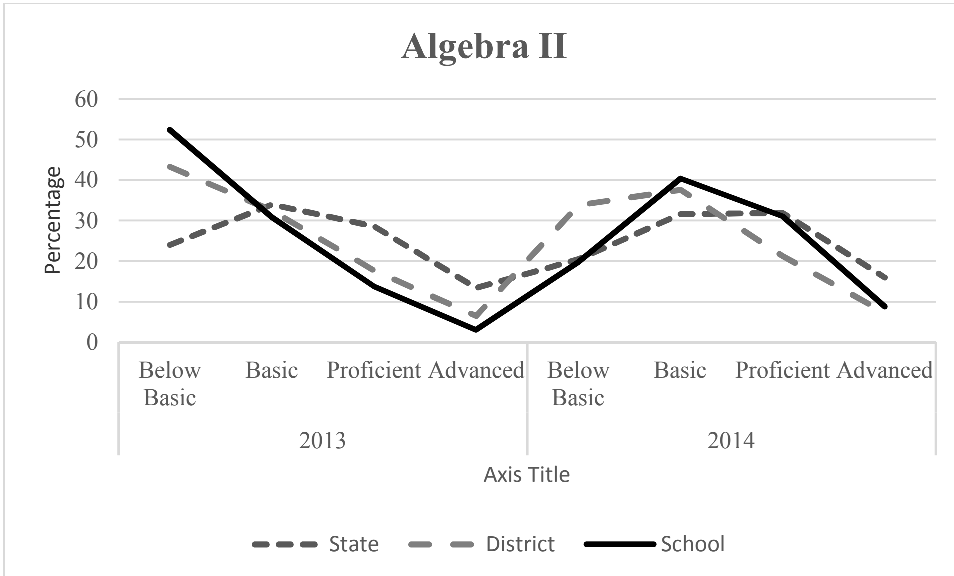

Figure 2. Algebra II EOC proficiency trend comparisons for TN, Midtown District, and MHS. (TDOE, n.d.-a)

Although student growth improved considerably in the 2014-2015 school year, the school did not meet their goal of a TVAAS greater than 1 in mathematics (TDOE, n.d.-a). It was unknown as to whether or not the improved achievement was significant. In other words, the benefit to subgroups such as students served by special education, economically disadvantaged students, whether there were gender and ethnic subgroup differences, and whether there were grade level and class level differences. Comprehensively understanding the impact of the intervention and enrichment program on student growth and achievement, enables school staff to improve their intervention efforts, hopefully, leading to greater student growth.

Rationale

MHS is located within a large urban school district, is situated in the southwest section of the district, and is fairly high performing in comparison to other comprehensive high schools within the district (TDOE, n.d.-a). The district is 72.7% low income, with 15.3% of students English Language Learners (ELL) and 12.4% of students with disabilities (TDOE, n.d.-a). The value-added district data indicated that while predicted growth was achieved for Algebra I for the 2013-2014 school year and the 3-year gains were above expectations, predicted growth was not achieved for Algebra II for the 2013-2014 school year. Also, the 3-year gains were below expectations (TDOE, n.d.-a). MHS is 56.7% low income, with 7.4% of students classified as ELL and 16.6% of students with disabilities (TDOE, n.d.-a). Specifically, MHS did not meet their targeted achievement in Algebra I, 56.5% proficient or higher. While they performed considerably higher than their targeted achievement in Algebra II, 22% proficient or higher, they still fell below the state average of 47.9% proficient or higher (TDOE, n.d.-a). In response, school administrators decided to expand a freshman intervention and enrichment weekly class to the entire school, to focus on math improvement (Jefferson, 2013).

The intervention and enrichment program employed at MHS had three levels: (a) computer-based intervention, Study Island, at an instructional level to build basic math skills and fill in achievement gaps for low-performing students receiving special education services; (b) teacher led intervention to build algebra skills in areas of struggle, provide individual guidance, and provide more opportunities for problem solving practice for students who scored below basic on their previous state math assessment; and (c) teacher led enrichment to build relevance and expand problem solving capabilities for students who scored basic or higher on their previous state math assessment. This program was designed based on many of the tenets of constructivism: constructing knowledge through discovery and background knowledge, developing conceptual understanding through problem solving, interactive teaching through individual feedback and guidance, specifically designed activities involving realistic problems, and a learner-centered approach (Narode, 1987; Pitt & Kirkwood, 2010; Prendergast & Donoghue, 2014; Sharma, 2014). Given that the design of the intervention and enrichment program was based on many of the guiding principles of constructivism, it seems appropriate to use constructivism as a framework for studying the outcomes of the program.

The purpose of this mixed-methods study was two-fold. First, I wanted to assess whether there were differences in student algebra achievement after implementing a school-wide intervention and enrichment program at MHS in Algebra I and Algebra II achievement and student growth in mathematics. Quantitative methods were used to test for significant improvements among the student subgroups (i.e., ethnicity, special education status, socioeconomic status, and gender). Second, qualitative interviews were conducted to explore teacher perspectives about the efficacy of the intervention program.

Definition of Terms

Algebra: A mathematical topic of study that includes, among other related topics, "the arithmetic of signed numbers, solutions of linear equations, quadratic equations, and systems of linear and/or quadratic equations, and the manipulation of polynomials, including factoring and rules of exponents" (Katz, 2007, pp. 185-186).

Common Core State Standards (CCSS): New standards built on the best of high-quality math standards from states across the country and drawn from the most important international models for mathematical practice (Common Core State

Standards Initiative [CCSSI], 2015). CCSS "concentrates on a clear set of math skills and concepts. Students will learn concepts in a more organized way both during the school year and across grades. The standards encourage students to solve real-world problems" (CCSSI, 2015, para 5).

Economically Disadvantaged Students: Up through the 2014-2015 school year, students were classified as economically disadvantaged according to the free or reduced-price lunch status. This changed in the 2015-2016 school year in TN as some districts began in the 2014-2015 school year to provide free meals to all students. In 2015-2016, the following students were considered economically disadvantaged: (a) students identified as receiving food stamps, (b) students who participated in the Temporary Assistance for Needy Families program, (c) students who are homeless, (d) students who are foster children, and (e) those who are Head Start participants (USDOE, 2012; Wilson, 2016).

Enrichment: Enrichment refers to the learning environment a student experiences while at school. Enrichment can be measured, and there are many ways to further the enrichment of students (IAC Publishing, 2017).

Integrated Math: A mathematics educational approach that integrates multiple mathematical areas. Each high school math course covers topics in algebra, geometry, statistics, and other appropriate subject matter (Mathnasium, 2018).

Intervention: Differentiated and targeted instructional practices utilizing data-based decision making to inform instruction (Patterson & Musselman, 2015).

Proficiency: Proficiency refers to measurements on standardized tests, such as proficiency levels, scales, and cut-off scores (Great Schools Partnership, 2014).

Student Performance: Knowledge and skills mastered by students in a course or subject area, usually measured by assessments and based on predetermined educational criteria (Lee, 2019).

Significance of the Study

Completing Algebra II in ninth grade is a significant predictor of postsecondary success, according to the College & Career Readiness & Success Center (CCRS, 2013). Similarly, completing Algebra II in high school increases the chances of attending college and being prepared for technology-based jobs that may or may not require college coursework (ACT, 2007; Kim, Kim, DesJardins, & McCall, 2015a). Additionally, passing Algebra I significantly increases the probability of graduating from high school, broadening employment opportunities, and improving wages (Schachter, 2013).

This study addressed a local problem, algebra achievement at an urban public high school, MHS. This project study was unique as the purpose was to study the impact of a school-wide mathematics intervention program developed by school staff and implemented at MHS during the 2014-2015 school year. The results of this study provided information about the effects of the intervention on student algebra achievement and student growth in mathematics, enabling MHS to continue to improve algebra intervention efforts and allowing other high schools to learn through MHS's efforts. Of specific interest were the impacts of the intervention on economically disadvantaged students, ethnically diverse students, female students, and students served by special education. Given that United States high school students, TN state students specifically, perform poorly in mathematics, evidence of how such a school-wide intervention and enrichment program impacted student algebra achievement outcomes in mathematics could inform future intervention and enrichment efforts (TDOE, n.d.-a; USDOE, 2013).

Research Questions and Hypotheses

In response to their students' poor algebra achievement, MHS implemented a school-wide math intervention and enrichment program during the 2014-2015 school year. The purpose of this study was to assess the efficacy of the intervention by comparing Algebra I and Algebra II EOC exam achievement scores before and after intervention implementation and by exploring math teachers' perspectives of the intervention program. The purpose of research questions is to state the specific questions researchers strive to answer (Creswell, 2012). In accordance with the framework for this study, the research was guided by three quantitative (QN) and one qualitative (QL) research questions. The quantitative elements of the study were guided by the following quantitative questions and hypotheses.

QNRQ1 – What is the difference in student achievement as measured by the Algebra I EOC from the 2014-2015 school year, the year after the school-wide intervention and enrichment program was implemented, and the 2013-2014 school year, the year before implementation?

$H_0 1$: There is no difference in student Algebra I achievement scores between the 2013-2014 school year and the 2014-2015 school year.

H_a1: There is a difference in student Algebra I achievement scores between the 2013-2014 school year and the 2014-2015 school year.

1. Categorical Variables
    a. Nominal: Gender, Special Education Status, Socioeconomic Status
    b. Ordinal: Ethnicity
2. Continuous Variable: Algebra I achievement score means

It is important to know for which students the intervention made the most impact. This research question was explored in total for all students, as stated in the research question, and for specific subgroups. The specific subgroups compared, based on the hypotheses were gender, social economic status, special education status, and ethnicity.

QNRQ2: What is the difference in student achievement as measured by the Algebra II EOC from the 2014-2015 school year, the year after the school-wide intervention and enrichment program was implemented, and the 2013-2014 school year, the year before implementation?

H_02: There is no difference in student Algebra II achievement between the 2013-2014 school year and the 2014-2015 school year.

H_a2: There is a difference in student Algebra II achievement scores between the 2013-2014 school year and the 2014-2015 school year.

1. Categorical Variables
    a. Nominal: Gender, Special Education Status, Socioeconomic Status
    b. Ordinal: Ethnicity
2. Continuous Variable: Algebra II achievement score means

It is important to know for which students the intervention made the most impact. This research question was explored in total for all students, as stated in the research question, and for specific subgroups. The specific subgroups compared, based on the hypotheses, were gender, social economic status, special education status, and ethnicity.

QNRQ3: What is the difference in student achievement as measured by the Algebra II EOC from the 2015-2016 school year, two years after the school-wide intervention and enrichment program was implemented, and as the 2013-2014 school year, the year before implementation?

$H_0$3: There is no difference in student Algebra II achievement scores between the 2013-2014 school year and the 2015-2016 school year.

H_a3: There is a difference in student Algebra II achievement scores between the 2013-2014 school year and the 2015-2016 school year.

1. Categorical Variables
   a. Nominal: Gender, Special Education Status, Socioeconomic Status
   b. Ordinal: Ethnicity
2. Continuous Variable: Algebra II achievement score means

It is important to know for which students the intervention was sustained into the 2015-2016 school year. This research question was explored in total for all students, as stated in the research question, and for specific subgroups. The specific subgroups compared, based on the hypotheses, were gender, social economic status, special education status, and ethnicity.

While quantitative research data are important for understanding research phenomenon from an objective perspective, the individual perspectives of those involved are often most illuminative (Creswell, 2012). Therefore, a QL research question was developed to pursue a mixed-methods approach. The QL research question (QLRQ1) for this study sought to explore the efficacy of the intervention program from the perspectives of math teachers who were responsible for the program.

QLRQ1: What are MHS math teachers' perceptions about the efficacy of the intervention and enrichment program?

The following issue subquestions characterize the specific issues explored when during the investigation of QLRQ1. They are as follows:

1. What are MHS math teachers' perceptions of program activities?
2. What are MHS math teachers' perceptions of implementation fidelity?
3. What are MHS math teachers' perceptions of student classroom engagement during math class?
4. What are MHS math teachers' perceptions of the overall effectiveness of the program for improving student achievement?

These issue subquestions provided a means for a thorough exploration of the qualitative research question QLRQ1.

Review of the Literature

Improving algebra proficiency and achievement is a complex and multifaceted undertaking. This review of literature addresses this complexity through several sections beginning with the theoretical framework and conceptual foundation for the study and then followed by a review of the broader problem. After these foundations are laid, what follows is a review of the literature on (a) foundations for success in algebra, (b) secondary mathematics and algebra instructional practices for typical learners, (c) secondary mathematics and algebra instructional practices for struggling learners, (d) secondary mathematics and algebra interventions, and (e) motivational strategies for secondary mathematics and algebra students. This organization allows the reader, after delving into the theoretical foundation and national problem, to gain a basic understanding of the following: (a) what is necessary for success in algebra; (b) how to teach algebra and secondary mathematics students; (c) how to intervene with struggling algebra and secondary mathematics students; and (d) how to motivate algebra and secondary mathematics students toward higher achievement.

Theoretical Foundation

Constructivism formed the theoretical basis for this study. The basic tenets of this theory applied to education suggest that students should develop the capacity to construct knowledge and to defend their constructions (see Gash, 2017; Narode, 1987; Tahir, 2010). Using a constructivist framework, teachers act as facilitators, providing resources, individual guidance, and feedback to students (Narode, 1987; Pitt & Kirkwood, 2010; Sharma, 2014; Tahir, 2010). Conceptual understanding, through problem solving, is emphasized under the constructivist framework and the questioning of assumptions from various perspectives is expected (Gash, 2017; Narode, 1987; Tahir, 2010). Given the current emphasis on conceptual understanding, reasoning with and creating with equations, and problem solving in algebra curriculum, as proposed by the CCSS, constructivism is an appropriate framework from which to examine math intervention and instruction (CCSSI, 2015).

Conceptual Framework

Piaget's theory of cognitive development, in particular, his description of the formal operations stage, provided a conceptual model as well as enhance the theoretical framework (see Furth & Wachs, 1975; Inhelder & Piaget, 1958; Niaz, 1989; Ojose, 2008; Tahir, 2010). Piaget is considered a forefather of constructivism and his analysis of the intellectual development of children generally supports the basic tenets of constructivism (Gash, 2014; Gash, 2017; Narode, 1987). Piaget's theory is particularly relevant for any study of secondary mathematics, as formal operations include such necessary cognitive abilities for math achievement as thinking in abstractions and logical reasoning (Ewing, Foster, & Whittington, 2011; Niaz, 1989; Ojose, 2008). Active experience, an influence on cognitive development, can be provided by teachers through various classroom activities (Ewing et al., 2011; Tahir, 2010). Social interaction, another influence on cognitive development according to Piagetian theory, can be facilitated through classroom activities and through the relationship students build with their teachers (Ewing et al., 2011; Inhelder & Piaget, 1958; Prendergast & Donoghue, 2014). As both experiential learning and social interaction are both aspects of current educational pedagogy, Piaget's theory continues to support current educational strategies with adolescents and is appropriate for theoretical support of this study (Didem & Mehmet, 2019; Slavich & Zimbardo, 2012).

Review of the Broader Problem

Topics included in this section include the importance of success in algebra for postsecondary outcomes and national data on secondary math achievement and readiness for college and career. Search terms included but were not limited to *algebra instruction, math intervention, algebra, secondary math instruction,* and *secondary math intervention*. The research reported here was found via education research databases such as ERIC, SAGE, and Education Source; Google Scholar; books; and article and book chapter requests through Walden's library.

Improved algebra achievement in high school is currently a goal at many American high schools. While improved algebra achievement is currently a goal, whether or not it is a good or even a necessary goal, is debated in the literature. Gaertner, Kim, DesJardins, and McClarty (2014) found that completing Algebra II is more important for college outcomes than career outcomes, and Kim et al. (2015a) found that completing Algebra II only slightly increases the probability of attending college. Additionally, Wilder (2013) suggested that success in college algebra, while predicting college success, does not improve student cognitive skills. Regardless, according to Schachter (2013), students' inability to pass Algebra I is often the reason they leave school, affecting minority students most. Given that indicators of high school and postsecondary success include completing without remediation Algebra I in eighth grade, Algebra II in ninth grade, and 3 more years of advanced math culminating in either Pre-Calculus or Calculus, students unable to pass Algebra I are predicted to have limited secondary and postsecondary success (CCRS, 2013; RELW, 2015). Specifically, repeating Algebra I in ninth grade after failing in eighth grade has not been shown to create substantial gains in algebra proficiency (RELW, 2015). Moreover, the groups most likely to fail algebra in the eighth grade are economically disadvantaged students, Hispanic students, and ELL students (RELW, 2015). Additionally, while race, class, and skill gaps have narrowed across several secondary math courses, including Algebra II, inequalities in calculus completion remain relatively unchanged. This suggests that while more students may be completing advanced high school courses, they are not attaining the necessary skills to complete a calculus course (Domina & Saldana, 2012; Kolluri, 2018). In summary, while secondary math achievement improves from taking algebra, overall school success is not necessarily improved or potentially harmed, and inequities among student groups continue to exist (Domina & Saldana, 2012; Kolluri, 2018; RELW, 2015; Schachter, 2013).

The Nation's Report Card showed that only 26% of 12th graders scored proficient or higher on the NAEP assessments in 2013, and the national average on the NAEP assessments remained unchanged from 2009 to 2013 (USDOE, 2013). Specifically, students who score proficient or higher on the NAEP assessment score 176 or more points out of 300 points (National Center for Education Statistics [NCES], 2015). Algebra is a core content area of the NAEP assessment and is a building block for several of the other core content areas, such as statistics and geometry (Executive Office of the President [EOP], 2014; Katz, 2007; USDOE, 2013). According to the ACT and the Council of the Great City Schools (2007), while not all students plan to attend college after high school, there is an increase in technology-based jobs requiring skills similar to those of college-bound students. This logically leads to the conclusion that a college readiness curriculum, including algebra courses, should be provided to all high school students (ACT, 2007). In support of this conclusion is evidence that high school students who participate in and master the college readiness curriculum are more likely to enroll in and complete postsecondary college coursework (ACT, 2007; RELW, 2015). According to the 2014 annual report by Achieve (2015), Closing the Expectations Gap, 23 states and the District of Columbia now require all high school students to enroll in a college preparatory curriculum, which includes four years of mathematics, including 2 years of algebra. However, in 2015, only 42% of students taking the ACT met the ACT College Readiness Benchmark in mathematics, a score of 19, declining from 45% in 2011 (ACT, 2015; CCRS, 2013). Economically disadvantaged students are less likely to meet this benchmark (ACT, 2015; EOP, 2014). The mathematics portion of the ACT primarily assesses students' preparedness to obtain a grade of C or higher in college algebra (ACT, 2015). This indicates that only 42% of students taking the ACT are prepared to earn at least a C in college algebra (ACT, 2015).

Determined to improve educational outcomes for all students, Chicago Public Schools implemented a college readiness curriculum for all students in 1997, and the results are not all positive for all students, particularly in regards to algebra outcomes (Allensworth & Nomi, 2009; Nomi & Raudenbush, 2016). In a study examining the effects of raising graduation requirements, no observable benefits were found for enrolling in Algebra I instead of remedial math, and there were multiple adverse effects. These effects were higher absenteeism, higher math failure rates, and decreased math grades (Allensworth & Nomi, 2009; Allensworth, Nomi, Montgomery, & Lee, 2009; Nomi & Raudenbush, 2016). Additionally, math skill levels for high-skill students were negatively impacted by the policy in schools where previously, there had been several remedial math students. De-tracking created more heterogeneous classrooms and therefore lowered the overall math ability in those algebra classes (Nomi, 2010; Nomi & Raudenbush, 2016). Conclusions from this research suggested that requiring college preparatory curriculum alone does not positively impact student achievement, but that factors such as student engagement, classroom climate, instructional quality, and student motivation also contribute to student algebra outcomes (Allensworth & Nomi, 2009; Allensworth et al., 2009; Nomi, 2010; Nomi & Raudenbush, 2016; Simon, Stoelinga, Bush-Richards, De Sena, & Dwyer, 2018). Mazzeo (2010), in a policy brief on Chicago Public Schools' efforts, stated

> This raises an important point: As long as students are minimally engaged in their courses and attend school irregularly, policymakers should not expect substantial improvements in learning. Getting the content and structure of courses right is just the first step. Real improvement in learning will require states and districts to develop strategies that get students excited about learning, attending class regularly, and working hard in their courses. (pp. 10-11)

Findings from both the NAEP and ACT data and this research point to both school and district level multidisciplinary concerns in need of improvement for the improvement of algebra achievement to be achieved (Allensworth & Nomi, 2009; Allensworth et al., 2009; Mazzeo, 2010; Nomi, 2010; Nomi & Raudenbush, 2016; Simon et al., 2018).

Critical Foundations for Algebra Success

Student engagement, motivation, and success in algebra are positively linked to student preparation for algebra (Durik, Hulleman, & Harackiewicz, 2015; Witzel, 2016). Student success in algebra is a culmination of success in understanding a variety of foundational mathematical topics, and a gap in understanding of any of these topics can lead to struggles in algebra (Witzel, 2016). The major topics covered in high school algebra are as follows: symbols and expressions, linear equations, quadratic equations, combinatorics and finite probability, functions, algebra, and polynomials (VanDerHeyden & Allsopp, 2014; Witzel, 2016). Readiness to study these topics requires mastery of specific arithmetic and geometry skills and concepts (VanDerHeyden & Allsopp, 2014; Witzel, 2016).

Witzel (2016) lists the following as critical foundations for success on the major topics covered in high school algebra: (a) whole-number operations; (b) identify, represent, and compare fractions and decimals; (c) rational-number operations; (d) properties and measures of two- and three- dimensional shapes; and (e) similar triangles and slopes. Similarly, the CCSS topics emphasized in elementary school as essential for high school math success include counting and cardinality, operations and algebraic thinking, number and operations in base ten, number and operations – fractions, measurement and data, and geometry (CCSSI, 2015; VanDerHeyden & Allsopp, 2014). In middle school, the topics emphasized are geometry, ratio and proportional relationships, the number system, expressions and equations, functions, and statistics and probability (CCSSI, 2015; VanDerHeyden & Allsopp, 2014). These topics, as well as operations and algebraic thinking, are expanded upon in high school coursework to include algebra (VanDerHeyden & Allsopp, 2014).

More specifically, success in algebra requires number sense, or conceptual understanding of numeracy skills (Witzel, 2016). Having number sense proceeds a conceptual understanding of computation, and fluent calculation, both necessary for success in algebra as calculation fluency allows students to focus their attention on conceptual understanding of new topics (Siegler et al., 2012; Witzel, 2016). Success with whole number division specifically is highly correlated with success in high school mathematics, including algebra (Siegler et al., 2012). Some common problematic computational misconceptions include the belief that the equals sign indicates which operation to perform and that negative signs only represent subtraction (Barbieri, Miller-Cotto, & Booth, 2019; Booth, Barbieri, Eyer, & Pare-Blagoev, 2014). Order of operations, in general, is a source of difficulty for students (Barbieri et al., 2019; Booth et al., 2014). Students also inappropriately apply the commutative property, associative property, distributive property, and sometimes use the wrong operations (Booth et al., 2014). While not prominent errors among algebra students, these errors are indicative of students who struggle significantly in high school mathematics (Barbieri et al., 2019; Booth et al., 2014). Additionally, conceptually understanding fractions as well as computational proficiency with fractions is essential for algebra readiness, and many consider proficiency with fractions to be the most necessary arithmetic skill for success in algebra (Purwadi, Sudiarta, & Suparta, 2019; Siegler et al., 2012; Torbeyns, Schneider, Xin, & Siegler, 2015; Witzel, 2016).

Other skills considered important for success in algebra are related to the abstraction that students are introduced to in algebra course work. Students often struggle with the notion that variables can only represent one value and misunderstand the concept of like terms (Barbieri et al., 2019; Booth et al., 2014). These misconceptions lead to combining unlike terms, deleting or adding a variable, and solving for only one variable (Barbieri et al., 2019; Booth et al., 2014). Problem solving skills, also related to abstraction, are necessary for successful algebra problem solving (Bouck & Bouck, 2016; Xin et al., 2011). Word problems require students to interpret the problem, construct the problem, as well as complete the necessary computations (Bouck & Bouck, 2016). Specific skills necessary for solving word problems include fluent reading skills, language skills to include strong vocabulary, working memory, nonverbal problem solving skills, and fluent computation skills (Bouck & Bouck, 2016; Walkington, Clinton, & Shivraj, 2018). In algebra specifically, students, to construct the problem, need to represent the information in a word problem symbolically in equations, building on the aforementioned skills (Bouck, & Bouck, 2016; Walkington et al., 2018; Xin et al., 2011).

Strong reading and language skills are not only essential for problem solving, they are also necessary for reading math textbooks (Massey & Riley, 2013; Wei, Lenz, & Blackorby, 2016). Reading skills are considered by many a strong predictor of success in secondary math (Massey & Riley, 2013; Wei et al., 2016). The combination of natural language and symbolic language presented in math textbooks is unique to math and some science texts and requires students to comprehend and use language differently than in other academic classes (Massey & Riley, 2013; Wei et al., 2016). In summary, there are many critical foundational skills necessary for success in algebra, with strong reading and number sense skills being essential.

Instructional Strategies

To build upon acquired foundational skills necessary for success in algebra, effective teachers must choose evidence-based instructional strategies and adapt them based on the content and student needs (VanDerHeyden & Allsopp, 2014). The recommended process for teaching a new math concept involves following the CCSS learning standards, using student data, building conceptual understanding, developing problem solving skills, fostering fluency, and creating opportunities for generalization (VanDerHeyden & Allsopp, 2014). VanDerHeyden and Allsopp (2014), suggested the following indicators that a math teacher is effective: (a) integrates activities to cultivate conceptual comprehension; (b) offers adequate opportunities to build fluency and generalization of conceptual comprehension and skills; and (c) uses explicit, systematic instructional strategies that reinforce mathematical knowledge gains for students who need more intensive instruction.

Evidenced-based practices that build mathematical reasoning and problem solving include: (a) requiring students to justify their reasoning; (b) using mistakes as an opportunity for learning; (c) using problems to help students learn new concepts; (d) allowing students to explore new problems on their own as an introduction to new material; and (e) choosing relevant problems (Seeley, 2016a). Similarly, instructional practices recommended by the National Council of Teachers of Mathematics (NCTM) include the following:

> Establish mathematics goals to focus learning, implement tasks that promote reasoning and problem solving, use and connect mathematical representations, facilitate meaningful mathematical discourse, pose purposeful questions, build procedural fluency from conceptual understanding, support productive struggle in learning mathematics, and elicit and use evidence of student thinking. (NCTM, 2014, p.10)

These practices engage students in a discussion about their work and reasoning, creating a student-centered classroom, rather than a teacher-centered approach based on lecture and practice (NCTM, 2014; Seeley, 2016b). One recommended way to create a student-centered classroom is to use the You-We-I model (Seeley, 2016a). The model represents the following instructional process: Students (You) first explore a problem; the class (We) then has a teacher-directed discussion about what they did, their reasoning, and what they learned; and then the teacher (I) helps students connect their work to the mathematical content and procedures in the lesson (Seeley, 2016a). Using a model such as this also allows students opportunities to engage in productive struggle, strengthen reasoning skills, and learn multiple strategies for solving problems, which expands problem solving skills while accommodating diverse learners (Lynch & Star, 2016; NCTM, 2014; Seeley, 2016a).

Some educators argue the most important outcome for students in their mathematics education is to develop mathematical habits of mind (Matsura, Sword, Piecham, Stevens, & Cuoco, 2013; Seeley, 2016a). Defined by Seeley (2016a), this means “the ability to think mathematically, analyze situations, understand relationships, and adapt what they know to solve a wide range of problems” (p. 13). These habits of mind include: (a) performing thought experiments; (b) finding, articulating, and explaining patterns; (c) creating and using representations; (d) generalizing from examples; (e) articulating generality in precise language; and (f) expecting mathematics to make sense (Cuoco, Goldenberg, & Mark, 2010; Seeley, 2016a). Additionally, mathematical habits of mind are closely aligned with CCSS, in particular, the Common Core Standards for Mathematical Practice (Matsura et al., 2013). These mathematical practices, for all secondary math instruction, according to the National Council of Teachers of Mathematics (2014) include the following: (a) comprehend problems and persist in solving them; (b) think conceptually and quantitatively; (c) build feasible arguments and evaluate others’ reasoning; (d) model mathematically; (e) use suitable tools purposefully; (f) focus on accuracy; (g) seek and utilize structure; and (h) seek and convey uniformity in reiterated reasoning. These mathematics instructional practices are essential for effective and comprehensive secondary mathematics instruction.

Algebra students specifically need opportunities to struggle with concepts so they can make conceptual connections with algebraic procedures, allowing for the development of both conceptual understanding and procedural fluency (American Institutes for Research [AIR], 2014b). Rakes, Valentine, McGatha, and Ronau (2010) found the development of conceptual understanding in algebra improved student algebra achievement more than developing procedural understanding. Similarly, key findings by the AIR (2014b) on algebra instruction suggested critical features, to focus on conceptual understanding, for effective instruction in Algebra I. The features included: (a) content specific activities for teaching algebraic symbols; (b) comparison of solution methods to increase algebraic reasoning; (c) risk taking through prediction, investigation, and justification to increase learning; (d) technology support for mathematical exploration; and (e) content that includes modeling activities. Clearly, effective algebra instruction would include these elements.

Additional evidence of improving student algebra achievement through building conceptual understanding is found in studies on teaching specific algebra constructs. Developing student awareness of the structural similarity between arithmetic and algebraic expressions has been shown to support student learning of transformations (Banerjee & Subramaniam, 2012; Schuler-Meyer, 2017). Using prediction questions to prompt reflection and discussion to begin lessons provokes students to connect learned ideas when learning linear and exponential functions (Kasmer & Kim, 2012). Wittmann, Flood, and Black (2013) show that students who solve problems efficiently treat terms in an equation like physical objects; they use spatial reasoning to manipulate mathematical terms more so than mathematical language, exhibiting a conceptual understanding of algebraic procedures.

Algebra instruction should also be systematic and explicit to be effective (Hughes, 2016; Rakes et al., 2010; VanDerHeyden & Allsopp, 2014). Systematic instruction naturally builds on the natural progression of skills requiring teachers to plan for the learning of skills, as well as the application, maintenance, and generalization of those skills (Hughes, 2016). Strategies for systematic instruction include: (a) showing multiple examples of similarly structured problems, (b) discussing why and how each step was completed, (c) using non-examples to show when not to use specific skills, (d) having students rework problems, (e) using examples of worked problems with common errors, (f) teaching to mastery, and (g) providing a range of application examples to support the transfer of new skills to new situations (Hughes, 2016). Explicit algebra instruction engages students through communicating purpose and relevancy, modeling with questioning and discussion, interactive problem solving with teacher feedback, guided practice of the learned skills while discussing why something works, and independent practice of the learned skills (Hughes, 2016). Additional, evidence-based recommendations from the IES Practice Guide include using worked problems to involve students in examining algebraic reasoning, teaching students to apply the structure of algebraic representations, and teaching students to choose different algebraic strategies when problem solving (National Center for Education Evaluation and Regional Assistance [NCEE], 2015).

Technology used for math and algebra instruction improves student achievement (Derderian, 2014; EOP, 2014; Kim, Chang, Choi, Park, & Kim, 2016; NCTM, 2014; Rakes et al., 2010). Kim, et al. (2016) showed that when students regularly used computers for school work, the students exhibited high mathematics self-efficacy and had higher mathematics performance than students who did not regularly use computers for school work. Classroom connectivity technology or wireless communication systems that connect graphing calculators with teacher computers, increase student interaction with algebra content, increase opportunities for class discourse around algebra concepts, and improve teacher formative assessment opportunities. All of these are associated with improved student achievement (Hegedus, Dalton, & Tapper, 2015; Irving et al., 2016; Pape et al., 2013). Further, classroom connectivity technology significantly impacts student conceptual learning and procedural learning (Derderian, 2014; Hegedus et al., 2015). This in conjunction with direct, explicit instruction with a focus on conceptual understanding drawing on evidence-based instructional practices, makes for effective secondary math and algebra instruction (AIR, 2014b; Derderian, 2014; Hegedus et al., 2015; Hughes, 2016; NCTM, 2014; Rakes et al., 2010; VanDerHeyden & Allsopp, 2014).

Instructional Strategies for Struggling Learners

Students who struggle with mathematics, like typical students, benefit from instruction well aligned with the CCSS and instruction that is focused on the foundational skills for their grade level (Allsopp, Ingen, Simsek, & Haley, 2016; EOP, 2014; Powell, Fuchs, & Fuchs, 2013; Van Baxtel, 2016). Economically disadvantaged, struggling students profit from increased instructional time and differentiation of instruction within the classroom to be successful (EOP, 2014). Intensive math intervention furthers struggling students' mathematical knowledge (RELW, 2015).

Many struggling students benefit from skill prioritization (Powell et al., 2013; Van Baxtel, 2016). One strategy is to use a mountain hike analogy (Powell et al., 2013). A CCSS cluster is at the summit of the mountain with standards and foundational skills that fall below the cluster integrated such that their mastery leads to mastery of the cluster (Powell et al., 2013). To create such a mountain or prioritization of skills, each struggling student should be assessed to determine their specific needs (Powell et al., 2013). Once the mountains have been created, evidenced-based instruction that is logically sequenced to teach the identified foundational skills should be utilized while still providing instruction on the cluster, enabling students to make connections between the skills and the concepts (Powell et al., 2013; Van Baxtel, 2016).

Another instructional strategy that shows efficacy with struggling secondary students includes a three-part instructional strategy where students work conceptually at three different levels: concrete, representational, and abstract, referred to as CRA (Allsopp et al., 2016; Derderian, 2014; Montague & Jitendra, 2012). Students who struggle with mathematics often struggle when having to apply concepts at an abstract level. CRA allows students to move easily from one level to the other, working toward an understanding of the abstractness of mathematics (Derderian, 2014). Instructional strategies that improve CRA levels include individualized mathematics, adjusted speech, daily re-looping of previously learned material, ecological approach, explicit timing, and explicit vocabulary building (Derderian, 2014). Allsopp et al. (2016) recommends a specific algebra instructional process for struggling students utilizing CRA, which includes the following steps: identify target algebra content and mathematical practices, represent the problem, teach for understanding, differentiate instruction, and teach for proficiency, and build fluency.

A third approach for working with struggling math students combines direct instruction with strategy instruction (Freeman-Green, O'Brien, Wood, & Hitt, 2015; Montague & Jitendra, 2012). This approach is organized, teacher-oriented, and most appropriate for improving basic math skills necessary for algebra (Freeman-Green et al., 2015; Montague & Jitendra, 2012). Components of this approach include sequencing instruction, drill and practice, segmentation, student/teacher dialogue, processing task demands using sequencing and prompting, technology, modeling problem solving tasks, small group instruction, strategy cues (e.g., mnemonics), and supplements to instruction (e.g., tutors and homework) (Freeman-Green et al., 2015; Montague & Jitendra, 2012; Witzel, 2016).

Additionally, Response to Intervention (RTI) approach, recommended for struggling secondary math students, is a three-tiered approach where the majority of student needs are met in Tier 1 or classroom instruction (Derderian, 2014; Little & Dieker, 2016). Struggling students are placed in either Tier 2 or Tier 3, based on formative assessment data. They will receive small group instruction and interventions on their skills deficits during an intervention period or block of the day, enabling them to fully access classroom math instruction (Derderian, 2014; Little & Dieker, 2016). Data should continue to be collected through frequent formative assessment or progress monitoring (Derderian, 2014; Lembke, Strickland, & Powell, 2016; Little & Dieker, 2016). Once students make sufficient progress, they can be transitioned out of the tiered intervention classes (Derderian, 2014; Little & Dieker, 2016). Some recommended practices for intervention classes include multi-sensory instruction, explicit instruction in task sequencing, student verbalization of reasoning, a variety of visuals, purposeful prompting, mnemonics, peer-mediated learning, and frequent student feedback (Allsopp et al., 2016; Derderian, 2014; Little & Dieker, 2016). In summary, a RTI approach is recommended for providing math intervention and recommended intervention practices specific to secondary students include skill prioritization, CRA, and strategy instruction.

Interventions

Struggling learners in algebra and mathematics can benefit from specific interventions (Cortes et al., 2014; RELW, 2015; Sarfo et al., 2014; Vaughn & Fletcher, 2012; Vaughn & Swanson, 2015). There are some defined intervention practices for secondary students struggling with mathematics, although working with interventions at the secondary level is often challenging (Patterson & Musselman, 2015). According to Chodura, Kuhn, and Holling (2015), computer-based interventions with human tutors, and direct or assisted instruction all emerged as effective practices in their meta-analysis. Direct instruction is particularly effective as an intervention for arithmetic skills (Chodura et al., 2015). Montague and Jitendra (2012), advocate for instructional strategies based on direct instruction such as CRA, Cognitive Strategy Instruction (CSI) or *Solve It!* which is based on CSI, and Schema-Based Instruction (SBI). *Solve It!* is a cognitive strategy intervention for math problem solving skills (Freeman-Green et al., 2015; Krawec, Huang, Montague, Kressler, & de Alba, 2012; Montague & Jitendra, 2012). Additionally, What Works Clearinghouse lists five interventions for high school math students and a total of seven interventions for secondary math students (IES, n.d.). Only three of these interventions, the University of Chicago School Mathematics Project 6-12 Curriculum, Cognitive Tutor, and Core-Plus Mathematics, have a positive effectiveness rating; however, these ratings are based on only a small amount of evidence (Institute of Education Sciences [IES], n.d.). Using a Response to Intervention (RTI) framework for delivering the intervention to secondary students is recommended as a means of grouping students using data to determine their intervention content and intensity (Hunt & Little, 2014; Patterson & Musselman, 2015).

Interventions specific to algebra instruction encompass interventions that have been generalized from both general intervention and mathematics interventions, as well as interventions specific to algebra. Specific to generalized interventions that are evidenced-based for algebra include heterogeneous peer-tutoring, CRA, and using incorrectly worked examples (Agrawal & Morin, 2016; Barbieri & Booth, 2016; Purwadi et al., 2019; Sarfo et al., 2014; Whorley & Naresh, 2014). In intervention form, CRA has been specifically designed according to nine highlighted events of instruction to provide effective systematic intervention for algebra students (Purwadi et al., 2019; Sarfo et al., 2014). Additionally, a specific intervention evidenced to be effective in one study, *AlgebraByExample,* was developed based on the effective strategy of using both correct and incorrect worked examples (Booth et al., 2015).

Some intervention strategies currently applied to algebra intervention include supporting reasoning through personalization, visualization strategies to include algebra tiles and multiplication grids, and functional thinking (Day, 2014; Linsell, Cavanaugh, & Tahir, 2013; Maenpaa, 2013; Walkington, 2013; Walkington & Bernacki, 2018; Wilkie, 2014). Personalization or matching students' out of school interests and experiences to instruction improves problem solving performance as students better understand the context of the problems they are attempting to solve, allowing for informal reasoning and more productive strategies (Linsell et al., 2013; Walkington & Bernacki, 2018). Students are also better able to write appropriate algebraic equations from word problems, allowing for better success at solving the word problems (Linsell et al., 2013; Walkington, 2013). Visualization of algebraic tasks aids in the conceptual understanding of algebraic tasks improving students' ability to solve algebra problems (Baroudi, 2015; Wilkie, 2014). Many algebra tasks can be represented as patterns, aiding students in working, and understanding the problems (Baroudi, 2015). Both algebra tiles and multiplication grids can be used to help students visualize algebra patterns (Day, 2014; Maenpaa, 2013). Additionally, using functional thinking, or thinking that is focused on the relationships between variables, in instruction or during an intervention builds a conceptual understanding of how variables work and help students better understand algebraic notation (Linsell et al., 2013; Wilkie, 2014). To summarize, there are a variety of evidence-based intervention strategies for secondary algebra students to include both computer-based and direct instruction practices.

Motivation for Mathematics Success

Instructional practices and intervention for struggling students culminating in improvement in secondary math achievement are more likely if secondary students are motivated to understand math and motivated to improve their math achievement. Motivation is, in part, derived from interest, which develops from the interactions among students, teachers, and content (Bong, Lee, & Woo, 2015; Matthews, 2018; Prendergast & Donoghue, 2014; Turner, Kackar-Cam, & Trucano, 2015). Math instruction can be designed to promote interest, improving student engagement and achievement (Durik et al., 2015; Kim, Jiang, & Song, 2015b; Prendergast & Donoghue, 2014). Interest in math is considered a stronger motivator than the utility of math; however, the utility of math is motivating for some students, particularly those of perceived higher ability (Durik et al., 2015; Kim, et al., 2015b). Additionally, those students who have a perceived higher ability in math are most likely to have a high interest in math (Durik et al., 2015).

One way to raise interest in math content is to improve situational interest or interest in the specific task or discussion (Durik et al., 2015; Matthews, 2018; Prendergast & O'Donoghue, 2014; Prendergast & Treacy, 2018; Turner, et al., 2015). Humor and novelty are two ways to increase situational interest (Durik et al., 2015). Tasks designed to with opportunities connections among ideas, meaningful tasks, discovery tasks, scaffolding, and providing a rationale for relevance also increase situational interest (Matthews, 2018; Prendergast & Donoghue, 2014; Prendergast & Treacy, 2018; Turner et al., 2015). One specific example is to use student interests for algebraic modeling, allowing students to make choices based on their interests when developing their word problems (Whaley, 2012).

The research-based instructional strategies employed by MHS for the intervention and enrichment program were grounded in constructivist theory. The research-based instructional strategies were differentiated based on student needs, determined by data-based decision-making. The research questions were centered around the efficacy of the implemented research-based instructional strategies and improved mathematical achievement of algebra students who participated in the intervention and enrichment program.

Implications

My hope is that the information gleaned from the data analysis provided direction in developing and improving interventions specific to struggling high school algebra students. This direction could either take the form of developing a framework for algebra intervention, policy regarding algebra intervention, or a specific curriculum for a specific group of students struggling in algebra. For example, a school policy recommendation regarding intervention with low-income students or female students would be the result of this study, depending on the findings from the study. Possibly, a specific intervention curriculum for algebra for ELL students would be developed from this study's results. Also, an improvement in the implementation of intervention could possibly be developed based on this study's results. There are several possibilities for the project, given the nature of this study.

Summary

Currently, improving algebra achievement is a priority across the country to improve postsecondary outcomes for students. Good algebra instruction is rooted in constructivism and Piagetian theory, allowing the student the opportunity to construct new knowledge from work on relevant and engaging problems. Success in algebra depends on such sound foundational skills as reading, number sense, fractions, and calculation fluency, to name a few items from a sizable list. Effective instructional practices, based on the CCSS, both exploratory and explicit in nature, differentiated for the needs of the students, coupled with effective data-based interventions for struggling learners, are essential for improving algebra outcomes. Improving student interest and motivation in mathematics is equally important in improving student success in algebra. It is the hope that the current research project added to what is already known and lead to a greater understanding of algebra intervention and student motivation on improving algebra outcomes.

Section 2: The Methodology

Mixed Method Design and Approach

The purpose of this study was to investigate the impact of an intervention and enrichment program on student achievement, so a mixed methods approach is appropriate to evaluate both quantitative and qualitative data (see Creswell, 2012). A quantitative methodology to examine archival data was used to address the research questions and purpose. Quantitative methods are necessary to appropriately analyze factual archival data to determine the existence of significant outcomes (Creswell, 2012; Lodico, Spaulding, & Voegtle, 2006). Descriptive statistics were used to describe the data. Propensity matching was used to minimize selection bias and ensure that treatment and control groups are equated on key covariates. Factorial analysis of variance (ANOVA) was used to analyze the EOC Algebra data, specifically, the group means (see Creswell, 2012; Harris & Horst, 2016; Lodico et al., 2006; TDOE, n.d.-a).

Qualitative methods were used to address the qualitative research question, related subquestions, and purpose. Qualitative methods are necessary to appropriately collect, code, and analyze teacher interview information (Creswell, 2012; Lodico et al., 2006). This information was collected for triangulation and to better understand the impact of the intervention on student achievement in the classroom from the perspective of math teachers (see Creswell, 2012; Lodico et al., 2006). Teacher interviews were conducted concurrently with the analysis of the quantitative archived data collection. The qualitative outcomes, once coded and organized based on themes, were compared with the quantitative results for triangulation purposes and integrated with the quantitative results for a complete understanding of the impact of this intervention and enrichment program (see Creswell, 2012; Lodico et al., 2006).

Setting and Sample

The population under study included students at MHS taking Algebra 1 and Algebra II. Given that the purpose was to determine the impact of the intervention and enrichment intervention on schoolwide algebra achievement and growth, the entire population, approximately 300 students, were involved in the study of each research question. Given that the entire population of interest was included in the study, the sample size was considered sufficient for the study (see Creswell, 2012).

Criteria for participation were enrollment in a high school algebra course at MHS and participation in either the Algebra I EOC or Algebra II EOC. All high school freshmen pursuing a high school diploma must enroll in Algebra I or Algebra IA unless they completed Algebra I as an eighth-grade student, in which case they enroll in Algebra II. Sophomores must enroll in Algebra II or Algebra IB unless they have already completed Algebra II. Those sophomores enrolled in Algebra IB must enroll in Algebra II during either their junior or senior year, with the junior year recommended. MHS is a diverse school, with more than half the student population being students of color and, at a minimum, at least 40% economically disadvantaged (TDOE, n.d.-a). Demographic details for each year are detailed in Tables 2 and 3.

The treatment group under study were those students at MHS who completed Algebra I and Algebra II. The control group under study were those students in the school district who completed Algebra I and Algebra II, but were not exposed to the math intervention. The district's research department provided the de-identified data for all students in the district who met the criteria for answering the research questions. 1:1 propensity score nearest neighbor matching without replacement was used to form the final treatment and control groups. The sample of students used in the analyses was based on the matched groups. The unmatched (*N*) and matched (*n*) for the groups for each research question are in Tables 4 through 6.

Table 2

MHS Student Population Demographics (%)

Year	Economically Disadvantaged	EL Learners	Special Education	Female
2013-2014	56.7	7.4	16.6	46.0
2014-2015	68.0	6.3	15.3	45.0
2015-2016	39.0	6.0	17.0	45.0

Note: (MNPS, n.d.; TDOE, n.d.-a)

Table 3

MHS Student Population Ethnicity (%)

Year	White	African American	Hispanic	Asian	Native American
2013-2014	46.7	37.1	8.8	7.0	.4
2014-2015	46.0	34.9	10.8	7.8	.5
2015-2016	45.0	36.0	12.0	8.0	0

Note: (TDOE, n.d.-a)

A small sample of three math teachers, who taught math at MHS during the 2014-2015 school year was recruited for the purpose of conducting teacher interviews. The sampling method used was convenience sampling, as the study was limited to teacher availability and willingness to participate (see Creswell, 2012; Lodico et al., 2006). The type of math class and intervention group instructed that year was noted, but was not an inclusionary criterion for participation. Interview participants' personal information, such as name and participation status, was kept confidential by coding the participants. All participants were provided with informed consent forms and consented to participate with their signatures. Interview participants were informed of their right to withdraw from the study at any time, to minimize any harm that participation might cause. None of the participants withdrew.

Data Collection Strategies

Quantitative Sequence

Student EOC scores, for both Algebra I and Algebra II, were the data source for this study. The Tennessee EOC exams were developed by a team of professional writers experienced in algebra content, and the items were field tested, reviewed, and edited (TDOE, n.d.-a). Test directions were developed in a similar way (TDOE, n.d.-a). The test developer and publisher for the 2013-2014 and 2014-2015 Algebra EOC's were Pearson Education (TDOE, n.d.-a). The Tennessee EOC exams, for the year 2015-2016, were revised and testing procedures updated to align with CCSS (TDOE, n.d.-a). The test developer and publisher for the 2015-2016 school year was Measure, Inc. Test items reflected state curriculum standards for both Algebra I and Algebra II (TDOE, n.d.-a). Accommodations were allowed for students with disabilities and EL students (TDOE, n.d.-a). Student EOC achievement scores were found on the state TVAAS website and the district's database. The de-identified raw data used in this study are available by request from the researcher.

Qualitative Sequence

Teacher interview data were collected using an interview protocol, found in Appendix B, adapted from Creswell (2012). The questions were designed to collect teachers' impressions of the impact of the intervention and enrichment program, their students' preparedness for high school math, and their beliefs about effective math instruction. Participants were recruited through an email invitation from the MHS staff list of the 2014-2015 school year. Interview sessions lasted approximately 30 minutes and were tape recorded for improved transcription and validity purposes (see Creswell, 2012; Lodico et al., 2006). Member checking occurred throughout the interview sessions to ensure the accuracy and completeness of the responses, improving the validity of outcomes (Creswell, 2012; Lodico et al., 2006). The data and emerging themes from the interviews were organized using a cataloging system for organization and enhanced interpretation (Creswell, 2012; Lodico et al., 2006).

During the study, I worked with teachers, administrators, and other staff at MHS, but I am not employed by the school. I am employed by Student Support Services at the Board of Education as a school psychologist. I do not report to anyone at MHS, nor am I evaluated by anyone at MHS. I also do not evaluate anyone at MHS or have any influence on their evaluations, retention, or tenure. I had recognition and awareness of my responsibility to be especially careful in my data collection and analysis to provide the school with objective results.

Data Analysis

Archival data, Algebra I and Algebra II EOC achievement scores, and teacher interviews, were used to answer the research questions. Access to the data set was granted upon district approval for the project. Once my proposal was approved by Walden University, the process for district approval began. The requirements for district approval included a proposal, a data use agreement (Appendix C), interview protocol (Appendix B), consent form, recruitment email, submission, and IRB approval.

To better determine the impact of the intervention and enrichment program, propensity matching using districtwide data was performed to form a comparison group. 1:1 propensity score nearest neighbor matches without replacement were used to match students using the following key variables: ethnicity, gender, course enrollment, projected EOC score, special education status, eighth grade TCAP math score, and socioeconomic status (see Harris & Horst, 2016). Student level matching helped establish baseline equivalence by statistically controlling for key variables such as grade, gender, ethnicity, free and reduced lunch, and student achievement. The large pool of comparison students within the district increased the likelihood of constructing a valid, well matched comparison group (see Harris & Horst, 2016).

For each quantitative research question, the data was analyzed in total but also disaggregated by subgroups. The subgroups under study were gender, social economic status, special education status, and ethnicity. Algebra I and Algebra II EOC achievement scores are continuous data (see Creswell, 2012; TDOE, n.d.-a ; Triola, 2012). Descriptive statistics to include mean scores were computed for each subgroup as well as the total group for analysis (see Creswell, 2012; Lodico et al., 2006). I used ANOVA for each subgroup as well as the total group to test each quantitative research question (see Creswell, 2012; Lodico et al., 2006; Triola, 2012).

The teacher interviews were reviewed, transcribed, and then coded into categories, constructing detailed descriptions of the teacher's perspectives and any events referenced (see Creswell, 2012; Lodico et al., 2006). I further analyzed these descriptions with the intent of identifying themes in the data. These themes were compared with the quantitative results for the purpose of triangulation to see if the results are similar, strengthening the overall validity of the study, as well as used to understand better the impact of the intervention and enrichment program on classroom achievement. Both the quantitative results and qualitative outcomes were integrated for a complete understanding of any change in student achievement as a result of the intervention and enrichment program.

Assumptions and Limitations

There are various assumptions that should be described. First, I assumed that students were appropriately placed in intervention classes based on state summative testing, course benchmark assessment, and special education data. I also assumed that teachers provided appropriate, targeted instruction during those intervention classes, based on course performance data and individual instructional needs. It was assumed the demographics of students in each course match those of the school. Lastly, I made the assumption that the course EOC exams were administered with fidelity, with student accommodations given as appropriate. Should any of these assumptions be false, the construct validity of the study results would be questionable (see Creswell, 2012).

Like any research study, there were a few limitations. One limitation of this study was that the study was only conducted in one school and not various schools, limiting the generalizability of the results to other high schools or districts (see Creswell, 2012; Lodico et al., 2006). Another limitation was that the school district is an urban school district, also limiting the generalizability of the results to other high schools or districts (see Creswell, 2012; Lodico et al., 2006). A third limitation was researcher bias arising from personal interests unknowingly influencing the results, particularly the qualitative results (see Creswell, 2012). Finally, in investigating QNRQ3, the scores were based on a different standardized exam due to a switch by the district. Although the new exam was aligned psychometrically with content and statistical specifications with the previous exam students would have taken, this is still a limitation.

A few limitations emerged during data analysis. The small sample size available for analysis for QNRQ3 was a limitation, limiting the inferences drawn from the results (see Lodico et al., 2006). Additionally, neither QNRQ2 nor QNRQ3 were analyzed for the subgroups of ethnicity, special education status, and socioeconomic status due to the violation of homogeneity of variance. The violation of this assumption prevented the analysis of these variables for both questions pertaining to Algebra II EOC performance (see Statistics Solutions, n.d.; Triola, 2012).

Data Analysis Results

A convergent mixed method design was appropriately employed for analyzing and presenting the data was appropriate because the interview data were collected concurrently with the analysis of the archived data (see Creswell, 2012). The interview results were used for triangulation, strengthening the external validity of the study results, and were integrated with the quantitative analysis results for a complete understanding of any change in student achievement (see Creswell, 2012; Lodico et al., 2006). Quantitative findings were presented first, with qualitative findings next, and then the integration of the findings. Before the presentation of the results, the quantitative data collection analyses based on propensity methods were discussed.

For the quantitative analyses, archival data were obtained without identifying information, such as student names, from the participating school district in March 2019. The data included the student information from the treatment high school and student information from the rest of the district, for the purpose of matching the data to create a control group. Propensity score analysis, generally, was used to parallel a randomized study within a nonrandomized study by creating a comparison group (see Nicholas & Gulliford, 2008; Pan & Bai, 2015). This technique reduces bias in nonrandomized studies by matching the distributions of the covariates or observed characteristics between the two groups (Nicholas & Gulliford, 2008; Pan & Bai, 2015). Propensity score matching is the process of matching each participant in the treatment group with another participant not receiving the treatment with the same or similar propensity score (Nicholas & Gulliford, 2008; Pan & Bai, 2015). Propensity score nearest neighbor one-to-one matching without replacement was used to match students using the following covariates; gender, ethnicity, special education status, socioeconomic status, and projected end-of-year algebra score based on the standardized state assessment exam. The propensity matching procedures were carried out using the R program MatchIt (see Ho, Imai, King, & Stuart, 2007).

The selection of covariates is not a trivial process, and only those covariates known to influence the outcome should be included (Harris & Horst, 2016; Pan & Bai, 2015). Nearest neighbor one-to-one matching without replacement using MathIt in R, matched each participant with another participant in the control group at the closest distance (see Harris & Horst, 2016; Pan & Bai, 2015). Without replacement refers to removing the comparison group participant from the pool of potential matches once they have been matched with a treatment group participant (Harris & Horst, 2016; Pan & Bai, 2015). Nearest neighbor matching is considered the most commonly used method for matching in the behavioral sciences, and while there are quality control concerns, it is sufficient for creating balanced matched groups (Harris & Horst, 2016; Pan & Bai, 2015).

Several assumptions needed to be met when using propensity score analysis. The first was that the treatment assignment and response are conditionally independent (see Pan & Bai, 2015). The second assumed common support between the treatment and comparison groups (see Harris & Horst, 2016; Pan & Bai, 2015). Common support, according to Harris and Horst (2016), refers to "the extent to which intervention group participants and nonparticipants overlap in their distributions of propensity scores" (p. 7). Another assumption, for causal inferencing using propensity scores, stated that "the observation on one unit should be unaffected by the particular assignments of treatment to the other units" (Cox, 1958, p. 19; Pan & Bai, 2015). For this study, these assumptions were met, so that the treatment assignment was independent of the response, there was mutual support between the groups, and that observations on the comparison group units were unaffected by the observations on the treatment group units (see Creswell, 2012; Lodico et al., 2006; Pan & Bai, 2015).

The quality evaluation of the propensity matching is critically important for making inferences from the results. It is the process in which the quality of the covariate balance is evaluated, either statistically or graphically (Pan & Bai, 2015). The standardized difference based on a statistical effect size was used for this study. The standardized difference as a statistical measure is commonly used for the purpose of propensity score matching evaluation, because it does not depend on sample size (Pan & Bai, 2015). The standardized difference for each covariate was calculated before (i.e. unmatched groups) and calculated after matching (i.e. matched groups). The rule of thumb often used to assess the quality of the matching, hence, covariate balance are, (a) a value less than .10 indicates the covariate balance is more than adequate; (b) a value between .10 to .20 indicates moderately acceptable balance, not too troublesome; and (c) a value greater than .20 would indicate a serious imbalance. As can be seen in Tables 4-6, the propensity score matching produced balanced covariate results for all three research questions. For all of the values after matching, the standardized mean difference was below .20, and mostly well below the serious threshold of .20.

Regarding the qualitative data collection and analysis, three teachers were interviewed in May 2019 using the developed interview protocol, which is found in Appendix B. Consent forms were reviewed and signed, and the interviews were completed within 20 minutes. The interviews were recorded and transcribed for accuracy. Two of the teachers, Teacher 1 and Teacher 2, were White males who taught standard and honors level mathematics courses at MHS, and Teacher 3 was an African American female who taught special education mathematics courses. All three math teachers taught a math intervention during the 2014-2015 school year, and one teacher was intricately involved in developing enrichment resources for the teachers instructing the math enrichment that year. Four of the interview questions inquired about their personal beliefs as they related to math instruction, their motivational strategies, and their students' preparedness for high school math. Four questions were specific to the intervention/enrichment program. The interview questions were derived based on QLRQ1 and approved by the IRB, number 11-27-17-0384949. Interview responses were analyzed for common themes.

Table 4

Standardized Differences (Covariates) for Research Question 1 (QNRQ1)

	Unmatched			Matched		
	TRT	CTRL	STD	TRT	CTRL	STD
N	282	5770		211	211	
Gender						
Male (%)	55	50	0.10	51	51	0.00
Female (%)	45	50	0.10	49	49	0.00
Ethnicity						
White (%)	43	27	0.34	44	46	0.04
Black (%)	37	47	0.20	36	36	0.00
Hispanic (%)	12	21	0.24	11	11	0.00
Asian (%)	8	5	0.12	9	7	0.07
Special Educ. Status						
No (%)	85	90	0.15	95	96	0.05
Yes (%)	15	10	0.15	5	4	0.05
Socioeconomic Status						
No (%)	47	46	0.02	50	50	0.00
Yes (%)	53	54	0.02	50	50	0.00
Algebra Projected (Mean (SD))	44 (25)	47 (28)	0.11	48 (24)	48 (24)	0.00

Note. TRT = treatment; CTRL = control; STD = standardized mean difference

Table 5

Standardized Differences (Covariates) for Research Question 2 (QNRQ2)

	Unmatched			Matched		
	TRT	CTRL	STD	TRT	CTRL	STD
N	391	4710		333	333	
Gender						
Male (%)	51	49	0.04	51	49	0.04
Female (%)	49	51	0.04	49	51	0.04
Ethnicity						
White (%)	49	31	0.37	48	50	0.04
Black (%)	32	47	0.31	33	34	0.02
Hispanic (%)	12	17	0.14	12	12	0.00
Asian (%)	7	5	0.08	7	4	0.13
Special Educ. Status						
No (%)	91	93	0.07	90	89	0.03
Yes (%)	9	7	0.07	10	11	0.03
Socioeconomic Status						
No (%)	63	54	0.18	62	61	0.02
Yes (%)	37	46	0.18	38	39	0.02
Algebra Projected (Mean (SD))	39 (25)	39 (27)	0.00	39 (25)	37 (25)	0.08

Note. TRT = treatment; CTRL = control; STD = standardized mean difference

Table 6

Standardized Differences (Covariates) for Research Question 3 (QNRQ3)

	Unmatched			Matched		
	TRT	CNTRL	STD	TRT	CNTRL	STD
N	29	322		25	25	
Gender						
Male (%)	52	44	0.16	52	44	0.16
Female (%)	48	56	0.16	48	56	0.16
Ethnicity						
White (%)	45	27	0.38	48	56	0.16
Black (%)	24	52	0.60	28	24	0.09
Hispanic (%)	14	18	0.11	12	8	0.13
Asian (%)	17	3	0.48	12	12	0.00
Special Educ. Status						
No (%)	97	89	0.32	96	96	0.00
Yes (%)	3	11	0.32	4	4	0.00
Socioeconomic Status						
No (%)	52	48	0.08	52	56	0.08
Yes (%)	48	52	0.08	48	44	0.08
Algebra Projected (Mean (SD))	32 (21)	36 (24)	0.13	33 (21)	37 (26)	0.17

Note. TRT = treatment; CTRL = control; STD = standardized mean difference

Quantitative Findings

Outcome analysis after propensity matching can be completed on matched data as if it were the original data (see Nicholas & Gulliford, 2008; Pan & Bai, 2015). The outcome analyses for all research questions were conducted using a factorial analysis of variance (ANOVA). Given the rich dataset provided by the school district, and missing data at random assumed, there were many subparts to each research question that could be analyzed. The outcome variable (dependent variable) for all of the research questions, was a standardized measure based on EOC exam scores.

Research Question 1.1 (QNRQ1.1). There were three subparts to this research question based on the covariates of gender, ethnicity, special education status, and socioeconomic status. Given there were more than one statistical analysis conducted using the same set of data, the Bonferroni method was used to determine the alpha level to avoid a type I error, falsely flagging a significant result (Armstrong, 2014). Because there were three analyses of variances conducted for QNRQ1, an alpha level of .02 was used to determine significance for each analysis of variance. The first research question subpart 1 (QNRQ1.1), a 2 x 2 x 4 three-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), gender (male, female), and ethnicity (White, Black, Hispanic, Asian). The outcome variable was the actual Algebra I EOC score from the 2014-15 testing year. Tables 7-9 are associated with QNRQ1.1. Levene's test of homogeneity of variance was not significant, $F(15,403) = 1.16$, $p = .301$, indicating that the assumption of equal variances was tenable. It is appropriate to proceed with the results from the analysis of variance. As can be seen in Table 8, none of the interactions were significant; therefore, simple effects testing was not required, and the discussion could focus on the main effects. The main effect of group was significant, $F(1,403) = 12.91$, $p = .00$, the main effect of ethnicity was significant,

$F(3,403) = 8.50$, $p = .00$, and the main effect of gender was not significant, $F(1,403) = .04$, $p = .835$.

Given that the groups only had two levels, post-hoc testing was not required, the treatment group performed significantly lower than the control group on the actual Algebra I EOC state assessment ($M = 40.99$ and $M = 52.26$ respectively), see Table 7. The main effect of ethnicity had four levels; therefore, post-hoc testing based on Tukey was conducted. In Table 7, the marginal means are provided, and Table 9, the post-hoc testing results can be found. As seen in Table 9, black students scored significantly lower than all other ethnicity groups. There were no other group differences based on ethnicity.

Table 7

Estimated Marginal Means for the Actual End of Course Algebra I State Assessment for QNRQ1.1

	N	Mean	Std. Error
Group			
*Treatment	209	40.99	2.17
**Control	210	52.26	2.26
Gender			
Male	213	46.95	2.31
Female	206	46.30	2.12
Ethnicity			
White	189	45.04	1.79
Black	151	36.07	1.98
Hispanic	47	49.44	3.64
Asian	32	55.95	4.36

* One American Indian and One Pacific Islander observation removed ($n < 5$)
** One Pacific Islander observation remove ($n <5$)

Table 8

Analysis of Variance Summary: Tests of Between-Subjects Effects for QNRQ1.1

Source	Type III Sum of Squares	*DF*	Mean Squares	*F*	*p*
Group	7626.83	1	7626.83	12.91	**0.00**
Gender	25.53	1	25.53	0.04	0.84
Ethnicity	15069.12	3	5023.04	8.50	**0.00**
Group * Gender	133.32	1	133.32	0.23	0.64
Group * Ethnicity	1662.70	3	554.23	0.94	0.42
Gender * Ethnicity	812.10	3	270.70	0.46	0.71
Group * Gender * Ethnicity	400.22	3	133.41	0.23	0.88
Error	238086.03	403	590.78		

*Bold indicate significance at $p < .02$

Table 9

Post-Hoc Tests for Ethnicity for QNRQ1.1

Race (I)	Race (J)	Mean Difference	Significance
White	Black	**8.95**	**0.01**
	Hispanic	-4.33	0.70
	Asian	-10.40	0.12
Black	White	**-8.95**	**0.01**
	Hispanic	**-13.27**	**0.01**
	Asian	**-19.35**	**0.00**
Hispanic	White	4.33	0.70
	Black	**13.27**	**0.01**
	Asian	-6.07	0.70
Asian	White	10.40	0.12
	Black	**19.35**	**0.00**
	Hispanic	6.07	0.70

*Bold indicate significance at $p < .05$

Research Question 1.2 (QNRQ1.2). The first research question subpart 2 (QNRQ1.2), a 2 x 2 x 2 three-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), gender (male, female), and special education status (no, yes). The outcome variable was the actual Algebra I EOC exam score from the 2014-15 testing year. Tables 10 and 11 are associated with QNRQ1.2. Levene's test of homogeneity of variance was not significant, $F(7,411) = 1.28$, $p = .258$, indicating that the assumption of equal variances was tenable. It was appropriate to proceed with the results from the analysis of variance. As can be seen in Table 11, none of the interactions were significant; therefore, simple effects testing was not required, and the discussion could focus on the main effects. The main effect of special education status was significant, $F(1,411) = 9.10$, $p = .00$. The main effects of group and gender were not significant. Given that special education status only had two levels, post-hoc testing was not required, the students not considered with any special education status performed significantly higher than the students who were considered eligible for a special education status on the actual Algebra I EOC state assessment ($M = 43.90$ and $M = 23.82$ respectively), see Table 10.

Research Question 1.3 (QNRQ1.3). The first research question subpart 3 (QNRQ1.3), a 2 x 2 x 2 three-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), gender (male, female), and socioeconomic status (no, yes). The outcome variable was the actual Algebra I EOC exam score from the 2014-15 testing year. Tables 12 and 13 are associated with QNRQ1.3. Levene's test of homogeneity of variance was not significant, $F(7,411) =$

1.76, $p = .094$, indicating that the assumption of equal variances was tenable. It was appropriate to proceed with the results from the analysis of variance. As can be seen in Table 13, none of the interactions were significant; therefore, simple effects testing was not required, and the discussion focused on the main effects.

Table 10

Estimated Marginal Means for the Actual End of Course Algebra I State Assessment for QNRQ1.2

		N	Mean	Std. Error
Group				
	*Treatment	209	30.65	4.27
	**Control	210	37.08	5.11
Gender				
	Male	213	35.84	3.44
	Female	206	31.89	5.70
Special Educ. Status				
	No	400	43.90	1.23
	Yes	19	23.82	6.54

* One American Indian and One Pacific Islander observation removed ($n < 5$)
** One Pacific Islander observation remove ($n <5$)

Table 11

Analysis of Variance Summary: Tests of Between-Subjects Effects for QNRQ1.2

Source	Type III Sum of Squares	*DF*	Mean Squares	*F*	*p*
Group	568.09	1	568.09	0.93	0.34
Gender	213.89	1	213.89	0.35	0.55
Special Educ. Status	5537.26	1	5537.26	9.10	**0.00**
Group * Gender	0.33	1	0.33	0.00	0.98
Group * Special Educ. Status	624.64	1	624.64	1.03	0.31
Gender * Special Educ. Status	325.21	1	325.21	0.53	0.47
Group * Gender * Special Educ. Status	5.54	1	5.54	0.01	0.92
Error	250139.97	411	608.61		

*Bold indicate significance at $p < .02$

The main effect of group was significant, $F(1,411) = 27.71$, $p = .00$. The main effect of socioeconomic status was not significant, $F(1,411) = 4.79$, $p = .03$. The main effect of gender was not significant. Given that group and special education status only had two levels, post-hoc testing was not required. The students not considered with any financial aid need based status performed higher than the students who were considered eligible for financial assistance status on the actual Algebra I EOC state assessment (M = 45.82 and M = 40.52 respectively), see Table 12. The results ($p = .03$) could not be considered significant given the conservative p-value used for significance of .02. In addition, as related to treatment versus control group after controlling for socioeconomic status, students in the control group outperformed students in the treatment group on the actual Algebra I EOC state assessment (M = 49.55 and M = 36.80 respectively), see Table 12.

Table 12

Estimated Marginal Means for the Actual End of Course Algebra I State Assessment for QNRQ1.3

	N	Mean	Std. Error
Group			
*Treatment	209	36.80	1.72
**Control	210	49.55	1.71
Gender			
Male	213	42.50	1.70
Female	206	43.85	1.73
Socioeconomic Status			
No	210	45.82	1.71
Yes	209	40.52	1.71

* One American Indian and One Pacific Islander observation removed (n < 5)
** One Pacific Islander observation remove (n <5)

Table 13

Analysis of Variance Summary: Tests of Between-Subjects Effects QNRQ1.3

Source	Type III Sum of Squares	*DF*	Mean Squares	*F*	*p*
Group	17011.32	1	17011.32	27.71	**0.00**
Gender	192.80	1	192.80	0.31	0.58
Socioeconomic Status	2937.44	1	2937.44	4.79	0.03
Group * Gender	25.90	1	25.90	0.04	0.84
Group * Socioeconomic Status	336.61	1	336.61	0.55	0.46
Gender * Socioeconomic Status	109.74	1	109.74	0.18	0.67
Group * Gender * Socioeconomic Status	740.19	1	740.19	1.21	0.27
Error	252275.89	411	613.81		

*Bold indicate significance at $p < .02$

Research Question 2 (QNRQ2). Due to the violation of homogeneity of variance when considering ethnicity, special education status and socioeconomic status, these variables were not investigated for this research question. In answering QNRQ2, a 2 x 2 two-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), and gender (male, female). The outcome variable was the actual Algebra II EOC exam score from the 2014-15 testing year. Tables 14 and 15 are associated with QNRQ2. Levene's test of homogeneity of variance was not significant, $F(3,661) = 2.41$, $p = .066$, indicating that the assumption of equal variances was tenable. It was appropriate, therefore, to proceed with the results from the analysis of variance. As can be seen in Table 15 the two-way interaction was not significant; therefore, simple effects testing was not required, and the discussion could focus on the main effects. The main effects of group and gender were not significant, see Table 15, and the estimated marginal means are provided in Table 14.

Table 14

Estimated Marginal Means for the Actual End of Course Algebra II State Assessment for QNRQ2

		N	Mean	Std. Error
Group				
	*Treatment	332	40.80	1.46
	Control	333	38.89	1.45
Gender				
	Male	330	39.39	1.46
	Female	335	40.29	1.45

* One Pacific Islander observation removed ($n < 5$)

Table 15

Analysis of Variance Summary: Tests of Between-Subjects Effects for QNRQ2

Source	Type III Sum of Squares	*DF*	Mean Squares	*F*	*p*
Group	606.92	1	606.92	0.86	0.35
Gender	133.18	1	133.18	0.19	0.66
Group * Gender	131.35	1	131.35	0.19	0.67
Error	464897.28	661	703.32		

*Bold indicate significance at $p < .05$

Research Question 3 (QNRQ3). Due to the violation of homogeneity of variance when considering ethnicity, special education status and socioeconomic status, these variables were not investigated for this research question. Furthermore, the small sample size available for this research question did not lend itself to sub-group analyses beyond gender, see Table 6. In answering research question three (QNRQ3), a 2 x 2 two-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), and gender (male, female). The outcome variable was the actual Algebra II EOC exam score from the 2015-16 testing year. Tables 16 and 17 are associated with QNRQ3. Levene's test of homogeneity of variance was not significant, $F(3,46) = 1.15$, $p = .339$, indicating that the assumption of equal variances was tenable. It was appropriate, therefore, to proceed with the results from the analysis of variance. As can be seen in Table 17, the two-way interaction was not significant; therefore, simple effects testing not required, and the discussion could focus on the main effects. The main effects of group and gender were not significant, see Table 17, and the estimated marginal means are provided in Table 16.

Table 16

Estimated Marginal Means for the Actual End-of-Year Algebra II State Assessment for QNRQ3

		N	Mean	Std. Error
Group				
	Treatment	25	32.25	5.00
	Control	25	35.27	5.03
Gender				
	Male	24	33.87	5.11
	Female	26	33.65	4.91

Table 17

Analysis of Variance Summary: Tests of Between-Subjects Effects for QNRQ3

Source	Type III Sum of Squares	*DF*	Mean Squares	*F*	*p*
Group	112.57	1	112.57	0.18	0.67
Gender	0.61	1	0.61	0.00	0.98
Group * Gender	324.78	1	324.78	0.52	0.47
Error	28648.33	46	622.79		

*Bold indicate significance at $p < .05$

Qualitative Findings

The qualitative results were insightful and at times diverse regarding the strengths and weaknesses of the intervention and enrichment program. The teachers ($N = 3$) were all actively engaged in the interview and appeared interested and at times, passionate in their responses. They all appeared to hold to specific personal beliefs about their craft and defended their beliefs at length. Teachers' personal beliefs are summarized in Table 18.

Teacher 2 and Teacher 3 strongly believed that research-based instruction was necessary for effective math instruction. Teacher 1, who differed, described himself as a "discrete math kind of person" and subscribed more to teaching the process. Teacher 3 believed that relevance was important and stated that it was necessary to get student buy-in to do the math. Teacher 1 and Teacher 2 did not believe relevance was necessary and had similar reasons and examples related to learning math. Teacher 1 said, "I think of mathematics as more of like working your muscles, your intellectual muscles." Teacher 2 believed that math is a tool that students need to learn to use and that math's relevance is later discovered in further course study and in science applications. He went on to say,

> The conversation we should have with kids is more about, you know, to come to school is an opportunity machine. And if I'm going to give you all of the opportunities that are available, I need to teach you a broad range of topics, And I can't just say this is relevant to you right now.

Motivational strategies utilized by the teachers were varied. Teacher 3 said she focused on building students' confidence about their skills, by showing students that math goes in steps, that new material really was just adding to what they already knew, and that if students followed the process, they could solve any problem. Teacher 1 was similar, in that he showed students the process and stuck to the practical material versus the conceptual material. Teacher 2 simply stated, "Giving them tasks with high cognitive demand." He went on to explain these were usually open-ended tasks students worked on in groups and felt it was essential to build these activities into your instruction for at least ten minutes at day.

Teacher reports of student preparedness for high school mathematics were varied. Teacher 1 said 80% of his students were prepared. Teacher 2 said 60% were prepared mathematically, but only 20% were prepared for the rigor of a high school math classroom. Teacher 3, who worked only with special education students, reported that only 10% of her students were prepared for high school mathematics. The missing content skills, for students not prepared, reported by these teachers include basic math facts, regrouping for subtraction, division, fractions, and the ability to generalize.

Table 18

Personal Beliefs of Interviewed Teachers

Question	Yes	No
Is it possible to have an effective math classroom without the implementation of research-based methods?	2	1
Is relevance important in high school math instruction?	1	2

The interview questions specifically related to the teacher perceptions about the intervention and enrichment program efficacy, including classroom changes attributed to the intervention/enrichment program, implementation fidelity, and impact on student achievement. Effective elements, as reported by the teachers, included the following: (a) math problem of the week; (b) the computer-based program, Study Island; (c) classroom instruction for lower to mid-level students that included scaffolding to course content; (d) good resources for enrichment; and (e) math instruction by a different instructor who may present material in a different way. Ineffective elements centered mostly on the enrichment aspect of the program, with the exception of the mention that some intervention teachers were simply working from materials designed for younger students, which did not match the maturity level of the students actually taught. Concerns regarding the enrichment include: (a) enrichment students were not pushed enough as they had already met the standard; (b) non-math content teachers led the enrichment sections; and (c) while the lesson plans for the enrichment were well developed, the teachers leading these sections did use plans created by someone else.

When asked about changes in his classroom attributable to the intervention/enrichment program, Teacher 1 said he really was not sure if there were any and that it was difficult to tell. He did say that when reviewing for EOC exams, students seemed more familiar with content as they remembered many of the problems from the problem of the week, but outside of that, he was unsure. Both Teacher 2 and Teacher 3 expressed that student engagement in the classroom improved, particularly among the lower and mid-level students. Teacher 2 believed that due to scaffolding in the interventions, which filled in content gaps, students were more willing to engage the mathematics. Teacher 3 said that students were simply more willing to ask questions and that they were better understanding that there was more than one way to do the math. She attributed this change to students having more time to do some "figuring out" and self-correction during the intervention classes, as well as having the opportunity to have a different teacher than their regular course teacher, providing different possible strategies.

Teachers reported concerns with implementation fidelity. Teacher 1, stated, "I would like to think so, but, you know, I wasn't in everyone's classroom." Teacher 2 and Teacher 3 were more specific and consistent across six concerns, which included: (a) not all enrichment teachers accessed support from math teachers or provided resources; (b) not enough data from the enrichment sections was tracked; (c) it was difficult to keep teachers accountable; (d) there was no way to keep students accountable other than coursework grades and benchmark performance; (e) not all teachers bought into the intervention/enrichment program; and (f) while support, materials, and direction were provided, there was no formal PD session to really introduce and explain the program.

Responses from teachers were varied when asked about whether the intervention and enrichment program was effective in improving math achievement. Teacher 3 believed the program was effective in improving math achievement. Teacher 2 believed the program was effective for the lower students, but not overall. His reasons were based on the lack of implementation fidelity and that enrichment piece did not really work well. Teacher 1 was unsure and believed it was difficult to gauge.

Upon analysis, a few distinct themes emerged, however, the main theme was the trouble with implementation fidelity of the intervention and enrichment program. This was discussed throughout the interviews, particularly by Teacher 2 and Teacher 3, in relation to the enrichment aspect of the program, as well as teacher accountability and teacher buy-in. Another major theme was the effectiveness for lower-performing math students, which surfaced across questions. Specific issues mentioned were improved course engagement for these students and effective elements such as Study Island, teacher scaffolding of interventions to coursework to fill in gaps, and a greater understanding of multiple methods for problem solving. Additionally, the enrichment sessions were not generally considered effective according to the teachers' reports for various reasons, to include that many non-math teachers taught these sections from prepared resources, there was a lack of data tracking from these sections, and that many activities may have been fun or interesting, but possibly were not impactful on actual math achievement.

Summary of Quantitative and Qualitative Results

A few main effects were found for QNRQ1 (EOC Algebra I scores comparing pre intervention [2013/2014] to post intervention [2014/2015] school years). First, the treatment group performed significantly lower than the control group. When analyzing subgroups, black students performed significantly lower than the other ethnicities, and both low socioeconomic status students and students receiving special education services performed significantly lower than those of typical or high socioeconomic status and students not receiving special education services, respectively. The results (p = .03) for socioeconomic status could not be considered significant given the conservative *p*-value used for significance testing of .02 suggested by the Bonferroni method for analyzing these data using a three-way ANOVA. These results were not indicative of a positive effect for the intervention and enrichment program on Algebra I students. No main effects were found for QNRQ2 (EOC Algebra II scores comparing pre intervention to post intervention for the first year of implementation [2013/2014 to 2014/2015]) or QNRQ3 (EOC Algebra II scores comparing pre intervention to post intervention for the second year of implementation [2013/2014 to 2014/2015]). However, it was noteworthy that MHS was previously performing below the district on Algebra II EOC outcomes, and these results suggest that MHS students performed consistently with their peers, so it is possible that gains for Algebra II students were made during the 2014-2015 school year. Additionally, based on previous student outcomes, while no main effect was found for the treatment group in QNRQ3, residual effects of the intervention and enrichment program cannot be ruled out.

Qualitatively, a few themes emerged. The most notable was the lack of implementation fidelity of the intervention and enrichment program, along with the effectiveness for lower-performing students and the lack of effectiveness for the enrichment sessions, which targeted higher-performing students, as related by the three math intervention teachers who were interviewed. Based on the qualitative findings related to a lack of implementation fidelity, a policy paper focusing on implementation fidelity was deemed the most appropriate project genre.

Section 3: The Project

Introduction

In Section 1, I reviewed national and state data that demonstrated a lack of proficiency in algebra skills among high school students, as well as the professional literature on best practices in high school math instruction and intervention. In Section 2, I discussed the methodology for the study, the analysis methods, and the quantitative and qualitative results. In this section, I discuss my project, to include a detailed description, goals for the project, the rationale for genre selection, a review of professional literature, and a detailed discussion of the implementation of my project.

Description and Goals

The policy recommendation for establishing a process for fidelity monitoring of academic interventions was directly derived from MHS's attempt at improving math achievement through a school-wide intervention and enrichment program. Despite MHS's efforts, the results indicated that no gains in algebra achievement were realized on TN EOC assessments. Results of teacher interviews indicated that implementation fidelity was poor and was a major factor in the lack of improvement. I concluded, based on the findings that for MHS to improve student achievement, the school should implement a systematic process for assessing implementation fidelity for all implemented academic interventions (see Harn, Damico, & Stoolmiller, 2017).

There are several steps for developing and implementing a systematic process for assessing implementation fidelity, to include establishing a leadership team, securing teacher buy-in, purchasing resources, providing professional development as needed, determining fidelity assessment tools and assessment schedule, conducting fidelity assessment, and providing teacher feedback and coaching (TDOE, 2016). Currently, MHS does not have a prescribed leadership team to begin the development of a fidelity assessment process. Therefore, the school administration should establish a leadership team to facilitate the development and implementation of a systematic process for assessing implementation fidelity based on these research findings results (TDOE, 2016).

The anticipated outcome of developing and implementing a systematic process for assessing implementation fidelity would be improved intervention implementation, resulting in improved academic outcomes for students (McKenna & Parenti, 2017; Missett & Foster, 2015). By developing and implementing such as process, MHS will establish long-term implementation capability within their school so that teachers are better able to implement evidence-based interventions with a high level of fidelity and to extend their implementation to other settings and contexts (see McIntosh & Goodman, 2016; Sugai, Simonsen, Freeman, & La Salle, 2016). The policy recommendation could provide the structure necessary for building such capacity for implementation at MHS and improving student achievement.

Rationale

The purpose of this study was to assess whether there were differences in student algebra achievement after implementing a school-wide intervention and enrichment program at MHS in regards to student outcomes in Algebra I and Algebra II achievement. I also interviewed math teachers who taught some of the math interventions, in part, to determine the strengths and weaknesses of the school-wide intervention and enrichment program. My goal as a researcher was to determine whether or not achievement gains were realized and why. Based on the data analysis, I developed a policy recommendation for MHS for developing and implementing a systematic process for measuring implementation fidelity of academic interventions. The research findings indicated that no achievement improvement was realized from the school-wide intervention and enrichment program and also, that implementation fidelity was not measured or monitored. Therefore, MHS could benefit from focusing on measuring and ultimately improving the fidelity of implemented academic interventions.

I developed an interview protocol, found in Appendix B, for teachers that specifically asked about the strengths and weaknesses of the intervention and enrichment program. When asked specifically, "Do you believe the intervention/enrichment program was implemented with fidelity?" none of the three teachers gave a solidly affirmative answer and two teachers listed specific concerns with fidelity, which included (a) not all enrichment teachers accessed support from math teachers or provided resources; (b) not enough data from the enrichment sections was tracked; (c) it was difficult to keep teachers accountable; (d) there was no way to keep students accountable other than coursework grades and benchmark performance; (e) not all teachers bought into the intervention/enrichment program; and (f) while support, materials, and direction were provided, there was no formal PD session to really introduce and explain the program. A systematic process for measuring fidelity coupled with a leadership team responsible for supporting the process would ensure that teachers improved invention implementation.

Review of the Literature

Only 17% of 12th graders from TN scored at the proficient level or higher in mathematics on the NAEP assessments, and in 2015, 30% of students in TN met the national benchmark in mathematics as measured by the ACT while 42% of students nationally met the benchmark (Broderick, 2016; USDOE, 2013). Improving academic achievement across grade levels is a high priority in TN schools, as TN is currently performing below national standards (Broderick, 2016; USDOE, 2013). To improve academic achievement, evidenced-based instructional strategies and interventions need to be implemented with fidelity (McKenna & Parenti, 2017; Missett & Foster, 2015). Implementation fidelity is defined and explored from the perspective of educational research and classroom applications in this literature review. Additionally, assessment of fidelity and measurement tools are both examined.

Topics covered in this review of literature focus on the necessity of implementation fidelity in education improvement efforts, from educational research to applied practices in the classroom. Search terms included but were not limited to *implementation fidelity, intervention implementation, fidelity, fidelity checks,* and *fidelity rubrics*. Education research databases and indices were searched including ERIC, SAGE, Education Source; and Google Scholar; purchased books; and articles requested through the Walden Library.

Implementation Fidelity

Implementation fidelity can be defined in a variety of ways; however, most definitions can be distilled to the basic idea that implementation fidelity is “the degree to which a program model is instituted as intended" (Dhillon, Darrow, & Meyers, 2015, p. 9; Harn et al., 2017; Yeaton & Sechrest, 1981). To be more specific, implementation fidelity is defined by Anderson "as the similarity between enacted practice and the benchmark of program designers' specifications" (2017, p. 1291; Missett & Foster, 2015). When applied to an education setting involving intervention, it is defined "as the extent to which an intervention is delivered as intended by end users in an authentic education setting" (McKenna & Parenti, 2017; Roberts, 2017, p. 1). AIR (2015) specifically references educators in its definition, "Fidelity refers to how closely prescribed procedures are followed and, in the context of schools, the degree to which educators implement program, assessments, and implementation plans the way they were intended." These definitions do not fully encompass the extent or quality of implementation fidelity, therefore necessitating further definition through a variety of models (Anderson, 2017; Dhillon et al., 2015).

One model of implementation fidelity focuses on five different constructs: adherence, exposure, quality of delivery, participant responsiveness, and program differentiation (Dane & Schneider, 1998; Dhillon et al., 2015; Favre & Knight, 2016). Adherence refers to what some deem is the basic definition of implementation fidelity, as to whether or not an intervention or program is being implemented as designed and it relates to teacher professional development (Carroll et al., 2007; Dane & Schneider, 1998; Favre & Knight, 2016). Exposure is defined by the amount of intervention or programming being delivered, as prescribed by design (Carroll et al., 2007; Dane & Schneider, 1998; Favre & Knight, 2016). Quality of delivery is described as the manner in which an intervention or program is delivered (Carroll et al., 2007; Dane & Schneider, 1998; Harn et al., 2017). Participant responsiveness refers to the measurement of participant engagement and participation in the lesson (Carroll et al., 2007; Dane & Schneider, 1998; Favre & Knight, 2016; Harn et al., 2017). Program differentiation can be described as the identification of essential intervention or program elements and, according to some, measures something distinctly different from alternative programs (Carroll et al., 2007; Dane & Schneider, 1998; Dhillon et al., 2015; Favre & Knight, 2016).

Another model is based on three components, excluding participant responsiveness and program differentiation: strength, integrity, and effectiveness of treatment (Dhillon et al., 2015; Yeaton & Sechrest, 1981). This model prioritizes the elements directly related to treatment as opposed to the more comprehensive model with five constructs (Carroll et al., 2007; Dhillon et al., 2015; Yeaton & Sechrest, 1981). Strength is described in Yeaton and Sechrest as the "likelihood the treatment could have its intended outcome" (1981, p. 156). Integrity aligns with adherence and is described as the "degree to which a treatment is delivered as intended" (Dane & Schneider, 1998; Yeaton & Sechrest, 1981, p. 160). Effectiveness comprises several elements to include statistical effectiveness, practice standards, social validation, and cost benefits (Yeaton & Sechrest, 1981).

Other models have been proposed, based on fit to specific contexts, adding to practice and research in those contexts (Guo et al., 2016). In early literacy, for example, a three-factor model consisting of adherence and dosage, participant responsiveness, and program differentiation was found to best fit the data for implementation fidelity (Guo et al., 2016). Additionally, it was found that program differentiation significantly impacted early-literacy gains (Guo et al., 2016). In mathematics, often, the focus is on adherence only to measure implementation fidelity (Nelson, Van Norman, Parker, & Cormier, 2019).

The alignment of implementation constructs is complicated further by differences in emphasis on aspects of fidelity to be considered (Carroll et al., 2007; Dhillon et al., 2015). Some emphasize intervention fidelity and organizational fidelity, described by others as fidelity to structure and fidelity to processes or interactions (Dhillon et al., 2015; McKenna & Parenti, 2017). Fidelity to structure or intervention fidelity, both refer to practitioner adherence to program or intervention core component delivery, time allocation, and intervention completion (Anderson, 2017; Dhillon et al., 2015; Harn et al., 2017; McKenna & Parenti, 2017). Fidelity to processes or interactions refers to the quality of processes or interactions when implementing an intervention and is often considered in an educational setting, the quality of instruction and the quality of teacher-student interaction during the intervention (Anderson, 2017; Dhillon et al., 2015; Harn et al., 2017; McKenna & Parenti, 2017). Organizational fidelity focuses on the implementation of program supports, such as instructor or interventionist training (Dhillon et al., 2015). To summarize, generally, implementation fidelity either by definition, model, or aspect, describes how well a program or aspect of a program is implemented as designed.

Applications in Educational Research

One focus of implementation fidelity in educational research is research in designing and evaluating educational interventions and practices aimed at improving student achievement (Allor & Stokes, 2017; Meyers & Brandt, 2015; Missett & Foster, 2015; Roberts, 2017). Implementation fidelity is essential in such educational research to accurately interpret treatment results of an intervention or educational practice, as well as assess the generalizability of such practices and determine improvements in implementation (Dhillon et al., 2015; Meyers & Brandt, 2015; Missett & Foster, 2015; Murrah, Kosovich, & Hulleman, 2017). As a result, implementation fidelity should be measured when evaluating interventions and educational practices, involving substantial planning to avoid reliability and validity concerns (Dhillon et al., 2015; Missett & Foster, 2015; Murrah et al., 2017).

There are a variety of reasons that implementation fidelity would be measured in educational research (Anderson, 2017). Program evaluation or studies evaluating the efficacy of policy or understanding how much of a program, dosage, or fidelity of structure is essential to understanding the program or policy's impact (Anderson, 2017; Dhillon et al., 2015; Guo et al., 2016; McKenna & Parenti, 2017). Other research investigates the processes through which policies or programs are implemented, or fidelity of process (Anderson, 2017; Dhillon et al., 2015; McKenna & Parenti, 2017). An example would be a study on how teachers adjust a practice or program to fit their school's needs (Anderson, 2017). Additionally, there are studies that attempt to explain relationships between different facets of implementation as a process and an outcome

(Anderson, 2017). An example would be a study that examines the significance of teacher buy-in to maintaining program delivery (Anderson, 2017).

One five-step process for measuring implementation fidelity of an intervention includes defining the intervention logic models, identifying fidelity measures, conducting psychometric analyses, conducting within and between-group fidelity analyses, and linking fidelity to outcomes (Murrah et al., 2017). There are three models to define in the first step to include the actual intervention model, or the intervention black box (Kosovich, 2013; Murrah et al., 2017). The intervention black box is comprised of the intervention processes or core components of the intervention, the psychological processes or proximal changes in participants, and the outcomes or desired changes (Doabler et al., 2016; Kosovich, 2013; Murrah et al., 2017). The next model, the change logic model, according to Murrah et al., is "a conceptual representation of the intervention organized in the hypothesized causal order of events" (2017, p. 40). This model includes all of the components of the intervention black box and aids researchers in developing the third model, the operational logic model (Dhillon et al., 2015; Doabler et al., 2016; Murrah et al., 2017; Nelson, Cordray, Hulleman, Darrow, & Sommer, 2012). The operational logic model "identifies which indicators the researchers deem important for measuring the core components" (Murrah et al., 2017, pp. 40-41). The operational logic model clarifies for researchers what needs to be measured and what types of measures are needed to appropriately analyze implementation fidelity for a specific intervention (Crawford, Freeman, Huscroft-D'Angelo, Fuentes, & Higgins, 2019; Dhillon et al., 2015; Killion, 2016; Kisa & Correnti, 2015; Murrah et al., 2017).

When the components to be measured are determined, the next step is identifying fidelity measures (Dhillon et al., 2015; Murrah et al., 2017). Appropriate evidence to support the use of each measure should be determined, aligning to the intended use of the measure and with the logic model (Lakin & Rambo-Hernandez, 2019; Murrah et al., 2017). Each treatment component should be measured, both directly and indirectly, using observational data, self-report data, checklists, interviews, or data logs, for example (Dhillon et al., 2015; Missett & Foster, 2015; Murrah et al., 2017). After the measures have been chosen, psychometric analyses, the next step, should be conducted for each fidelity measure, gathering reliability and dimensionality information (Crawford et al., 2019; Kosovich, 2013; Murrah et al., 2017; Nelson et al., 2012). First, researchers determine whether there will be a single fidelity index, combining the individual measures, which is most common, or if there will be sub-scales of fidelity directly corresponding to different components (Harn et al., 2017; Murrah et al., 2017). Once that has been determined, researchers can concentrate on scale reliability (Murrah et al., 2017; Nelson et al., 2012). Piloting fidelity measurement instruments is necessary to determine validity and reliability data and refining the instruments, as necessary (Crawford et al., 2019; Lakin & Rambo-Hernandez, 2019).

After the fidelity measures have been determined to be appropriate, the next step, within and between-group fidelity analyses can begin (Murrah et al., 2017). Within-group analyses describe “how well the intervention was implemented as well as how implementation may have varied across individuals and groups” (Murrah et al., 2017, p. 44). Between-group analyses contrast treatment and control groups and can be managed by using an Achieved Relative Strength index (ARS; Murrah et al., 2017). ARS is often used to compare one group's level of measured fidelity to that of other groups or a predetermined absolute standard (Murrah et al., 2017). Once the analyses are complete, researchers can focus on the last step, linking fidelity to outcomes (Dhillon et al., 2015; Murrah et al., 2017). There are varied methodologies for linking fidelity to outcomes, including analysis of variance (ANOVA) and hierarchical linear modeling (HLM) (Dhillon et al., 2015). Theoretically, there should be appropriate correlations between outcomes and fidelity measures, so linking the two should provide valuable information on the impact of measured components on outcomes, the impact of fidelity on intervention effects, and subgroup effects for different measured components (Murrah et al., 2017).

Measuring implementation fidelity should be incorporated into intervention program design to include continuing intervention evaluation for the purposes of intervention improvement and continued development (Allor & Stokes, 2017; Crawford et al., 2019; Meyers & Brandt, 2015; Roberts, 2017). There are three stages in designing an intervention, to include development, efficacy or replication, and effectiveness, and each stage has different implementation fidelity activities (Allor & Stokes, 2017). The development stage mainly comprises developing prototype fidelity measures, piloting those measures, refining the measures, and assessing their reliability and validity (Allor & Stokes, 2017; Crawford et al., 2019). During the efficacy state, fidelity data is collected and analyzed throughout trials, to determine necessary levels of implementation for effectiveness and whether and how implementation could be improved (Allor &

Stokes, 2017). During the effectiveness stage, fidelity data is collected and analyzed throughout trials to guide future research, determine levels of implementation for routine practice, and, if needed, determine why differences exist from previous studies (Allor & Stokes, 2017). In summary, implementation fidelity is essential for the development and evaluation of educational interventions and practices, even though the process is technical and lengthy, and should be embedded in the design process.

Classroom Applications

Classroom applications of implementation fidelity include both teacher instruction and intervention applications, given current education policy requirements for evidence-based practices in classrooms to improve student achievement (McKenna & Parenti, 2017; Missett & Foster, 2015). Teachers are encouraged to implement programs with fidelity because these programs were deemed evidence-based and achieved positive results for students under those conditions prescribed by the program (Quinn & Kim, 2017). Classroom or core instruction that is not aligned with evidence-based practices or implemented as designed with fidelity may negatively impact student academic performance, resulting in unnecessary and inappropriate student referrals for additional intervention, whether through a specific multi-tiered intervention system (MTSS), like response to intervention (RTI) or positive behavior intervention system (PBIS), or special education (King-Sears, Walker, & Barry, 2018; McKenna & Parenti, 2017). Therefore, establishing and maintaining a high level of fidelity implementation of evidence-based practices in core instruction or regular classroom instruction is essential to improving the academic performance of all students and necessary for preventing unnecessary student referrals for more intensive intervention (King-Sears et al., 2018; Mages, 2017; McKenna & Parenti, 2017; Sugai et al., 2016).

In the classroom environment, implementation fidelity of interventions is often thought of as treatment fidelity, which is critical in determining whether changes in academic performance are due to the intervention (DeFouw, Codding, Collier-Meek, & Gould, 2018; Gresham, 2017; Lakin & Rambo-Hernandez, 2019; McKenna & Parenti, 2017). Treatment fidelity, according to Gresham, “refers to the methodological strategies used to monitor and improve the reliability and validity of academic and behavioral interventions in schools” (2017, p. 22). Treatment fidelity is comprised of treatment adherence, interventionist competence, treatment differentiation, and treatment receipt (Anderson, 2017; Gresham, 2017). Treatment adherence consists of treatment component adherence and session/daily adherence or accuracy and consistency (Gresham, 2017; Nelson et al., 2019). Interventionist competence can be defined as the experience and skill of the interventionist delivering the intervention, and treatment differentiation involve distinguishing treatments being used along theoretical dimensions (Gresham, 2017). Treatment receipt is comprised of intervention dosage, student understanding of the intervention, and student receptiveness to the intervention (Gresham, 2017).

Generally, schools have increasingly implemented MTSS, RTI, or PBIS processes for service delivery, which utilizes a student’s lack of progress to a research-based intervention to determine whether or not to change, modify or intensify the intervention (AIR, 2015; DeFouw et al., 2018; Gresham, 2017; McKenna & Parenti, 2017). The MTSS approach is based on the idea that a change in performance, academic or behavioral, is a function of intervention and student access to evidence-based instructional practices, in the classroom and the intervention is critical to MTSS, RTI, or PBIS implementation (Gresham, 2017; McKenna & Parenti, 2017; Sugai et al., 2016). As such, implementation fidelity measurement within the MTSS service delivery model is essential to determining whether or not a student's lack of progress warrants alterations to the student's intervention program (AIR, 2015; DeFouw et al., 2018; Gresham, 2017; King-Sears et al., 2018; McKenna & Parenti, 2017). The MTSS approach aims to establish content proficiency and long-term implementation capability within school buildings with teachers so that teachers have better opportunity to implement evidence-based programs and interventions with high levels of fidelity and to better adapt and extend their implementation over time and to other settings and contexts (McIntosh & Goodman, 2016; Sugai et al., 2016). To accomplish this level of MTSS implementation with fidelity, schools must build capacity for implementation (Sugai et al., 2016).

Implementation fidelity is critical for the delivery of special education services and directly impacts student performance (Boardman et al., 2016; Brock & Carter, 2017; King-Sears et al., 2018; McKenna & Parenti, 2017). Given that high levels of implementation fidelity are correlated with improved student outcomes, it is critical that these students receive the benefit of evidence-based practices implemented with fidelity for the opportunity for improved performance (Boardman et al., 2016; Brock & Carter, 2017; King-Sears et al., 2018; McKenna & Parenti, 2017). Low levels of implementation fidelity may result in lower levels of student performance and may also result in not providing appropriate opportunities for special education students to develop necessary skills (Boardman et al., 2016; King-Sears et al., 2018; McKenna & Ciullo, 2016; McKenna & Parenti, 2017). However, teachers and researchers report concerns about the implementation of evidence-based interventions for special education students, suggesting a need for effective professional development for teachers (Brock & Carter, 2017). Additionally, implementation fidelity is also a consideration when managing student behavior and discipline and can impact such special education processes as manifestation determinations (McKenna & Parenti, 2017; Walker & Hott, 2016).

An alternative classroom application process is the practice of adapting evidence-based practices to local contexts (Quinn & Kim, 2017). Structured adaptations, which maintain core principles while adapting program components, are effective for students when teachers are experienced with implementing the program with fidelity as designed (Quinn & Kim, 2017). Adaptive practices have not been found to be effective for teachers inexperienced with the program (Quinn & Kim, 2017).

The two categories of factors related to treatment fidelity are variables related to the intervention and variables related to the interventionist (Gresham, 2017). Variables related to the intervention include (a) ease of implementation, (b) materials and resources required for implementation, and (c) intervention complexity (Anderson, 2017; Gresham, 2017; Troyer, 2017). Interventions which are difficult to implement or require a high degree of effort are less likely to be implemented with high levels of fidelity, as are overly complex interventions, than easier, simpler interventions (Balu & Doolittle, 2016; Gresham, 2017; McKenna & Parenti, 2017; Troyer, 2017). Additionally, treatments that require materials and resources not typically found in school classrooms are less likely to be implemented with high levels of fidelity as treatments with more common materials (Anderson, 2017; Gresham, 2017; McKenna & Parenti, 2017). Variables related to the interventionist include (a) number of interventionists, (b) perception of effectiveness, and (c) motivation (Favre & Knight, 2016; Gresham, 2017; Lakin & Rambo-Hernandez, 2019). Treatments requiring more than one interventionist are less likely to be implemented with high levels of fidelity than those with only one interventionist (Gresham, 2017). Interventionists are more likely to implement treatment with high levels of fidelity if they believe the treatment to be effective and if they are motivated to invest their time and efforts into implementing the treatment (Favre & Knight, 2016; Gresham, 2017; Lakin & Rambo-Hernandez, 2019; McKenna & Parenti, 2017; Schechter, Kazakoff, Bundschuh, Prescott, & Macaruso, 2017). Belief in treatment or program effectiveness and teacher or interventionist motivation increases teacher engagement, which improves implementation fidelity (Lakin & Rambo-Hernandez, 2019; Schechter et al., 2017).

Implementation fidelity of evidence-based practices is achieved in part, through effective and rigorous professional development aimed at not only providing opportunities for teachers to learn new programs but to support teachers in changing, developing and maintaining effective practices for both typical students and students with disabilities across all subject areas (Balu & Doolittle, 2016; Brock & Carter, 2017; Killion, 2016; King-Sears et al., 2018; Mages, 2017; Sugai et al., 2016; Troyer, 2017). Evidence suggests that how teachers are trained may be more important than the number of hours spent training, and both the content and process of professional learning opportunities are equally significant in supporting teachers in the implementation of new evidence-based practices (Brock & Carter, 2017; Killion, 2016; Kisa & Correnti, 2015; Troyer, 2017). The level of implementation fidelity is higher when the outcomes of professional development are explicitly described and aligned with evidence-based practices. Also, for student outcomes and when professional development utilizes strategies for both content knowledge and transfer to practice, to include training, modeling, coaching, opportunities to plan instruction, performance feedback, and other supports (Brock & Carter, 2017; Fallon, Collier-Meek, Maggin, Sanetti, & Johnson, 2015; Killion, 2016; King-Sears et al., 2018; Kisa & Correnti, 2015; Troyer, 2017). One process for implementation or fidelity coaching involves five steps, to include (1) modeling the intervention, (2) sharing the fidelity protocol, (3) coaching prior to implementation, (4) observing during implementation, and (5) reflecting with the interventionist using fidelity data (King-Sears et al., 2018).

Another element of program or intervention implementation fidelity is often defined as student factors, such as student behavior and attendance (Balu & Doolittle, 2016; Grover, 2016; LaRusso, Donovan, & Snow, 2016). However, these factors could be redefined as school factors, like classroom management, parent engagement, alternate disciplinary practices, and school climate, and addressed through school improvement efforts in these areas (Balu & Doolittle, 2016). Another threat to intervention implementation fidelity is often the school schedule and schedule interruptions, as the time allotted often does not meet the needs of the intervention or the students (Balu & Doolittle, 2016; Grover, 2016; LaRusso et al., 2016). Testing and test preparation often interfere with implementation fidelity, as well (LaRusso et al., 2016). Additionally, intervention components that are structured and teacher-led rather than intervention components requiring adaptations and group interaction are more likely to be implemented with higher fidelity (Balu & Doolittle, 2016; Grover, 2016).

School-level threats to implementation fidelity include misalignment with classroom and school need; competing initiatives that while having overlapping goals, do not have overlapping implementation plans; multiple new program/curricula implementations at the same time; and leadership policies that are not supportive or prioritize implementation (LaRusso et al., 2016; Sugai et al., 2016). One way to address school level threats is through capacity development based on basic teaching and learning tenets, system implementation standards, and distributed leadership principles (Sugai et al., 2016). Capacity development entails developing and establishing competent and sustainable school systems where academic and behavioral practices are culturally responsive, implemented with high levels of fidelity, continuously adapted using data, supported through regular professional development, coordinated at the school and district levels, officially authorized by school and district leadership, and sustained over time (OSEP Technical Assistance Center on Positive Behavioral Interventions and Supports, 2015a; Sugai et al., 2016).

Fidelity Assessment

Fidelity is measured in a variety of ways, and measurement methods are not fully understood (Harn et al., 2017; Hauk, Salguero, & Kaser, 2016). One common way to approach fidelity assessment is to describe methods used for measuring fidelity of structure and fidelity of process (Harn et al., 2017; Hauk et al., 2016; Lakin & Rambo-Hernandez, 2019). Structural areas include intervention delivery to include adherence or differentiation, dosage or time allocation, and intervention completion (Anderson, 2017; Dhillon et al., 2015; Harn et al., 2017; McKenna & Parenti, 2017). Often these areas are assessed using direct observations, but some, such as dosage and intervention completion, can be measured through self-report or attendance logs (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019; McKenna & Parenti, 2017). Fidelity of process assessment is more complex due to the qualitative nature of the assessment (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). Quality factors involved include how well the interventionist appeared to comprehend the lesson and content, availability of materials, teacher response to student questions, language use, student engagement, the opportunity for student response, the accuracy of student response, and behavior management (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). Program-specific direct observations, focus groups, and teacher interviews are good data sources for the analysis of process areas (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). Measurement reliability is more of a concern when assessing fidelity of process; however, fidelity of process is important as it is considered by some as more directly related to student outcomes than fidelity of structure (Boardman et al., 2016; Harn et al., 2017). Student outcomes in reading and math are not predicted similarly using these fidelity measures, as reading outcomes were better predicted using fidelity of process, and math outcomes were better predicted by fidelity of structure (Boardman et al., 2016; Harn et al., 2017).

Another method of fidelity assessment involves a multidimensional approach where both the structural and process aspects of fidelity are measured simultaneously (Harn et al., 2017). This method is focused on measuring program dosage and program delivery and is considered a better representation of implementation fidelity than either a structural or process measure (Harn et al., 2017). Student outcomes in math were predicted by multidimensional methods similar to structural methods, but there was no advantage to these methods in reading outcomes (Harn et al., 2017).

Direct and indirect assessment methods are both appropriate when measuring treatment fidelity within classrooms, and there are advantages and disadvantages associated with either of them (Gresham, 2017; Missett & Foster, 2015). Time and place of the actual intervention is often the determining factor of which method is used (Gresham, 2017). Direct assessment methods consist of systematic observations of the delivered intervention within the classroom setting, often using an observation rubric developed specifically for the intervention employed, as well as audio recordings of the delivered intervention (Foorman, Dombek, & Smith, 2016; Gresham, 2017; Harn et al., 2017; McKenna & Parenti, 2017). This method is useful in that multiple different treatment components can be observed as well as the quality of delivery and student responsiveness, to include student behavior (Foorman et al., 2016; Gresham, 2017; Harn et al., 2017). As a result, content validity is critical for this type of assessment and is dependent on the number of observations and the length of observations (Gresham, 2017; Lakin & Rambo-Hernandez, 2019). One limitation of systematic observations is the high number of observations required to achieve a valid and appropriate measure (Gresham, 2017). Indirect methods often include surveys, checklists, and intervention logs, measuring fidelity after the intervention or treatment has already occurred (Gresham, 2017; McKenna & Parenti, 2017).

It is difficult to discern when to assess fidelity given the many purposes of measuring implementation fidelity (Harn et al., 2017). When assessing fidelity early in the implementation process, while it is likely to be low, the information gained is useful to determining professional development needs and providing instruction and support (Brock & Carter, 2017; Foorman et al., 2016; Harn et al., 2017). However, assessing early in implementation is not sufficient as fidelity should improve with additional supports and more teacher practice (Harn et al., 2017). Only assessing fidelity once upon implementation is not an adequate measure, given the contextual variability in schools, such as school schedule and attendance, and the need to provide continuous coaching support to teachers (Foorman et al., 2016; Harn et al., 2017). These circumstances indicate the importance of measuring implementation fidelity of an intervention at various stages of implementation, for instructional support, and maintenance purposes (Foorman et al., 2016; Harn et al., 2017). Therefore, schools should use a systematic process to assess implementation fidelity (Harn et al., 2017).

There is variability in what constitutes an acceptable level of fidelity when implementing evidence-based practices and interventions, and this variability is dependent on unique components of practices and interventions (Harn et al., 2017; Hauk et al., 2016; King-Sears et al., 2018; Lakin & Rambo-Hernandez, 2019). First, there are threshold effects when higher levels of fidelity do not lead to improved student outcomes

(Harn et al., 2017). Features of the intervention program or practice and variation in subpopulations, may both lead to threshold effects (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). For example, more explicitly defined program components may impact outcomes more positively than programs with less specified components at lower fidelity levels (Harn et al., 2017). Second, there is a need for program flexibility to support differentiation of instruction and culturally responsive classrooms (Lakin & Rambo-Hernandez, 2019). Therefore, appropriate levels of flexibility should be built into both the structural and process components to allow teachers to exercise professional judgment for the context of the program (Lakin & Rambo-Hernandez, 2019). Additionally, the differential impact of implementation fidelity on student outcomes has been found by the level of risk or intervention intensity, ethnic groups, and gender (Harn et al., 2017). For example, higher levels of fidelity may be more necessary for more at-risk students or those in the most intensive interventions than those students at lower risk levels (Boardman et al., 2016; Harn et al., 2017).

There are several threats to the reliability of intervention or treatment fidelity measurement to include reactivity of observations, interventionist drift, the complexity of treatment, and interventionist expectancies and feedback (Favre & Knight, 2016; Gresham, 2017; Harn et al., 2017; McKenna & Parenti, 2017). Reactivity of observations refers to the phenomenon of those being observed, the interventionist, in this case, knowing they are being observed and reacting by delivering the intervention or treatment with more integrity than is typical (Gresham, 2017; Harn et al., 2017). One way to improve reliability and reduce the reactivity effect is to conduct observations on a random schedule (Gresham, 2017). Interventionist drift refers to the tendency interventionists demonstrate to change their delivery of treatment over time (Favre & Knight, 2016; Gresham, 2017). Ways to improve reliability and prevent drift are to provide performance feedback to interventionists, either formally or through informal debriefing, and to ensure professional development is adequate for teachers to adjust their efficacy beliefs (Favre & Knight, 2016; Gresham, 2017). The complexity of treatment refers to the number of steps and difficulty of implementation of a treatment protocol (Gresham, 2017). Interventionist expectancies and feedback both denote behavioral reactions of the interventionist impacting reliability (Gresham, 2017; McKenna & Ciullo, 2016; McKenna & Parenti, 2017). Interventionists who expect an intervention to be effective are more likely to implement that intervention with more fidelity than those who do not expect the intervention to be effective (Favre & Knight, 2016; Gresham, 2017; Lakin & Rambo-Hernandez, 2019; McKenna & Parenti, 2017). Also, interventionists who receive regular, detailed performance feedback implemented intervention with much greater fidelity than those who were not provided such feedback (Brock & Carter, 2017; Fallon et al., 2015; Gresham, 2017; McKenna & Ciullo, 2016; McKenna & Parenti, 2017).

Fidelity Measurement Tools

Selecting appropriate fidelity measures, and confirming validity and reliability, to evaluate the fidelity of implementation is an important step in the process (Lakin & Rambo-Hernandez, 2019; Murrah et al., 2017). There are existing fidelity measures, and these measures often already have validity and reliability data to review (Ibrahim &

Sidani, 2015; Lakin & Rambo-Hernandez, 2019). Another advantage is that these measures can have a strong theoretical basis making them more credible (Lakin & Rambo-Hernandez, 2019). However, identifying such measures is complex as validity and reliability is not always wholly measured, all facets of fidelity may not be measured, and appropriateness can depend on participant characteristics (Ibrahim & Sidani, 2015; Lakin & Rambo-Hernandez, 2019; Lewis et al., 2015).

One review of fidelity measures found that adherence and interventionist competence were aptly measured by the reviewed measures; however, participant engagement and exposure were not (Ibrahim & Sidani, 2015). Additionally, it was found that few measurement studies report explicitly enough to measure use and to evaluate intervention differentiation (Ibrahim & Sidani, 2015). Another review of fidelity measures across eight constructs found that from 104 fidelity instruments, fewer than ten measures demonstrated evidence from more than two of those constructs, with only one measure demonstrating psychometric strength on all six assessment criteria (Lewis et al., 2015). The constructs include acceptability, adoption, appropriateness, cost, feasibility, fidelity, penetration, and sustainability (Lewis et al., 2015). The six assessment criteria include internal consistency, structural validity, predictive validity, norms, responsiveness, and usability (Lewis et al., 2015). Conclusions from both reviews indicated a need for further development of psychometrically sound measures that improve the psychometric quality of existing and new measures and account for all facets of the fidelity of intervention implementation (Ibrahim & Sidani, 2015; Lewis et al., 2015).

Participant characteristics, such as academic levels, gender, and ethnicity, can impact the appropriateness of fidelity measures (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). Using an intervention outcomes measure validated in the general population in a gifted education environment or for high-risk students can pose problems, for example (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). Problems posed in the gifted education environment include greater than expected measurement error, a ceiling effect, and regression to the mean (Lakin & Rambo-Hernandez, 2019).

To improve upon the fidelity of implementation measurement, it may be appropriate to develop new measures should measurement problems exist or if the existing measure does not align with the intervention's goals (Lakin & Rambo-Hernandez, 2019). The development of fidelity measures, at a minimum, involves gathering validity evidence, use expert guidance in writing or have an expert review the measurement items, and conducting a pilot test of the measures (Crawford et al., 2019; Lakin & Rambo-Hernandez, 2019). The collection of validity evidence should be aligned with the purposes of the intervention or evaluation (Lakin & Rambo-Hernandez, 2019).

Additional resources for fidelity measures in education include the National Center on Intensive Intervention, the Center on Response to Intervention, and in the state of Tennessee, the Response to Instruction and Intervention Framework (AIR, 2014a; AIR, 2015; TDOE, n.d.-b). Measurement tools available include individualization checklist, progress monitoring checklist, intensive intervention review log, data-based individualization implementation rubric, data meeting plan fidelity checklist, implementation logs, RTI fidelity of implementation rubric, and RTI essentials worksheet

(AIR, 2014a; AIR, 2015). The Response to Instruction and Intervention Framework contains sections across all tier of intervention and instruction on fidelity monitoring (TDOE, n.d.-b). Generally, multiple types of fidelity measures are widely available as well as resources to develop fidelity measures should that be needed.

Project Description

I developed a policy recommendation on measuring fidelity of implemented academic interventions, based on analysis of assessment scores and teacher interviews. These recommendations will be shared with the administration of MHS as well as members of the research department at the district board office. School administration should proceed with creating a leadership team and fine-tuning these recommendations before sharing with school staff. This document can also be shared with other stakeholders, such as district personnel, school staff, parents, and other high school administrators within the district.

Needed Resources and Existing Supports

MHS tried to implement school-wide math intervention and enrichment to improve student outcomes but was unsuccessful. Currently, the school uses a Response to Instruction and Intervention (RTI2) Framework to deliver academic intervention to students per state requirement (TDOE, 2016). Through the statewide implementation of RTI2, the state has provided fidelity documents, state training, and an implementation guide to assist schools with implementation. Additionally, the district provides ongoing training and intervention training, as well. However, finding and purchasing district approved interventions that engage high school students is still a challenge as well as providing ongoing professional development and coaching to teachers providing intervention.

Potential Barriers and Solutions

Potential barriers were identified in the project, the primary one being teacher buy-in, which is essential for successful intervention implementation with fidelity. Additional barriers include student attendance and student behavior. I propose several professional development strategies for improving teacher buy-in, in addition to establishing school-wide achievement improvement goals and giving teachers voice regarding school-wide goals and their needs (Greene, 2016). I also propose additional coaching for teachers struggling with student attendance and behavior during interventions, in addition to the current established school-wide attendance and behavior practices (Balu & Doolittle, 2016; King-Sears et al., 2018). I also propose additional communication between the school and parents, as recommended in the RTI2 Implementation Guide, for gaining parent support in reinforcing student attendance and behavior in intervention classes (TDOE, 2016).

Implementation

I developed a recommendation for developing and implementing a systematic process for measuring fidelity of implemented academic interventions. This process is based on research and state recommendations, as outlined in the RTI2 Implementation Guide. The goal for this project is to have a leadership team in place to develop and implement a process for measuring implementation fidelity within MHS. This will provide needed structure and accountability to the school's intervention process, as well as a needed coaching resource to teachers who are providing intervention, all improving intervention implementation.

The policy recommendations will be presented to MHS's administration and related leadership. I will propose that the recommendations be transformed into an implementation plan and presented to the leadership team, once established. The policy and practice changes can be presented to school staff at the beginning of the school year, during a time already scheduled for professional development.

Roles and Responsibilities

As part of this project student, I developed a policy recommendation to facilitate measuring academic intervention implementation fidelity and, ultimately, improve intervention implementation and student outcomes. I will be presenting the recommendations to MHS's administration and related leadership, with the recommendation that they follow the guidance of the state RTI2 Implementation Guide with adaptation for their school's individual needs by a school-level leadership team. After the presentation, I will distribute a formative evaluation to the administrators for their completion after thoroughly reviewing the policy recommendations. The goal of this recommendation is the development of a systematic process for assessing fidelity of implemented academic interventions. While I may be able to assist in MHS's development of such a process, the responsibility of the actual development and implementation of the process will be that of the leadership team, once established.

Project Evaluation Plan

I developed a policy recommendation, found in Appendix A, for measuring fidelity for implemented academic interventions at MHS. The evaluation focuses on the actual project and not on goals or student outcomes as a result of the project. A formative evaluation will be used to evaluate the policy recommendation, as formative evaluations are used when policies or projects are in the early stages of implementation. Formative evaluations can be used to make modifications or revisions for improvement and also for progress monitoring purposes, providing staff feedback (Stetler et al., 2006). I will present the policy recommendations to MHS's administration and related leadership, such as Special Education Lead and Dean of Students, after which, I will distribute a survey, found in Appendix D, for their completion after thoroughly reviewing the policy recommendations (Thomas, 2018). The response from this evaluation will be used to determine the understandability and relevance of the policy recommendations, as well as whether or not the recommendations can or will be implemented.

Project Implications

This policy recommendation could benefit teachers, administration, and, most importantly, students at MHS. Other district high schools could also benefit, as MHS, if successful, could serve as a model school for other schools in the district to emulate. This recommendation will serve as a guide, backed by research, to school leaders and teachers, on developing and implementing a systematic process for measuring fidelity of implemented academic interventions. This project may be especially beneficial to students, particularly struggling students, as the implementation of this process could result in improved academic achievement outcomes (Harn et al., 2017; Sugai et al., 2016).

School Community

Measuring fidelity of implemented interventions has been shown to improve the fidelity of intervention implementation. This occurs by analyzing the data collected and providing feedback to teachers, coaching, and other professional development as needed (Balu & Doolittle, 2016; King-Sears et al., 2018). Additionally, by measuring such student factors as attendance, behavior, and academic skill progress, parent communication regarding student progress is enhanced, and parents are better able to reinforce school efforts. Thus, systematically measuring fidelity improves the school community as a whole and builds capacity for extensions of intervention implementation, in addition to improving student academic achievement outcomes through improved academic interventions (Harn et al., 2017; Sugai et al., 2016).

Societal

This policy recommendation could serve as a model for other district and state high schools still struggling with systematically measuring fidelity of their implemented academic interventions. It can help other high schools determine what is missing from their own practices so that they can improve their own implementation and fidelity monitoring process. As academic interventions are more widely implemented with fidelity in high schools, student academic achievement could improve, leading to improved high school graduation and postsecondary entrance rates. Another benefit could be improved adult literacy rates, leading to potentially lower incarcerations rates, as people are better able to access employment (Michan, 2016).

Conclusion

The purpose of this project was to develop a policy recommendation to develop and implement a systematic process for measuring fidelity of implemented academic interventions at MHS. This section includes a rationale for the project rationale and review of literature, both based on my research results, as well as project description, project evaluation, and project implications. Needed resources, existing supports, and potential barriers and possible solutions are detailed, and a plan for implementation and evaluation is described. This project has implications for both the school community, the district community, and beyond. The next section focuses on my reflections on the project study and my conclusions.

Section 4: Reflections and Conclusions

Introduction

I addressed the lack of improvement in student achievement after implementing a school-wide math intervention and enrichment program by making a policy recommendation on implementation fidelity for academic interventions. Specifically, my recommendation, based on the research results and literature review from Section 3, is to develop and implement a systematic process for measuring implementation fidelity for the purpose of improving intervention implementation. In this section, I will discuss project strengths, limitations, alternative approaches, and implications and directions for future research. I will also reflect on my own professional and scholarly development through this project and the general importance of this work.

Project Strengths and Limitations

I used a mixed-methods design for this project study to address a local problem with high school algebra achievement. Using the study findings, I created a policy recommendation to improve the implementation fidelity of academic interventions at MHS. The policy recommendation was based upon data collection and analysis from Section 2, as well as current literature on implementation fidelity.

This policy recommendation is a guide for MHS to develop and implement a systematic process for measuring the fidelity of implemented academic interventions. One strength of this recommendation is that the school leadership team will be developing and implementing the process based on MHS needs. Another advantage of this recommendation is that it allows for additional professional development and mentoring support for staff, improving implementation, and staff buy-in. The process recommended is founded on continual data collection, resulting in continued problem solving around continuous improvement, building capacity for intervention within MHS, another strength. Additionally, the recommendation is based on TN state guidelines, allowing MHS to better collaborate with other high schools as they strive to make improvements.

One limitation of the policy recommendation is that it is assumed that intervention resources and training will be available prior to the start of school. It is also assumed that teacher turnover will not interrupt the process of assigning teachers to be interventionists, so they can prepare and attend professional development. Additionally, it is assumed that the leadership team will have ample time prior to the school year to develop the fidelity monitoring schedule, choose tools, and prepare the professional development for the beginning of the year.

Recommendations for Alternative Approaches

While lack of implementation fidelity was an emerging theme in the qualitative analysis, there were other noted concerns with the intervention and enrichment program. One was that some teachers did not take advantage of offered mentoring or resources for their intervention block. Another potential concern that emerged from the literature review was the amount of time for the intervention or dosage.

Another way to address the lack of improvement after the intervention would be to require more rigorous professional development for those teachers providing intervention as well as additional resources to include prepared interventions with scripted lessons. The intervention and enrichment program was developed by staff members, and while mentoring was encouraged, it was not required. Additionally, some staff members did not use the provided materials and instead created their own. This lack of preparedness may have impacted the lack of improvement in student outcomes. The necessity of proper professional development and resources was addressed in the policy recommendation, as they are necessary for implementation fidelity; however, the improvement of professional development could be made without implementing systematic fidelity monitoring, and student academic outcomes could improve.

Additionally, the dosage was most likely a factor impacting student outcomes. The intervention and enrichment program was implemented for 1 hour a week. More frequent intervention blocks, upping the intervention dosage, may have improved student outcomes for the intervention and enrichment program. However, increasing the dosage without improving implementation fidelity would not likely have made a long-lasting impact on student outcomes. Poor intervention implementation fidelity is actualized as decreased intervention dosage, suggesting that the more efficient way to increase dosage would be to improve implementation fidelity.

Scholarship, Project Development and Evaluation, and Leadership and Change

The research process is very complex, which I did not fully appreciate until going through this process personally. I learned many things, from the specifics of library research to improved writing skills to negotiating with stakeholders for data access. I also learned new things about statistics, as well as how to approach a mixed-methods study.

Additionally, I learned to organize my time better and juggle work and family responsibilities.

While having conducted literature reviews in the past, I never previously conducted such thorough, extensive, or current literature reviews as required for this process. And previously, the literature reviews were essentially just for the sake of the exercise and not connected to research questions or to specifically better understand a problem and to formulate potential solutions, which is quite different conceptually than conducting one simply for the exercise. Additionally, I had never conducted such extensive research using an online library and online resources, which was another growth experience.

This project was my second scholarly research experience, but the first one where I had to formulate research questions and hypotheses myself, in relation to the problem as well as the actual available data. I also had the experience of learning how to integrate quantitative and qualitative results in a mixed-methods design, along with the specifics of each piece, such as writing an interview protocol, transcribing interviews, analyzing interview data, and propensity matching. Acquiring the archived data from my school district was a learning experience in negotiation in that I had to prove the value of my project before my district would allow me access to the archived data I needed for my research.

This was the first time I had to take research and apply what was learned to develop a product based on research. Prior to this experience, I really had little knowledge of how policies were developed or formed, so to create a policy recommendation from the research was quite interesting and meaningful if for nothing other than what I learned. To form my policy recommendation, I also learned about change processes to include the supports and resources needed for effective and lasting change as they pertained to my project.

My personal growth as a scholar, practitioner, and project developer involved making priorities, time organization, persistence when dealing with adversity, the value of stakeholder input, and embracing setbacks in addition to honing my research and writing skills, and the learning detailed above in developing this project. My current employment involves working hours beyond the workday, usually writing reports. I had to learn to balance my writing responsibilities between work and this project and prioritize those responsibilities based on due dates related to federal timelines and semester plan goals. I had to learn to organize my time such that I still met my family responsibilities as well. Additionally, the process to acquire access to district archived data is quite involved and time consuming, requiring me to defend my project to the district research committee eventually and amend my proposal and project to include qualitative data collection and analysis, and more extensive quantitative analysis. From what appeared to be setbacks, my project is much more comprehensive, allowing me to develop a much better policy recommendation than I would have developed from my original project. From this, I learned the value of stakeholder input, but also to embrace setbacks as they are inevitably part of the project development process. Overall, my growth as a scholar, practitioner, and project developer is substantial in a variety of ways, which I have detailed. Lastly, my respect for my fellow researchers and their abilities has grown immensely through this process.

Reflection on Importance of the Work

The purpose of this study was to assess whether there were differences in student outcomes in Algebra I and Algebra II achievement, as measured by the Algebra I and Algebra II EOC exam achievement scores, after implementing this school-wide intervention and enrichment program at MHS. Also, to gather teacher impressions and program strengths and weaknesses, using teacher interview data. The goal of the project, based on the research results, was to develop a policy recommendation for MHS to develop and implement a systematic process for measuring academic intervention implementation fidelity, for the purposes of improving student academic achievement at MHS. The need for such a policy recommendation was revealed in the teacher interviews, where, after careful analysis, the lack of accountability and lack of fidelity emerged as a theme. A systematic process for measuring fidelity of implementation is necessary for continual intervention implementation improvement, necessary for the improvement of student academic outcomes, given that the current process for academic intervention at MHS is an RTI process (AIR, 2015; DeFouw et al., 2018; Gresham, 2017; Harn et al., 2017; King-Sears et al., 2018; McKenna & Parenti, 2017). Should MHS implement the policy recommendation, implementation of academic interventions should improve, and as a result, student academic outcomes, such as academic proficiency, will improve. Improving student academic outcomes leads to improved postsecondary and employment opportunities for students resulting in social change (ACT, 2007).

Implications, Applications, and Directions for Future Research

There are both local and national implications, applications, and directions for future research, regarding high school academic achievement and measuring fidelity of intervention implementation. At MHS, once the policy recommendation is implemented, fidelity and academic achievement data should continue to be collected and analyzed to make data-driven recommendations for continued improvement of student outcomes. Additionally, other district high schools should develop a similar systematic process, if not already in place, for measuring implementation fidelity, collect data, and also work toward implementation improvements to improve student academic outcomes.

The use of propensity matching in studying academic student outcomes in schools is not widely utilized by school districts but could be more widely utilized in studies to improve study validity by creating control groups to elevate studies to experimental research (Pan & Bai, 2015). This analysis method allows school developed intervention processes to be researched as experimental studies without actually conducting an experiment and the possible harm caused to participants that are inherent in experimental studies (see Creswell, 2012; Pan & Bai, 2015). The broader use of propensity matching by districts could aide data-based decisions at the district level, resulting in improved student outcomes.

Nationally, RTI and MTSS systems are being actively implemented at the elementary level, but the implementation of these systems is not as widely utilized at the high school level. Generally, there is much less confidence among educators on the success of these processes at the high school level, and the lack of student motivation, often perceived as an unyielding barrier to fidelity, is generally more pronounced at the high school level (Ehren, n.d.). Given these factors, more research on the impact of intervention implementation fidelity within these systems at the high school level would be valuable in advancing the use of academic interventions at the high school level to improve student outcomes.

Conclusion

This study began with a school developed math intervention and enrichment program for all students and ended with a policy recommendation for the school to develop and implement a systematic process for measuring fidelity to improve intervention implementation fidelity. The journey from the beginning to the actual project was filled with multiple learning opportunities, many unexpected. The impact of this work and growth has the potential to improve academic outcomes for the students at MHS, and also potentially, for students at other high schools, also struggling to implement interventions with fidelity.

Generally, the overall experience was enlightening as I came to understand from a research perspective, how interconnected and important all stakeholders are for school improvement to occur. Additionally, my respect for educational researchers has grown as I have wrestled with the complexities of this work first hand. My transformation into a practitioner-scholar will continue as I apply what I have learned from this journey to my current position and future opportunities, advocating for social change.

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Appendix A: The Project

Implementing Fidelity Assessment into the Intervention Process

A Policy Recommendation White Paper

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Introduction of the Local Problem

Midtown High School (MHS), a pseudonym for an urban high school located in Tennessee, developed and implemented a school-wide intervention and enrichment program, during the 2014-2015 school year, to improve student math achievement in response to underachievement in comparison to other TN high schools (Jefferson, 2013; TDOE, n.d.-a). On average, in TN, 63.4% of students scored proficient or higher on the Algebra I EOC in 2014, while only 47.9% of students scored proficient or higher on the Algebra II EOC (TDOE, n.d.-a). MHS fell below that state average, with 47.2% of students scoring proficient or higher on the Algebra I EOC in 2014 and 39.9% of students scoring proficient or higher on the Algebra II EOC (TDOE, n.d.-a). Additionally, an examination of Algebra I proficiency trends indicated MHS had a higher percentage of students scoring Below Basic than both the district and the state and a much lower percentage of students scoring Advanced than the state in both 2013 and 2014 (TDOE, n.d.-a). An examination of Algebra II proficiency trends yielded similar results; MHS had a higher percentage of students scoring Below Basic than both the district and the state and a lower percentage of students scoring Advanced than the district in both 2013 and 2014 (TDOE, n.d.-a).

The implemented intervention and enrichment program was designed to address student under-preparedness and lack of motivation for mathematics achievement (Jefferson, 2013). The school's goal was to improve student math proficiency (i.e., Below Basic, Basic, Proficient, and Advanced) on math EOC exams (Jefferson, (personal communication, May 15, 2015). The program used a tiered approach based on students' previous year-end state math assessment scores with more advanced students receiving math enrichment activities designed to hone problem solving skills while demonstrating relevance. Struggling students received targeted intervention dependent on their needs, ranging from computer-based basic skills instruction to re-teaching grade-level skills. However, the effectiveness of the program was unknown, either as a whole or as by specific subgroups: gender, students served by special education, ethnicity, English language (ELL) learners, and economically disadvantaged students.

Quantitative research was conducted to determine the significance of the change in student math achievement, as a whole as, well as by subgroup, after the implementation of the intervention and enrichment program, using the 2014-2015 EOC results. Three math teachers from the 2014-2015 school year were interviewed to obtain their input on the impact of the intervention and enrichment program. The interview results indicated varied beliefs regarding the program's effectiveness; however, the main theme was problems with implementation fidelity of the program. Therefore, MHS could benefit from focusing more efforts on implementation fidelity of math and other interventions being conducted within the school. This policy recommendation focuses on simple practices at the school level to improve the implementation fidelity of intervention programs.

Method

Research Questions

MHS implemented a school-wide math intervention and enrichment program, to improve student achievement as measured by the end of Course (EOC) state assessment results for Algebra I and Algebra II. The effectiveness of the program was unknown, as a whole or by subgroups: gender, students served by special education, ethnicity, and economically disadvantaged students. These efforts were a priority as MHS's math achievement fell below that of the state and district averages, and improvement was essential to prepare students for postsecondary opportunities. This policy recommendation was formed based on the findings from these research questions:

1. What is the difference in student achievement as measured by the Algebra I EOC from the 2014-2015 school year, the year after the school-wide intervention and enrichment program was implemented, and the 2013-2014 school year, the year before implementation?
2. What is the difference in student achievement as measured by the Algebra II EOC from the 2014-2015 school year, the year after the school-wide intervention and enrichment program was implemented, and the 2013-2014 school year, the year before implementation?
3. What is the difference in student achievement as measured by the Algebra II EOC from the 2015-2016 school year, two years after the school-wide intervention and enrichment program was implemented, and as the 2013-2014 school year, the year before implementation?
4. What are MHS math teachers' perceptions of the efficacy of the intervention and enrichment program?

A mixed-methods approach was used to address the research questions. Specifically, quantitative archival data was evaluated along with qualitative data collected through teacher interviews. The purpose was to determine the effectiveness of the intervention program implemented in 2014 to improve math performance and then recommend improvements to the intervention and enrichment program based on findings.

Data Collection

This policy recommendation is derived from both the quantitative data analysis results and the qualitative thematic analysis of the teacher interviews. Based on teacher input, as well as Algebra EOC results, the intent is to improve the implementation of interventions such that student achievement improvements are more fully realized at MHS. The quantitative data was archived EOC Algebra I and Algebra II assessment results. Interview data were collected from three math teachers who provided math intervention during the 2014-2015 school year.

Analysis and Results

The quantitative data were analyzed using inferential statistics. Propensity matching was used to minimize selection bias and to ensure that treatment and control groups were equated on key covariates. Factorial analysis of variance (ANOVA) tests were used to analyze the EOC Algebra state assessment data; specifically, the group means. The qualitative data collected from the teacher interviews were coded and analyzed for themes. The quantitative and qualitative results were compared for triangulation purposes. Both quantitative and qualitative results were used to answer the research questions.

To better determine the impact of the intervention and enrichment program, propensity matching using districtwide data was performed to form a comparison group.

1:1 propensity score nearest neighbor matches without replacement was used to match students using the following key variables: ethnicity, gender, course enrollment, projected EOC score, special education status, 8th grade TCAP math score, and socioeconomic status (see Harris & Horst, 2016). Student level matching helped establish baseline equivalence by statistically controlling for key variables such as grade, gender, ethnicity, free and reduced lunch, and student achievement. The large pool of comparison students within the district increased the likelihood of constructing a valid, well matched comparison group (see Harris & Horst, 2016).

RQ1 Results. There were three subparts to research question one given the covariates of gender, ethnicity, special education status, and socioeconomic status. Given there were more than one statistical analyses conducted using the same set of data, the Bonferroni method was used to determine the alpha level to avoid a type I error, falsely flagging a significant result (Armstrong, 2014). Since there were three analyses of variances conducted for RQ1, an alpha level of .02 was used to determine significance for each analysis of variance. The first research question subpart 1 (RQ1.1), a 2 x 2 x 4 three-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), gender (male, female), and ethnicity (White, Black, Hispanic, Asian). The outcome variable was the actual EOC Algebra I score from the 2014-15 testing year. The main effect of group was significant, $F(1,403) = 12.91$, $p = .00$, the main effect of ethnicity was significant, $F(3,403) = 8.50$, $p = .00$, and the main effect of gender was not significant, $F(1,403) = .04$, $p = .835$. Given that group only had two levels, post-hoc testing was not required. The treatment group performed significantly lower than the control group on the actual Algebra I EOC state assessment (*M* = 40.99 and *M* = 52.26, respectively). The main effect of ethnicity had four levels; therefore, post-hoc testing based on Tukey was conducted. Results of the post-hoc testing indicated that black students scored significantly lower than all other ethnicity groups. There were no other group differences based on ethnicity.

The first research question subpart 2 (RQ1.2), a 2 x 2 x 2 three-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), gender (male, female), and special education status (no, yes). The outcome variable was the actual EOC Algebra I score from the 2014-15 testing year. The main effect of special education status was significant, $F(1,411) = 9.10$, $p = .00$. The main effects of group and gender were not significant. Given that special education status only had two levels, post-hoc testing was not required. The students not considered with any special education status performed significantly higher than the students who were considered eligible for a special education status on the actual Algebra I EOC state assessment (*M* = 43.90 and *M* = 23.82 respectively).

The first research question subpart 3 (RQ1.3), a 2 x 2 x 2 three-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), gender (male, female), and socioeconomic status (no, yes). The outcome variable was the actual EOC Algebra I score from the 2014-15 testing year. The main effect of group was significant, $F(1,411) = 27.71$, $p = .00$. The main effect of socioeconomic status was not significant, $F(1,411) = 4.79$, $p = .03$. The results ($p = .03$) could not be considered significant given the conservative *p*-value used for significance

.02. The main effect of gender was not significant. Given that group and special education status only had two levels, post-hoc testing was not required. The students not considered with any financial aid need-based status performed significantly higher than the students who were considered eligible for financial assistance, based status on the actual Algebra I EOC state assessment (M = 45.82 and M = 40.52 respectively). Additionally, as related to treatment versus control group after controlling for socioeconomic status, students in the control group outperformed students in the treatment group on the actual Algebra I EOC state assessment (M = 49.55 and M = 36.80 respectively).

RQ2 Results. Due to the violation of homogeneity of variance when considering ethnicity, special education status, and socioeconomic status, these variables were not investigated for this research question. In answering research question two (RQ2), a 2 x 2 two-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), and gender (male, female). The outcome variable was the actual EOC Algebra II state assessment score from the 2014-15 testing year. The main effects of group and gender were not significant.

RQ3 Results. Due to the violation of homogeneity of variance when considering ethnicity, special education status, and socioeconomic status, these variables were not investigated for this research question. Furthermore, the small sample size available for this research question did not lend itself to sub-group analyses beyond gender. In answering research question three (RQ3), a 2 x 2 two-way analysis of variance was conducted to investigate the treatment effect based on group (treatment, control), and gender (male, female). The outcome variable was the actual EOC Algebra II state assessment score from the 2015-16 testing year. The main effects of group and gender were not significant.

RQ4. Three math teachers were interviewed, and the interviews were transcribed and analyzed. The teachers were all actively engaged in the interview and appeared interested and, at times, passionate in their responses. They all appeared to hold to specific personal beliefs about their craft and defended their beliefs at length. As a result, interviews were considered reliable, and no information provided was not included in the analysis. Analysis of the results revealed a few distinct themes; however, the central theme was the trouble with the implementation fidelity of the intervention and enrichment program. This theme was discussed throughout the interviews, particularly by Teacher 2 and Teacher 3, concerning the enrichment aspect of the program, as well as teacher accountability and teacher buy-in. Another major theme was the effectiveness for lower-performing math students, which surfaced across questions. Specific things mentioned were improved course engagement for these students and useful elements such as Study Island, teacher scaffolding of interventions to coursework to fill in gaps, and a greater understanding of multiple methods for problem solving. Additionally, the enrichment sessions were not generally considered effective according to the teachers' reports for various reasons.

Explanation of the Results

From the quantitative analysis results, the main effects have been identified, and from the qualitative results, major themes emerged. Based on these results, strengths and weaknesses were identified and compared to identify changes needed to improve academic intervention at MHS. The explanation of the results in this regard follows.

RQ1. Based on the quantitative results, the intervention and enrichment program did not result in positive change for Algebra I performance on the EOC state assessment. In fact, the treatment group performed significantly lower than the control group, even after controlling for socioeconomic status. While this may appear as if the treatment had a harmful effect, this cannot be assumed as MHS was performing below the district prior to treatment implementation, as they had a higher percentage of students scoring Below Basic than the district the previous two years (TDOE, n.d.-a). It was found that black students performed significantly lower than all other ethnic groups, again consistent with past performance. It should be acknowledged that there were no differences between the other ethnicities. Given that over 10% of students at MHS are Hispanic, this should be considered positive, especially since some of these students are EL students (TDOE, n.d.-a). Students receiving special education services were found to perform significantly below students not receiving special education services, consistent with past performance. Also, students eligible for financial assistance performed below those not eligible for financial assistance, again consistent with past performance. Also, it was positive that no difference was found between genders, suggesting equal performance for male and female students. Therefore, these results suggested that the treatment caused no positive change in Algebra I achievement; however, Hispanic student performance was consistent or higher than other ethnicities, and the performance of males and females could be considered equivalent.

RQ2. Generally, it was found that the program or treatment did not result in positive change for Algebra II EOC state assessment performance. There was no significant difference between the treatment and control groups. However, the lack of difference may be an indicator of growth, as again, MHS in the previous two years performed below the district in Algebra II EOC performance. MHS had a higher percentage of students scoring Below Basic than the district and a lower percentage of students scoring Advanced than the district (TDOE, n.d.-a). Additionally, it was positive that no difference was found between genders, suggesting equal performance for male and female students. These results for Algebra II EOC performance, despite the lack of significant positive change, were hopeful as in the two previous years, MHS students performed below district expectations and now appear to be more consistent with district performance. Additionally, the performance of males and females appeared to be equivalent.

RQ3. Quantitative results are suggestive of no positive change for Algebra II EOC state assessment performance for the 2015-2016 school year. There was no significant difference between the treatment and control groups or between males and females. Given the small sample size, these results were interpreted with caution, and inferences drawn were limited. For the students who participated in the treatment during the 2014-2015 school year, it could not be determined whether or not there were residual effects of the treatment. While there appeared to have been no positive change, the treatment group from 2014-2015 performed significantly below the control group on the Algebra I EOC state assessment. Therefore, it was logical that they subsequently performed significantly below the control group on the Algebra II EOC state assessment the following year; however, no differences were found. There are many possible explanations for this; however, residual effects of intervention and enrichment program could not be ruled out. Also, no difference between male and female students indicated equivalent performance between the genders.

RQ4. Strengths and weaknesses were highlighted throughout the interview sessions. One prominent theme was the benefit for lower-performing math students. Positive effects listed by teachers included improved classroom engagement in regular courses, as well as the use of Study Island for basic skills, teacher scaffolding of interventions to coursework to fill in gaps, and a greater understanding of multiple methods for problem solving. However, the enrichment activities were not seen as beneficial, so no benefits were found for higher-performing math students. Overall, the major theme that emerged, suggesting a need for improvement, was a lack of implementation fidelity. Teachers mentioned several concerns with fidelity; however, consistently, teacher accountability and teacher buy-in were expressed, indicating a need for improvement in intervention implementation fidelity. In summary, teachers indicated benefits for lower-performing students, no benefits for higher-performing students, and an overall concern for implementation fidelity, particularly with teacher accountability and teacher buy-in.

Review of Literature

Teacher instruction and classroom interventions need to be implemented with high levels of fidelity to ensure that evidence-based practices are being delivered to students and will improve student outcomes (King-Sears, Walker, & Barry, 2018; Mages, 2017; McKenna & Parenti, 2017; Sugai, Simonsen, Freeman, & La Salle, 2016). Intervention implementation fidelity should be measured throughout implementation so that improvements to implementation can be made as determined, to ensure continuous improvement for students and that high levels of fidelity can be achieved and maintained (Foorman, Dombek, & Smith, 2016; Harn, Damico, & Stoolmiller, 2017). For fidelity measurement to be done effectively, schools should use a systematic process to assess fidelity of intervention implementation (Harn et al., 2017).

Classroom Applications

Classroom applications of implementation fidelity, refer to the fidelity of both classroom instruction and implemented interventions, given current policy for evidence-based practices in education to improve student outcomes (McKenna & Parenti, 2017; Missett & Foster, 2015). In the classroom environment, implementation fidelity of interventions is often thought of as treatment fidelity, which according to Gresham, "refers to the methodological strategies used to monitor and improve the reliability and validity of academic and behavioral interventions in schools" (2017, p. 22). Treatment fidelity is comprised of treatment adherence, interventionist competence, treatment differentiation, and treatment receipt (Anderson, 2017; Gresham, 2017).

To fully describe the components of treatment fidelity, they are defined here. Treatment adherence consists of treatment component adherence and session/daily adherence or accuracy and consistency (Gresham, 2017). Interventionist competence can be defined as the experience and skill of the interventionist delivering the intervention

(Gresham, 2017). Treatment differentiation involves distinguishing treatments being used along theoretical dimensions (Gresham, 2017). Treatment receipt is comprised of intervention dosage, student understanding of the intervention, and student receptiveness to the intervention (Gresham, 2017).

Increasingly, schools have implemented tiered intervention practices, such as Response to Intervention (RTI), Positive Behavior Intervention Support (PBIS), and Multi-Tiered Systems of Support (MTSS), as evidence-based processes for implementing interventions with students, which utilize a student's lack of progress to a research-based intervention to determine whether or not to change, modify or intensify the intervention (AIR, 2015; DeFouw, Codding, Collier-Meek, & Gould, 2018; Gresham, 2017; McKenna & Parenti, 2017). As such, implementation fidelity measurement within these processes is essential to determining whether or not a student's lack of progress warrants alterations to the student's intervention program (AIR, 2015; DeFouw et al., 2018; Gresham, 2017; King-Sears et al., 2018; McKenna & Parenti, 2017). The purpose of these processes is to establish content proficiency and long-term implementation capability within school buildings and with teachers so that teachers have a better opportunity to implement evidence-based programs and interventions with high levels of fidelity. Also, to better adapt and extend their implementation over time and to other settings and contexts (McIntosh & Goodman, 2016; Sugai et al., 2016). To accomplish this level of process and intervention implementation with fidelity, schools must build capacity for implementation (Sugai et al., 2016).

Multiple factors impact treatment fidelity, including factors related to the intervention, interventionist, and students (Balu & Doolittle, 2016; Gresham, 2017). Factors related to the intervention include (a) ease of implementation, (b) materials and resources required for implementation, and (c) intervention complexity (Anderson, 2017; Gresham, 2017; Troyer, 2017). Factors related to the interventionist include: (a) number of interventionists, (b) perception of effectiveness, and (c) motivation (Favre & Knight, 2016; Gresham, 2017; Lakin & Rambo-Hernandez, 2019). Student factors include student behavior and attendance; however, these factors could be redefined as school factors, like classroom management, parent engagement, alternate disciplinary practices, and school climate and addressed through school improvement efforts in these areas (Balu & Doolittle, 2016).

Implementation fidelity of evidence-based practices is achieved in part, through effective and rigorous professional development aimed at providing opportunities for teachers to learn new programs, and also to support teachers in changing, developing and maintaining effective practices for students across all subject areas (Balu & Doolittle, 2016; King-Sears et al., 2018; Mages, 2017; Sugai et al., 2016; Troyer, 2017). Necessary components for supporting teachers in intervention implementation in addition to professional development or training include modeling, coaching, opportunities to plan instruction, and performance feedback (Brock & Carter, 2017; King-Sears et al., 2018; Troyer, 2017). One model for supporting teachers during implementation or fidelity coaching involves five steps, to include (1) modeling the intervention, (2) sharing the fidelity protocol, (3) coaching before implementation, (4) observing during implementation, and (5) reflecting with the interventionist using fidelity data (King-Sears et al., 2018).

Measuring Fidelity

One common way to approach fidelity assessment is to describe methods used for measuring fidelity of structure and fidelity of process (Harn et al., 2017; Hauk, Salguero, & Kaser, 2016; Lakin & Rambo-Hernandez, 2019). Structural areas include intervention delivery to include adherence or differentiation, dosage or time allocation, and intervention completion (Anderson, 2017; Dhillon, Darrow, & Meyers, 2015; Harn et al., 2017; McKenna & Parenti, 2017). Process areas can include how well the interventionist appeared to comprehend the lesson and content, availability of materials, teacher response to student questions, language use, student engagement, the opportunity for student response, the accuracy of student response, and behavior management (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019).

Structural areas are often assessed using direct observations, but some areas, such as dosage and intervention completion, can be measured through self-report or attendance logs (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019; McKenna & Parenti, 2017). Process areas can be evaluated through program-specific direct observations, focus groups, and teacher interviews (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). Student outcomes in reading and math are not predicted similarly using these fidelity measures, as reading outcomes were better predicted by assessing process areas, and math outcomes were better predicted by assessing structural areas (Boardman et al., 2016; Harn et al., 2017).

Direct systematic observations are a useful tool in that multiple different treatment components can be observed as well as the quality of delivery and student responsiveness, to include student behavior (Foorman et al., 2016; Gresham, 2017; Harn et al., 2017). As a result, content validity is critical for this type of assessment and is dependent on the number of observations and the length of observations (Gresham, 2017; Lakin & Rambo-Hernandez, 2019). One limitation of systematic observations is the high number of observations required to achieve a valid and appropriate measure (Gresham, 2017). Therefore, indirect methods, including surveys, checklists, and intervention logs, may be used to supplement direct observational data (Gresham, 2017; McKenna & Parenti, 2017).

Determining when and how often to assess fidelity is difficult and not easily done (Harn et al., 2017). Only assessing fidelity once upon implementation is not adequate, given the contextual variability in schools, such as school schedule and attendance, and the need to provide continuous coaching support to teachers (Foorman et al., 2016; Harn et al., 2017). Therefore, it is important to measure implementation fidelity of an intervention at various stages of implementation, for instructional support and maintenance purposes (Foorman et al., 2016; Harn et al., 2017).

Additionally, there is variability in what constitutes an acceptable level of fidelity when implementing evidence-based practices and interventions, and this variability is dependent on unique components of practices and interventions (Harn et al., 2017; Hauk et al., 2016; King-Sears et al., 2018; Lakin & Rambo-Hernandez, 2019). Specifically, there are threshold effects when higher levels of fidelity do not lead to improved student outcomes (Harn et al., 2017). Features of the intervention program or practice and variation in subpopulations, may both lead to threshold effects (Harn et al., 2017; Lakin & Rambo-Hernandez, 2019). There is also a need for program flexibility to support differentiation of instruction and culturally responsive classrooms, both essential for effective intervention implementation (Lakin & Rambo-Hernandez, 2019). Therefore, appropriate levels of flexibility should be built into both the structural and process areas to allow teachers to exercise professional judgment for the context of the program (Lakin & Rambo-Hernandez, 2019).

Fidelity Assessment Tools

Selecting appropriate fidelity measures, to include confirming validity and reliability, to evaluate the fidelity of implementation is important for developing a systematic process to assess fidelity (Lakin & Rambo-Hernandez, 2019; Murrah, Kosovich, & Hulleman, 2017). There are existing fidelity measures, and these measures often already have validity and reliability data to review (Ibrahim & Sidani, 2015; Lakin & Rambo-Hernandez, 2019). However, conclusions from two reviews of fidelity measures indicated a need for further development of psychometrically sound measures that improve the psychometric quality of existing and new measures and account for all facets of the fidelity of intervention implementation (Ibrahim & Sidani, 2015; Lewis et al., 2015).

To improve upon the fidelity of implementation measurement, it may be appropriate to develop new measures should measurement problems exist or if the existing measure does not align with the intervention's goals (Lakin & Rambo-

Hernandez, 2019). The development of fidelity measures, at a minimum, involves gathering validity evidence, using expert guidance in writing or the review of the measurement items, and conducting a pilot test of the measures (Crawford, Freeman, Huscroft-D'Angelo, Fuentes, & Higgins, 2019; Lakin & Rambo-Hernandez, 2019). Additional resources for fidelity measures in education include the National Center on Intensive Intervention, the Center on Response to Intervention, and in the state of Tennessee, the Response to Instruction and Intervention Framework (American Institutes for Research [AIR], 2014; AIR, 2015; TDOE, n.d.-b). Measurement tools available include individualization checklist, progress monitoring checklist, intensive intervention review log, data-based individualization implementation rubric, data meeting plan fidelity checklist, implementation logs, RTI fidelity of implementation rubric, and RTI essentials worksheet (AIR, 2014; AIR, 2015).

Recommendations for Improving Implementation Fidelity

The following recommendations of how to improve intervention implementation at MHS were made after careful consideration of the study findings and current research. I recommend that MHS develop a plan to assess the fidelity of interventions being implemented systematically. The plan should include the areas of weakness in implementation fidelity reported by the teachers. There are several steps involved with assessing fidelity of intervention fidelity, as well as a variety of measures involved. The focus of this recommendation is for academic interventions; however, a similar process should be developed for behavioral interventions. Additionally, since the implementation of the school-wide mathematics intervention and enrichment, MHS's district has adopted a Response to Instruction and Intervention Framework (RTI2) for academic interventions, per direction from the state, and is attempting to blend those practices with behavior interventions using an MTSS process. Despite this and other improvements, as before, no plan for systematically measuring fidelity of intervention implementation has been developed or implemented at the school level. According to the state RTI2 Implementation Guide, consistent with the current literature, there should be a school leadership team designated to develop a systematic process for fidelity assessment and complete fidelity monitoring (TDOE, 2016). Therefore, MHS should create a leadership team and develop a systematic process for monitoring the fidelity of implemented interventions. The details of this recommendation follow.

School Leadership Team

MHS is striving to improve academic achievement, particularly in mathematics, but also in other academic areas. Evidence-based practices, in both classroom and academic intervention, need to be implemented with fidelity for improvement in student outcomes; however, to accomplish a high level of implementation fidelity, schools need to build capacity for implementation (Sugai et al., 2016). To build such capacity, a school leadership team is needed to increase teacher buy-in and to develop systematic processes for implementation and around measuring fidelity of implementation (Harn et al., 2017; Sugai et al., 2016; TDOE, 2016). Through a collaborative approach, the team can collect and analyze data, identify challenges, and provide coaching support to teachers providing intervention. The team can also, through collaborative inquiry, prescribe a structure, fitting MHS's characteristics, for measuring fidelity and supporting teachers in their intervention practices.

Based on the recommendations from the RTI2 Implementation Guide, the team should consist of the administrator or his/her designee, instructional leads and/or coaches, classroom teachers, special education teachers, school psychologists, and school counselors. Given the personnel currently serving MHS, I propose a leadership team consisting of the following:

- Executive principal
- Dean of Students
- Special Education Lead
- EL Coach
- Intervention Coach
- School Psychologist
- ELA and Math Department Heads
- School Counseling Lead

The school leadership team should have a chair or facilitator, which is commonly the Dean of Students' role (TDOE, 2016). The facilitator is responsible for scheduling meetings, organizing the student achievement data, and facilitating the meetings (TDOE, 2016). The school leadership team should use FASTBridge data, a web-based program used for progress monitoring student progress in interventions, fidelity monitoring data, student attendance data, and teacher feedback to make decisions resulting in improved processes to support teachers and ultimately improved intervention implementation. The school leadership team will be responsible for creating a systematic plan for fidelity monitoring, to include who will do the monitoring, which measurement tools to use, how frequently monitoring should occur, and who will be responsible for compiling the monitoring data.

Teacher Buy-In

Teacher buy-in is essential for achieving high levels of intervention implementation fidelity. However, teacher buy-in for academic intervention, particularly at the high school level, is often difficult to obtain, given the complexities inherent in high school environments that can become barriers for successful implementation. Some of these potential barriers include student attendance, student behavior, school schedule, and access to intervention resources and materials (Balu & Doolittle, 2016). Given these concerns, the school leadership team will need to make a concerted effort to obtain teacher buy-in.

There are ways to secure teacher buy-in through professional development at the beginning of the year (Greene, 2016). My purpose is not to develop professional development, but to only provide professional development suggestions to improve teacher buy-in. The first suggestion is to validate the need for academic improvement, through sharing of the previous year’s academic data and then to collaborate around a common goal. Teachers should know their academic data, the successes, and areas where there is still room for improvement. They should also know their students, as in how many will come into their classes with the pre-requisite skills necessary to learn new material. Once they have the data, teachers should be given time to meet collaboratively within departments to engage the data and reflect upon it, in preparation for how to engage students (Greene, 2016). After having time to discuss and reflect upon the data, the staff should come back together and determine a growth goal school-wide for students in the areas of math, ELA, science, and history, as well as graduation rate. Allowing teachers to participate in establishing goals, helps secure buy-in (Greene, 2016).

Once the staff has established school-wide goals, the school leadership team should meet with those teachers who will be providing math and literacy intervention to students, and they should look at the progress monitoring and other academic data for those students who received academic intervention the previous year, to include incoming 9^{th}-grade students. Intervention teachers should collaborate within their department to also discuss and reflect on the data. The process is similar, in that they should come back together as a group and determine growth goals, and based on those goals, consider their intervention resources and training needs. Giving these teachers voice regarding their goals and needs, will gain their effort and support, as well as communicate the leadership teams' commitment to supporting them (Greene, 2016).

Policy Implementation

The Leadership Team is responsible for determining the structure for implementing academic interventions and developing a plan to ensure implementation fidelity, according to the RTI2 Implementation Guide (TDOE, 2016). TN determined that TN schools would implement academic interventions using the RTI2 Framework in the summer of 2013, and the implementation would be gradual, beginning with elementary schools. High schools were to implement the RTI2 Framework during the 2015-2016 school year. The implementation of RTI2 varies depending on the needs of each school, but the RTI2 Implementation Guide lays out a basic plan, along with support documents to aid with implementation (TDOE, 2016).

The first step for fidelity implementation is for MHS's Leadership Team to meet in the spring to determine the intervention needs of the school regarding resources. If materials need to be purchased, MHS's principal, with the guidance of the Intervention Coach, will purchase the needed materials. Second, the school's principal can then assign teachers to provide academic intervention and ensure they receive the appropriate professional development before the next school year. This professional development should provide overall information on the intervention process to include progress monitoring, fidelity monitoring, et cetera, as well as specific instruction on the intervention they are implementing. To effectively choose teachers, members of the Leadership Team will need to look at student data and estimate the number of students requiring academic intervention for the upcoming school year, while preparing for adjustments in the fall given student needs.

Monitoring Implementation Fidelity

The next steps are specific to monitoring implementation fidelity to improve intervention implementation. The Leadership Team needs to decide how they are going to monitor fidelity and how frequently. Once that is determined, the Leadership Team should designate who is going to do the monitoring and follow-up coaching. The RTI2 Implementation Guide recommends monitoring both intervention planning, intervention instruction, and student attendance, as well as student progress (TDOE, 2016). The RTI2 Implementation Guide also recommends student progress checks twice every quarter at data team meetings and intervention planning and instruction checks once every quarter (TDOE, 2016). Student attendance and participation monitoring is ongoing and discussed at data team meetings, as needed (TDOE, 2016).

The RTI2 Implementation Guide provides several different fidelity check measures for observation purposes that are fairly generic to most academic interventions (TDOE, 2016). There is an Intervention Walk-Through, 5 Minute Direct Observation, Direct Observation Rubric, and Observation Checklist for Tier II interventions (TDOE, 2016). These sample forms can be found in Project Appendices A-D. There are also sample fidelity check measures for specific Tier III interventions, based on the generic ones offered for the Tier II interventions, as well as a generic Tier III Fidelity Checklist, found in Project Appendix E, and Intervention Walk-Through, similar to the previously mentioned one (TDOE, 2016). There could also be fidelity measures included with the purchased interventions that could be used or adapted to fit MHS's needs. The Leadership Team should choose which fidelity checks to use and when. For example, the interventionists are all directly observed when first implementing a new intervention to provide better feedback when coaching. Then fade the direct observations to once a year and use the walk-throughs or checklists for the other fidelity checks, as the teachers require less feedback than when they began. Teachers providing intervention should be given copies of the fidelity checks and rubrics, so they are aware of the expectations before they are observed.

The RTI2 Implementation Guide designates the school principal and the team facilitator for completing fidelity monitoring (TDOE, 2016). At MHS, the Executive Principal, Dean of Students, and Special Education Lead could conduct the fidelity checks, assuming all held supervisory certification. The Leadership Team would need to establish a schedule for completing the fidelity checks and notify the teachers involved of the schedule and type of check being completed.

Student attendance and participation should be documented daily on either an Attendance Log or Intervention Log, of which there are generic forms provided in the RTI2 Implementation Guide (TDOE, 2016). Sample forms can be found in Project Appendices F and G. This is particularly important in the high school environment, to document actual participation in the intervention, as some students may be in the room but not engaged, or come in to be counted for attendance purposes, but then leave the classroom. These types of problems can be addressed individually by the data team if documented, or by the Leadership Team, if a more systematic problem. The Leadership Team needs to decide how student attendance and participation will be documented and provide the appropriate documents to the teachers implementing the intervention.

The Leadership Team is, in part, comprised of instructional coaches, the EL Coach, Special Education Lead, and Intervention Coach. These persons, with the assistance of the Department Heads, of both the English and Math departments, can serve as coaches for the teachers providing intervention, as needed. The Leadership Team should meet after the first set of fidelity checks are completed to discuss successes and concerns and to determine coaching needs. The team facilitator, or Dean of Students, is responsible for assimilating this data for the Leadership Team to review. Additionally, the teachers should receive feedback from the fidelity checks so that they know what went well and what their focus should be for improving implementation (King-Sears et al., 2018).

Student Factors

Student factors to consider include attendance and behavior, and can be addressed through classroom management, parent engagement, and school climate (Balu & Doolittle, 2016). Student attendance and behavior can be monitored by completing an Attendance Log or Intervention Log, and generic forms can be found in the RTI2 Implementation Guide (TDOE, 2016). Additionally, student attendance and behavior should be supported by school-wide rules and expectations that are defined in the school handbook and reinforced by school practices.

Once student attendance and behavior data have been collected for a few weeks, specific concerns regarding attendance and behavior can be noted at the first data team meeting. If the problem persists utilizing school-side strategies, one of the instructional coaches should work with the teacher to establish a plan of action to improve that student's attendance and behavior (Balu & Doolittle, 2016; King-Sears et al., 2018). Classroom management concerns should be noted during the first set of fidelity checks and subsequently discussed by the Leadership Team. Instructional coaches should work with teachers struggling to manage student behavior while implementing interventions to improve student participation and implementation fidelity (Balu & Doolittle, 2016; King-Sears et al., 2018).

Student attendance and behavior are also reinforced by engaging parents in the intervention process. One way to do this is to communicate student progress to parents, specific to the intervention. There are basic form letters in the RTI2 Implementation Guide that can be used to communicate progress to parents, and it is recommended that these be sent home with progress reports and report cards (TDOE, 2016). Sample letters can be found in Project Appendices H and I. It is also recommended to send home a letter at the beginning of the school year, informing parents that their student is being placed in an intervention and why (TDOE, 2016). Generic versions of this letter can be found in the RTI2 Implementation Guide (TDOE, 2016). Sample letters can be found in Project Appendices J and K. Information about specific interventions should also be provided to parents through information sessions at Parent-Teacher Association meetings. The Leadership Team must decide which letters to use and what information to share with parents.

Conclusion

Despite the benefits for low performing math students, MHS's intervention and enrichment program was not effective in significantly improving Algebra I EOC and Algebra II EOC state assessment performance, when compared with a control group. Residual effects of the intervention and implementation program are not evident, but also cannot be completely ruled out, given the small sample size. The lack of implementation fidelity emerged as a major theme and was cited as a concern in teacher interviews, prompting this policy recommendation, as poor fidelity of intervention implementation can have a negative impact on student improvement initiatives. This policy recommendation to create a school leadership team to develop and implement a systematic process for measuring fidelity of academic intervention implementation, based on state guidelines, as well as, implementing practices to secure teacher buy-in, should bring about systematic and individual changes that improve intervention implementation and improve MHS's capacity for intervention implementation. Consequently, improvements in student academic achievement will be realized.

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Project Appendix A: Intervention Walk-Through

Teacher_____________________________________ Grade Level______ Date____________

Intervention being provided____

Person Completing this Walkthrough/Observation___________________________________

Rating Scale: 1 = minimal evidence noted; 2=evidence noted; 3 = outstanding implementation

Classroom Setting

_____ Space is appropriate for intervention implementation.

Materials

_____ Evidence exists of program materials being used as designed.

_____ Teacher uses the Teacher's Guide/manual/instructions during intervention.

Teacher Instruction

_____ Teacher follows the selected program's instructional routines as designed.

______ Evidence exists that activities are student goal directed.

_____ Teacher fosters active student engagement and motivation to learn.

______ Classroom behavior management system is effective in providing an environment conducive to learning.

_____ Transitions are smooth and quick.

Student Actions

____ Evidence of active versus passive learning

____ Evidence of student engagement

Classroom Environment

______ Teacher and student interactions are mutually respectful and positive in tone.

______ Evidence exists that the teacher provides all students with an opportunity to learn.

______ Evidence indicates that the teacher implements activities that support student diversity.

I certify that everything reported on this form is accurate and correct and that interventions are being implemented with integrity at least 80% of the time.

___________________________________ ________________________________

Observer's signature Teacher's signature

Project Appendix B: Five-Minute Direct Observation

Instructor:________________________________ Date/Time ______________________________

Observed by:______________________________Area of Intervention:_______________________

Program/Skill:_____________________________Number of students in group:_________

WHAT TO LOOK FOR	NOTES
Active engagement of all students	
Modeling of instructional tasks	
Multiple chance to practice tasks	
Explicit instruction	
Corrective feedback	
Materials organized and readily available	
Engagement of students in independent activities	
Encouragement/direct praise	
Needed intervention provided	
Intervention began and ended on time	

Positive #1	
Positive #2	
Suggested Changes	
Next Steps	

I certify that everything reported on this form is accurate and correct and that interventions are being implemented with integrity at least 80% of the time.

____signature

Project Appendix C: Direct Observation Rubric

Observer:____________________________Interventionist:_________________________________
School:____________________________________Grade:____________________________________
Start Time:_________________________________End Time:__________________________________
Program:___________________________________Skill(s):____________________________________

Focus	**Criteria**			
	3	**2**	**1**	**0**
Structure and Delivery of Tier II/III Intervention **SCORE:__________**	Adherence to precision to fully implement procedures as prescribed. All components are used to deliver a high intensity intervention. Correct time schedule is followed to provide optimal intervention during the time allocated. Intervention is delivered as designed.	Interventionist and students are engaged. Pace is effective and students are actively involved. Correct materials are used. Intervention time is focused and uninterrupted. Lesson is delivered as designed.	Interventionist and students are in correct places but materials are not at hand. Interventionist appears unprepared. Time delay to effectively begin intervention time. Some interruptions noted. No clear plan for the lesson.	Intervention not occurring at scheduled time and no manual or lesson plans used
Management **SCORE:__________**	Enthusiastic delivery by interventionist. Correct and effective management in place. Interventionist and students effectively making use of time. Structure of intervention provides effective pacing and optimal use materials.	Good delivery by interventionist. Management is effective. A few difficulties noted during implementation. Most students engaged in learning. Structure guides intervention time with occasional lapses in time.	Poor delivery by interventionist. The interventionist does not follow set procedures for effective implementation. Several students off task. Structure lacks coherence.	Ineffective delivery by interventionist. Students are not engaged. Interventionist does not guide structure for intervention.

Sample Tier II Direct Observation Rubric (page 2)

Progress Monitoring, Documentation, and Communication **SCORE:__________**	Progress monitoring is completed once every other week and clearly documented on all forms. Communication of assessment results with teachers and parents exceeds the minimum requirements. Documentation of interventions and progress is very clear to understand and well organized and systematically communicated.	Progress monitoring is generally accurate. Communication with teacher and parents happens at least twice each nine weeks. Documentation of interventions and student progress is adequately communicated.	Progress monitoring is sporadic. There is not a clear system for communicating results with the teacher or parents. Limited documentation of interventions or progress is noted. Progress is rarely communicated.	Progress monitoring is not occurring. No communication with teachers or parents. No documentation of interventions or progress.

Observations:

Strengths:
Concerns:

Results Checklist	**YES**	**NO**
Post observation review of fidelity check		
Review of areas of concern addressed, if any were indicated		
Plans for improvement established in areas identified		

I certify that everything reported on this form is accurate and correct and that interventions are being implemented with integrity at least 80% of the time.

____ signature

Project Appendix D: Observation Checklist

Observer:________________________Interventionist:________________________________
School:________________________________Grade:_________________________________
Start Time:_____________________________End Time:______________________________
Program:_______________________________Skill(s):_________________________________

The Tier II Intervention is:

Description	Yes	No
Provided by or supervised by a highly qualified teacher with training in area of intervention		
Targeting one specific area of need/deficit/skill		
Targeting as a skill that was identified as an area of need by an assessment		
Occurring in addition to Tier I instruction		
Delivered in a small-group format		
Delivered with fidelity		
Delivered with evidence based materials		
Provided the appropriate amount of time daily		
Provided the appropriate amount of time weekly		
Progress monitored at least every other week		

I certify that everything reported on this form is accurate and correct and that interventions are being implemented with integrity at least 80% of the time.

____signature

Project Appendix E: Fidelity Checklist

Instructor:______________________________ Date/Time: ___________________________

Observed by:___________________________Area of Intervention:____________________

Lesson Number:__________________Number of students in group:___________________

Start and Stop Time:_____________________ Total Time of Observation:_______________

High level of implementation=2 Inconsistent level of implementation=1 Low level of implementation=0

AREA	Level of Implementation	Comments
Materials and Time		
Teacher and student materials ready	**2 1 0**	
Teacher organized and familiar with lesson	**2 1 0**	
Instruction/Presentation		
Follows steps and wording in lessons	**2 1 0**	
Uses clear signals	**2 1 0**	
Provides students many opportunities to respond	**2 1 0**	
Models skills/strategies appropriately and with ease	**2 1 0**	
Corrects all errors using correct technique	**2 1 0**	
Provides students with adequate think time	**2 1 0**	
Presents individual turns	**2 1 0**	
Moves quickly from one exercise to the next	**2 1 0**	
Maintains good pacing	**2 1 0**	
Ensures students are firm on content prior to moving forward	**2 1 0**	

Completes all parts of teacher-directed lesson	**2 1 0**	
General Observation of the Group		
Student engagement in lesson	**2 1 0**	
Student success at completing activities	**2 1 0**	
Teacher familiarity with lesson formats and progression through activities	**2 1 0**	
Teacher encouragement of student effort	**2 1 0**	
Transitions between activities were smooth	**2 1 0**	

Notes:____

____

____

____

____

____

I certify that everything reported on this form is accurate and correct and that interventions are being implemented with integrity at least 80% of the time.

____signature

Project Appendix F: Intervention Log

Name of Student:________________Teacher: ________________Month of: _________

Week	Date/Time	* Intervention Used	Skill area addressed	Observations/Notes (optional)
Week 1				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Week 2				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Week 3				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Week 4				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Week 5				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				

** Insert name of intervention program or code from action plan*

<u>Progress Monitoring scores</u> ***Please attach progress monitoring graphs before RTI² meetings*

Week 1 ________Week 2 ________Week 3 ______Week 4 _________

Week 5 _________

Intervention Fidelity Statement: I certify that the above noted strategies/interventions were conducted as described.

____
Teacher Signature

Project Appendix G: Intervention and Attendance Log

Student_________________________Grade Level _________Month_____________Year___

School__________________________Program____________Skill______________________

Person Providing Intervention____

Time	M	T	W	T	F	Wkly Total s	M	T	W	T	F	Wkly Totals	M	T	W	T	F	Wkly Totals
Date																		
Lesson Number																		
Student Attendance																		
Time	M	T	W	T	F	Wkly Total s	M	T	W	T	F	Wkly Totals	M	T	W	T	F	Wkly Totals
Date																		
Lesson Number																		
Student Attendance																		

Use the Following Key:
A= Student Absent
P= Student Present
TA=Teacher Absent
T= Testing
R= Reteach
O=Other (Please explain under comments)
FM=Fidelity Monitored

Skills in Question:
L = Language
PA=Phonemic Awareness
P = Phonics
F = Fluency
V = Vocabulary
C = Comprehension
W=Written Expression
MC=Math Calculation
MP=Math Problem Solving

Month to Date Lesson Gains
Number of school days this month______
Number of lessons taught ______
Out of _________ days

Comments:

I certify that everything reported on this form is accurate and correct and that interventions are being implemented with integrity at least 80% of the time.

____

_____________________________(signature)

Project Appendix H: Sample Parent Letter for Reading Intervention

Insert District or School Name
Reading/Language Arts 6-12
Response to Intervention (RTI) Parent Letter
Tier I to Tier II

Student:____

Date:____

Dear Parent,

Each semester, every student at (insert school name) is given a universal screening assessment to determine his/her reading abilities. Your child's scores show that he/she is struggling in reading. Along with the universal screening, your child's progress has been monitored every two weeks or more. Although he/she is receiving English/Language Arts instruction daily in Tier I, he/she has still not shown enough improvement. Your child will now receive an additional (insert number of minutes) minutes of reading interventions each day. This Tier II intervention will be done in small groups with trained personnel using research based materials. Your child's progress will be monitored every other week. Additional assessments maybe completed in order to inform instruction and intervention. You will receive information on your child's progress. It is our goal to provide the best instruction and materials to help your child succeed.

We encourage you, as the parent or guardian, to encourage your child to read regularly at home, reading a variety of materials. Be sure to encourage your child to do his/her best and let them know you believe in his/her ability to improve. If you have questions or would like more information, please contact your child's teacher.

Respectfully,

Insert Signature
Insert District/School Contact Information

Project Appendix I: Sample Parent Letter for Math Intervention

Insert District or School Name
Math 6-12
Response to Intervention (RTI) Parent Letter
Tier I to Tier II

Student:____

Date:____

Dear Parent,

Each semester, every student at (insert school name) is given a universal screening assessment to determine his/her math abilities. Your child's scores show that he/she is struggling in math. Along with the universal screening, your child's progress has been monitored every two weeks or more. Although he/she is receiving math instruction daily in Tier I, he/she has still not shown enough improvement. Your child will now receive an additional (insert number of minutes) minutes of math interventions each day. This Tier II intervention will be done in small groups with trained personnel using research based materials. Your child's progress will be monitored every other week. Additional assessments maybe completed in order to inform instruction and intervention. You will receive information on your child's progress. It is our goal to provide the best instruction and materials to help your child succeed.

We encourage you, as the parent or guardian, to ask your child to share his/her math work with you regularly. Be sure to encourage your child to do his/her best and let them know you believe in his/her ability to improve. If you have questions or would like more information, please contact your child's teacher.

Respectfully,

Insert Signature
Insert District/School Contact Information

Project Appendix J: Sample Progress Monitoring Letter for Reading Intervention

Insert District or School Name
Reading/Language Arts 6-12
Response to Intervention (RTI)
Progress Monitoring Letter

Dear Parent,

A letter previously notified you that your student is receiving additional reading interventions. During this intervention period, your child has been receiving small group, systematic intervention in reading. Your child has had his/her progress monitored every other week using assessments that are specific to the intervention being used. Attached you will find a copy of your child's progress monitoring. All progress monitoring is reported using a graph so that you can see the progress your child is making.

Based on our progress measurements, we believe your child is:

	Making **good progress** and we plan to discontinue the additional intervention.
	Making **good progress** and we plan to decrease the amount of additional intervention time being provided.
	Making **some progress** and we plan to continue the intervention at this time.
	Making **limited progress** and we plan to consider changes in the intervention that we are providing.
	Making **insufficient progress** and we plan to change the intervention plan at this time. Further assessment and/or a parent meeting may be necessary.

Middle School/High School students who struggle in any subject area may become discouraged. We will continue to encourage your child to be at school every day, give his/her best effort and ask questions when he/she does not understand. Please continue to do the same at home. Your belief in your child's ability to improve is of great importance to him/her.

As the school staff, we are pleased to have this opportunity to provide your child with this needed assistance. If you have additional questions or concerns, please contact your child's teacher.

Respectfully,

Insert Signature
Insert District or School Contact Information

Project Appendix K: Sample Progress Monitoring Letter for Math Intervention

Insert District or School Name
Math 6-12
Response to Intervention (RTI)
Progress Monitoring Letter

Dear Parent,

A letter previously notified you that your student is receiving additional math interventions. During this intervention period, your child has been receiving small group, systematic intervention in math. Your child has had his/her progress monitored every other week using assessments that are specific to the intervention being used. Attached you will find a copy of your child's progress monitoring. All progress monitoring is reported using a graph so that you can see the progress your child is making.

Based on our progress measurements, we believe your child is:

	Making **good progress** and we plan to discontinue the additional intervention.
	Making **good progress** and we plan to decrease the amount of additional intervention time being provided.
	Making **some progress** and we plan to continue the intervention at this time.
	Making **limited progress** and we plan to consider changes in the intervention that we are providing.
	Making **insufficient progress** and we plan to change the intervention plan at this time. Further assessment and/or a parent meeting may be necessary.

Middle School/High School students who struggle in any subject area may become discouraged. We will continue to encourage your child to be at school every day, give his/her best effort and ask questions when he/she does not understand. Please continue to do the same at home. Your belief in your child's ability to improve is of great importance to him/her.

As the school staff, we are pleased to have this opportunity to provide your child with this needed assistance. If you have additional questions or concerns, please contact your child's teacher.

Respectfully,

Insert Signature
Insert District or School Contact Information

Appendix B: Interview Protocol

(Adapted from Creswell, 2012)

Project: Outcomes of a School-Wide Mathematics Intervention

Time of Interview:

Date: Place:

Interviewer:

Interviewee:

Position of Interviewee:

The purpose of this study is to assess whether there are differences in student outcomes in Algebra I and Algebra II achievement, as measured by the Algebra I and Algebra II EOC exam proficiency levels and raw scores, after implementing this school-wide intervention and enrichment program. The goal of this interview is to gain a deeper understanding of how math teachers viewed the effects of the school-wide intervention and enrichment program. All data collected will be confidential, and your names will not be used throughout the whole data analysis. The researcher will use coded names (Teacher A, Teacher B, Teacher C) while coding, triangulating, and reporting any data for my project study. This interview should take around twenty minutes.

Questions:

1. In your opinion, is it possible to have an effective math classroom without the implementation of research-based instructional strategies?

2. Describe the intervention/enrichment activities you believe were most effective and why. Which activities were not effective?

3. What changes did you observe in your math classes that you believe were a result of the intervention/enrichment program?

4. What strategies do you use to motivate math students to achieve at higher levels?

5. In your opinion, is relevance important in high school math instructions?

6. Do you believe the intervention/enrichment program was implemented with fidelity? Explain.

7. In your opinion, what percentage of your students are prepared for high school math? What skills are those students missing?

8. In your opinion, was the intervention/enrichment program effective in improving math achievement? Why or why not?

Appendix C: Data Use Agreement

This Data Use Agreement (“Agreement”), effective as of December 1, 2017, is entered into by and between Lisa M. Garrett and Metro Nashville Public Schools. The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set (“LDS”) for use in research in accord with the HIPAA and FERPA Regulations.

1. Definitions. Unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the “HIPAA Regulations” codified at Title 45 parts 160 through 164 of the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable HIPAA or FERPA Regulations

Data Fields in the LDS. **No direct identifiers such as names may be included in the Limited Data Set (LDS).** The researcher will also not name the organization in the doctoral project report that is published in Proquest. In preparing the LDS, Data Provider or shall include the **data fields specified as follows**, which are the minimum necessary to accomplish the research: Algebra I scores for students enrolled at Hillwood High School in 2013-2014 and 2014-2015, Algebra II EOC scores for students enrolled at Hillwood High School in 2013-2014, 2014-2015, and 2015-2016, and associated demographics of these students to include: gender, special education participation, EL participation, and economic disadvantage status.

3. Responsibilities of Data Recipient. Data Recipient agrees to:

   a. Use or disclose the LDS only as permitted by this Agreement or as required by law;

   b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

   c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

   d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

   e. Not use the information in the LDS to identify or contact the individuals who are data subjects.

4. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS for its research activities only.

5. Term and Termination.

a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

6. Miscellaneous.

a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER	**DATA RECIPIENT**
Signed: ______________________________	Signed: ________________________
Print Name: __________________________	Print Name: ____________________
Print Title: ___________________________	Print Title: _____________________

Appendix D: Evaluation and Feedback Survey

Please check your selection for the following statements and return this form to Lisa Garrett. Thank you in advance.

	Agree	**Disagree**	**Unsure**
The information provided in the policy recommendation was easy to understand.			
The topic discussed in the policy recommendation is relevant to my school.			
The topic discussed in the policy recommendation is relevant to my role in the school.			
I will be able to apply what I learned from the policy recommendation in my school.			
Applying the concepts in the policy recommendations would benefit my school.			

Please provide feedback and comments regarding your thoughts on the policy recommendation.

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