12-2016

A Mixed-Methods Program Evaluation of Two Middle School Mathematics Intervention Programs

Angela Hines
Gardner-Webb University

A Mixed-Methods Program Evaluation of Two Middle School Mathematics Intervention Programs

By
Angela Hines

A Dissertation Submitted to the
Gardner-Webb University School of Education
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Education

Gardner-Webb University
2016

Approval Page

This dissertation was submitted by Angela Hines under the direction of the persons listed below. It was submitted to the Gardner-Webb University School of Education and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Gardner-Webb University.

______________________________	______________________
Jennifer Putnam, Ed.D. Committee Chair	Date
______________________________	______________________
Kelsey Musselman, Ed.D. Committee Member	Date
______________________________	______________________
Kelly Clark, Ed.D. Committee Member	Date
______________________________	______________________
Jeffrey Rogers, Ph.D. Dean of the Gayle Bolt Price School of Graduate Studies	Date

Acknowledgements

This doctoral journey has not been a solo voyage. I have been blessed with a coach, my dissertation chair, who has been extremely encouraging and honest through this process. Dr. Jennifer Putnam has been a tremendous support and helped me realize this is a process, a journey, and a wonderful learning experience. She helped me stay focused and was one of my biggest cheerleaders along the way.

I would also like to thank my committee members, Dr. Kelly Clark and Dr. Kelsey Musselman, for their guidance and support. These ladies were a significant presence in my journey and provided me with varying viewpoints and nuggets of knowledge I will carry with me forever.

I acknowledge the support from all of my middle school family and my special cohort who supported and encouraged my efforts by continually believing in me. My dear friend, Kristie Love, who was always there to show her support and helped me grow as an educator and friend. Mr. David Ivey, my principal, and Mrs. Angel Dalton, my assistant principal, for the daily reminders and encouragement. Mr. Brady Johnson and Dr. Melanie Taylor along with the executive cabinet for giving me permission to conduct my research and to collect and use the needed data for my study. Finally, I would like to thank my family. My loving husband, David, who is now a better house cleaner than me and has always supported any endeavor I have undertaken. No matter what I have wanted to pursue, he has encouraged and supported me 100%. My children, Jacob and Anna, for putting up with my constant reading and writing through the meals, holidays, and visits home from college. Thank you for helping me reach and realize my goals.

Abstract

A Mixed-Methods Program Evaluation of Two Middle School Mathematics Intervention Programs. Hines, Angela, 2016: Dissertation, Gardner-Webb University, Academic Achievement/Instructional Effectiveness/Program Effectiveness/Teacher Effectiveness/Constructivism

The purpose of this study was to conduct a program evaluation of two mathematics intervention programs, Transmath and Vmath, in order to discover whether students who are exposed to the intervention programs will show growth in their mathematics performance. The effectiveness of the programs was measured quantitatively by collecting a pre and postassessment score using Moby Max and qualitatively regarding the implementation and effectiveness of the two programs by conducting classroom observations and teacher interviews.

The literature in this study identifies the connection between RTI, tiered intervention, mathematics intervention, and program implementation fidelity. The current literature contains a great deal of information on mathematics programs and how they help raise achievement scores on standardized testing; however, little literature is available comparing the use of mathematics programs and the amount of growth produced. Knowing that there is a gap in the research as to mathematics intervention programs and how they help raise achievement scores, this study aimed to address the following overarching research question: How effective are the Transmath and Vmath programs when used as an intervention strategy for struggling middle grade math students?

This study is significant in that it presents findings related to the effectiveness of the Transmath and Vmath interventions and the relationship between academic growth as measured by Moby Max and program implementation and teacher perception. Information from this program evaluation offers insight into which mathematics intervention program will result in the most achievement growth for middle school students.

Table of Contents

Page

Chapter 1: Introduction

Statement of the Problem

Middle school students in the United States are falling behind in mathematics achievement (Education Commission of the States, 2013, para. 1). Therefore, schools must find a way to close the learning and performance gaps to ensure these students are working on grade level.

> The Program for International Student Assessment, or PISA, collects test results from 65 countries for its rankings, which come out every three years. The results, from 2012, show that U.S. students ranked below mean in math among the world's most-developed countries. (Chappell, 2013, para. 2)

The Education Commission of the States (2013) identified the fact that early development of mathematics skills, even more than the development of early reading skills, is a greater predictor of future success for students, even in the area of reading achievement (para. 1). For many years, schools have taken on the challenge of improving reading and math skills. It is important for schools, especially elementary and middle schools, to increase the focus on mathematics instruction to ensure interventions are offered to struggling students. According to What Works Clearinghouse (2004),

> The call to improve mathematics education has also been driven by the widespread belief that competence in mathematics enables individuals to become informed and competent in a technology-dependent society. But that call for improvement has not been accompanied by evidence-based recommendations for how to achieve it. (p. 5)

Many students benefit from differentiated instruction within the regular classroom setting where differentiated alternative assignments are offered from the regular classroom teacher ("Differentiating," 2005; Ferrara, 2010; Scott 2012; Williams 2012), but many other students need a focused mathematics intervention program to help them be successful and to close gaps. Clements and Sarama (2015) stated,

> High-quality education can help children mathematize. Without such education beginning in preschool, too many children, especially from low-resource communities, follow a path of failure in mathematics. However, present-day early childhood classrooms in many countries do not provide high quality mathematics experiences, with many children learning little over the course of an entire academic year and some regressing on certain skills. (para. 4)

To assure that all students are receiving adequate mathematics instruction, mathematics intervention programs are becoming a necessity in many elementary, middle, and even high schools. Response to Intervention (RTI) is a proactive approach used to measure student achievement gaps through the guidance of data and selection of targeted teaching strategies. RTI is designed to help students move toward grade-level achievement ("Understanding response," 2015, para. 8).

Mirroring the 1990s movement for focused reading achievement, awareness of the need for focused mathematics interventions has developed in recent years. Even though math intervention is an underresearched area in relation to the research on reading interventions, research findings point to the need for quality math interventions guided by the RTI framework ("RTI and math instruction," n.d., para. 3). Although "little research has been conducted to identify the most effective ways to initiate and implement RTI frameworks for mathematics, there is a rich body of research on effective mathematics interventions implemented outside an RTI framework" ("Assisting students struggling," 2009, p. 10). This encouraging research can be used as a guide to develop math interventions within the RTI framework. Wright (2015) noted that when deciding on a particular mathematics intervention, factors must be appropriately defined and individualized for each student. It must also meet the requirements of the school district's math curriculum and measure the degree to which the student possesses or lacks the necessary auxiliary skills (Wright, 2015, para. 1). Many programs have been created and touted as the most effective intervention program to improve student mathematics achievement, but research of these programs has yet to be definitive. Some of these programs are Cortez Management Mathematics Lab System, I CAN Learn Middle School Mathematics, Saxon Mathematics, SuccessMaker, APlus, Larson's Prealgebra, Mathematics Navigator, Transition Math (Transmath), Vmath, Dreambox Learning and i-Ready Diagnostic and Instruction (Cooper, 2015, pp. 3-5).

Local Context of the Problem

The investigation into low-performing students led to this study which took place at a rural middle school, referred to as Whitefield Middle School (WMS) in Intercontinental County Schools (IS), a pseudonym of a county located in western North Carolina. Data indicate that for the past 2 years, mathematics achievement scores at this school were well below both the district and state in all grade levels and demographic categories. Data reported by the North Carolina Department of Public Instruction (NCDPI) for 2013-2014 and 2014-2015, and displayed in Table 1, showed that less than half of the sixth graders in North Carolina and less than one third of the sixth graders at WMS were proficient on the North Carolina end-of-grade (NCEOG) assessments in the area of mathematics for both years.

Table 1

Percentage of Sixth-Grade Students Proficient on NCEOG

Variable	NC 2013-2014	IS 2013-2014	WMS 2013-2014	NC 2014-2015	IS 2014-2015	WMS 2014-2015
All	46.8%	51.5%	27.8%	48.5%	46.2%	23.5%
Female	48.4%	53%	29.8%	49.9%	47.8%	22.9%
Male	45.4%	50.2%	26.3%	47.2%	44.6%	24%

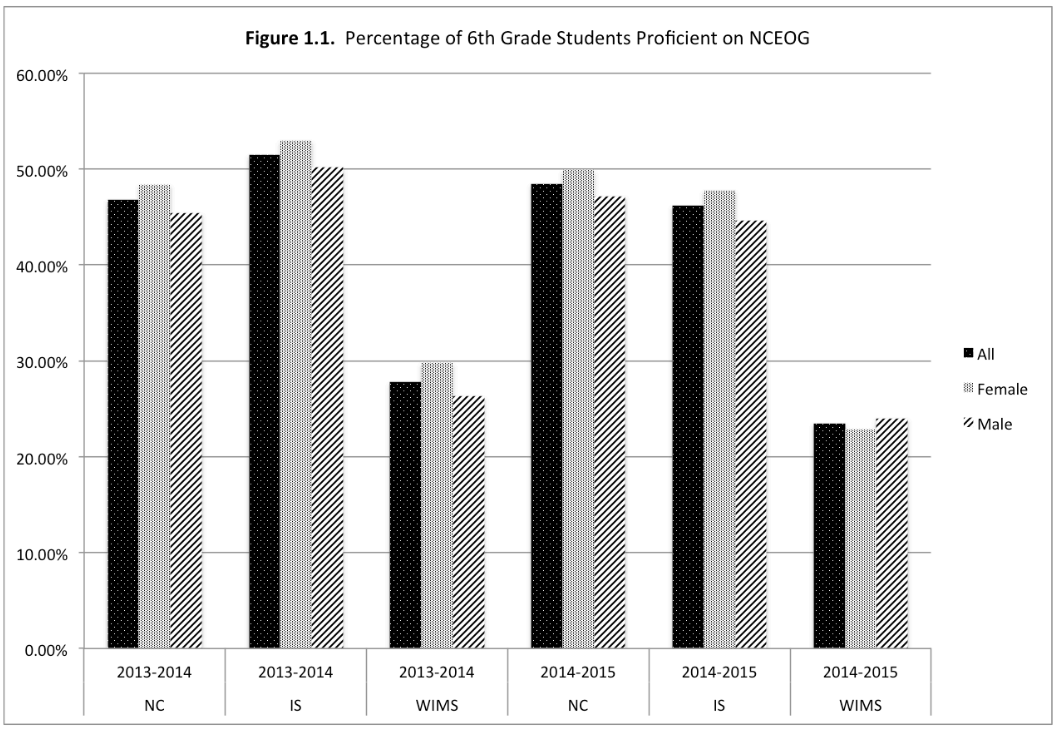

Figure 1. Percentage of Sixth-Grade Students Proficient on NCEOG.

Data displayed in Table 1 and Figure 1 highlighted the fact that mathematics scores at WMS were lower than the state and district in 2013-2014 and 2014-2015.

Data reported by NCDPI for 2013-2014 and 2014-2015, and displayed in Table 2, showed that less than half of the seventh graders in North Carolina were proficient on the

NCEOG assessments in the area of mathematics.

Table 2

Percentage of Seventh-Grade Students Proficient on NCEOG

Variable	NC 2013-2014	IS 2013-2014	WMS 2013-2014	NC 2014-2015	IS 2014-2015	WMS 2014-2015
All	42.2%	51.3%	27.6%	46.9%	46.2%	18.8%
Female	42.9%	54.1%	25.2%	49%	47.8%	19.2%
Male	41.5%	48.5%	29.5%	44.9%	44.6%	19.2%

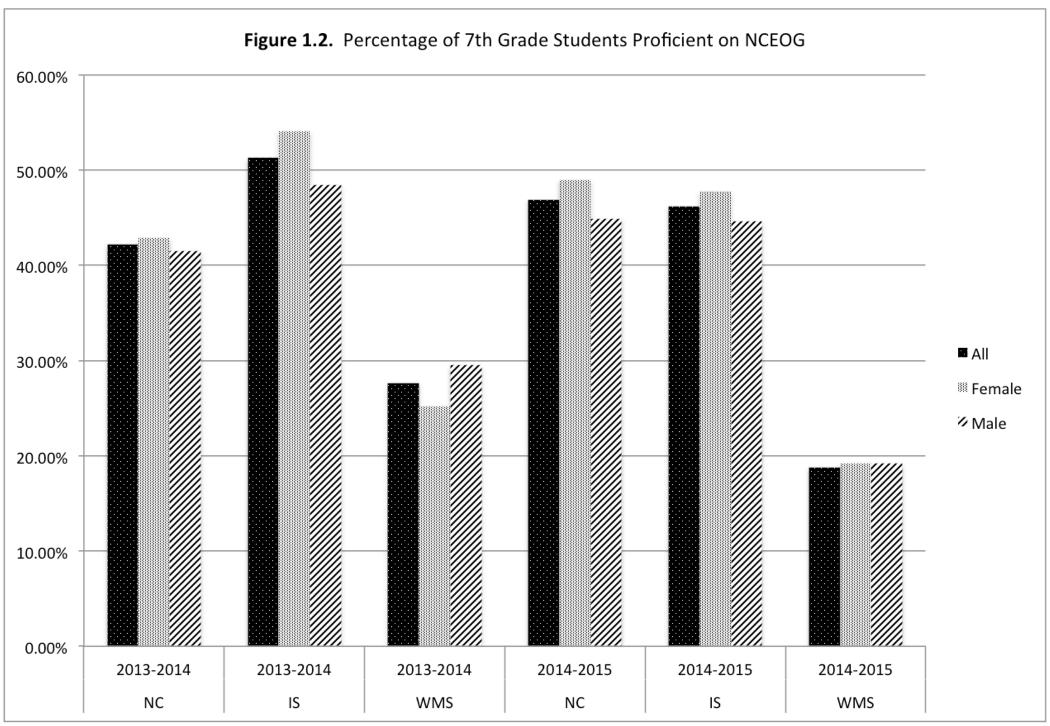

Figure 2. Percentage of Seventh-Grade Students Proficient on NCEOG.

Data displayed in Table 2 and Figure 2 reiterated the fact that mathematics scores at WMS were lower than the state and district in 2013-2014 and 2014-2015.

Data reported by NCDPI for 2013-2014 and 2014-2015, and displayed in Table 3, show that less than half of the eighth graders in North Carolina were proficient on the NCEOG assessments in the area of mathematics.

Table 3

Percentage of Eighth-Grade Students Proficient on NCEOG

Variable	NC 2013-2014	IS 2013-2014	WMS 2013-2014	NC 2014-2015	IS 2014-2015	WMS 2014-2015
All	42.2%	51.3%	24%	43.2%	45.5%	21.2%
Female	42.9%	54.1%	28.3%	44.4%	45.7%	21.4%
Male	41.5%	48.5%	20%	42.1%	45.2%	21%

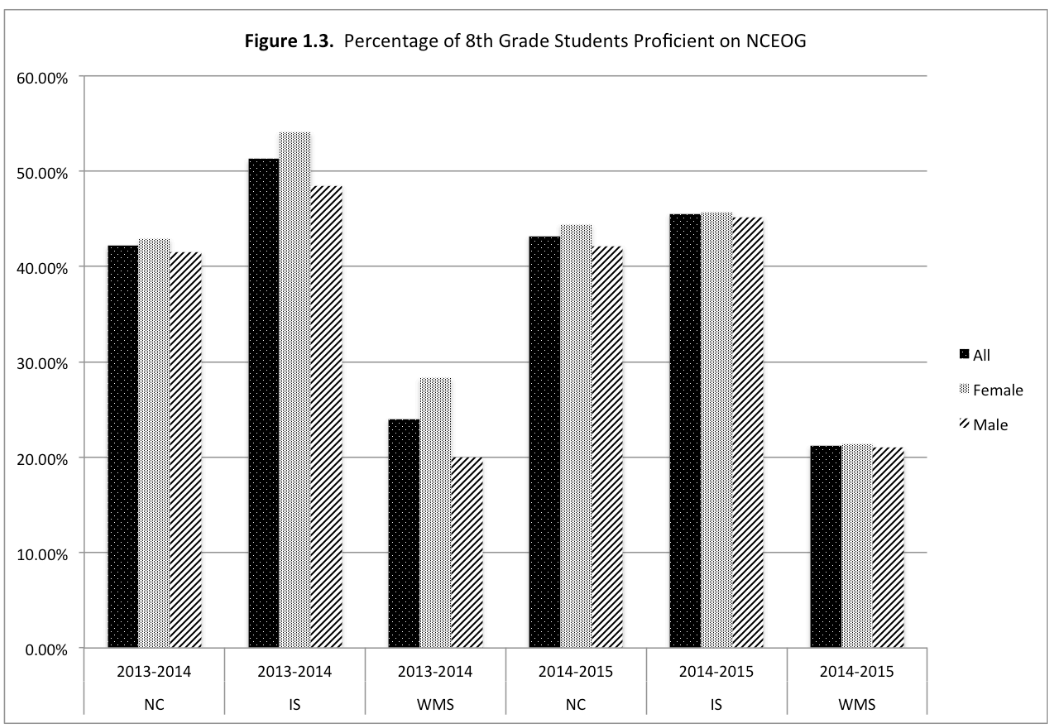

Figure 3. Percentage of Eighth-Grade Students Proficient on NCEOG.

Data displayed in Table 3 and Figure 3 emphasized the fact that mathematics scores at WMS were lower than the state and district in 2013-2014 and 2014-2015.

These data highlight a large discrepancy in the NCEOG mathematics assessment performance of students at WMS as compared to IS as a school district and North Carolina as a whole. Due to this discrepancy, mathematics intervention classes are being implemented at WMS to assist the students with foundational skills they may be missing as well as development of skills in which they may be weak. As part of this implementation, it is important to determine the most effective program in terms of student growth in order to make future curriculum decisions. Data from two intervention programs currently in place at WMS were assessed by conducting a program evaluation on the Vmath and Transmath programs to determine their impact on the academic growth of students enrolled in the programs. Both of these programs have been in place at WMS for several years. Vmath has been used for 3 years, and Transmath has been used for 5 years; but there has never been an evaluation of either program to determine the effectiveness of the intervention. Two separate groups of students were part of these programs and were placed in groups based on universal screening data.

Related Literature

With the collected NCEOG mathematics performance data highlighting the weakness in students at WMS, research was conducted on finding a solution. What Works Clearinghouse (2004), a government education research publication, provides many schools with methods and resources to help educators improve student learning and achievement. Several strategies for use with unsuccessful math students are suggested for schools and/or districts ("Assisting students struggling," 2009, p. 4). Interventions should be based on the individual student and the particular identified achievement gap. "When the mathematics content being taught is unconnected to students' ability level and/or experiences, serious achievement gaps result" ("Why do students struggle," n.d., para. 3). When achievement gaps begin to be prominent in the student's ability to perform in the classroom, the student is classified as unsuccessful in his or her attempt to perform in the mathematics classroom and is in need of specialized instruction or intervention (North Carolina Public Schools, n.d., p. 3).

Many strategies have been suggested as additions to the core classroom math instruction. These suggestions include first using universal math screenings to determine the students who may need additional math instruction in the form of interventions ("Assisting students struggling," 2009, p. 4). Universal screenings are grade-level assessments given to all students to determine students who are performing at grade level and students who may be at risk ("Universal screening," n.d., para.1). Once these students are identified, explicit and systematic intervention instruction in addition to core math instruction is offered. This intervention instruction is suggested to include solving word problems based on the problem structure, using visuals or models, and providing 10 minutes of math fluency during every session of the intervention class ("Assisting students struggling," 2009, p. 7).

This study assessed two programs, Vmath and Transmath, used for mathematics intervention at the middle school level in IS. The purpose of this mixed-method study was to assess the academic growth of two groups of students placed in Vmath and Transmath intervention classes in terms of Moby Max. Moby Max is a completely integrated program for Grades K-8 curriculum with a built-in assessment tool. This tool is completely aligned to the Common Core State Standards and identifies skill sets and gives a breakdown of a student's math proficiency by grade level, domain, and standard ("Moby Max," 2015, para. 8). Vmath and Transmath are programs developed by

Voyager Sopris Learning and are used in IS to increase student learning and achievement. Voyager Sopris is a company that claims it is “committed to partnering with school districts to overcome obstacles that students, teachers, and school leaders face every day” (“About us,” 2015, para. 1). According to the Vmath Training Manual (2012), Voyager Sopris states all of their products are research-based and proven to increase student achievement.

Voyager Sopris based the creation of the Vmath and Transmath programs on the instructional theory work of Englemann and Carnine who asserted a “consistent support for using an explicit approach to teaching mathematics” (Voyager Learning, 2009, p. 5). Voyager Learning (2009) noted the National Math Advisory Panel reported that students who have mathematical difficulties need explicit instruction, and this has proven to have positive effects on students’ abilities to compute and answer word problems (p. 5). According to Cambium Learning (2010), the National Math Advisory Panel defined explicit instruction as providing “clear models for solving a problem, opportunities for students to talk through decisions and steps, extensive practice of newly learned skills and extensive feedback” (p. 3). The Vmath and Transmath programs were created using this idea of explicit instruction. Finally, Voyager Sopris referred to Rosenshine’s conclusion that effective instruction is highly interactive, briskly paced, and clearly presented resulting in high rates of student success (Cambium Learning, 2010, p. 3). The use of these two programs at WMS were explored in greater depth.

Vmath

Vmath is a targeted math intervention program for struggling students in Grades 2-8. It provides additional opportunities to master critical math concepts and skills. Vmath is specifically designed to reinforce grade-level expectations. Students receiving

Vmath are offered this intervention 3-5 days a week during a 45-minute block reserved at WMS for intervention and enrichment classes. Vmath is not intended to replace the regular math class but is used as an extra block of math instruction time to help students develop skills and confidence in their math ability.

> Through a balanced, systematic approach, Vmath creates successful learning experiences for students and develops confident, independent learners of mathematics. With a blended print and technology solution, or a digital-only option, Vmath delivers essential content using strategies proven to accelerate and motivate at-risk students. ("Vmath third edition," 2015, para. 2)

According to Vmath Third Edition (2015), there are several reasons Vmath works for struggling math students. The program is built around consistent differentiated lesson plan formats that allow for a student to develop a conceptual understanding of mathematical procedures and application of mathematical skills as well as develop a more robust mathematical vocabulary through adventures, both online and in classroom activities, using learned problem-solving skills.

The Vmath program is arranged into seven levels corresponding to a particular grade level, with seven modules per level. Each of the modules has 10 to 15 lessons with two preskills lessons, extra practice, and reteach lessons. There is also time built into the program for teachers to differentiate within the classroom and assess formatively. According to Vmath Third Edition (2015), each grade has specific levels covered within the Vmath curriculum. Sixth-grade students are placed in level G. Modules covered are Foundations, Rational Numbers Part A, Rational Numbers Part B, Expressions, Equations and Inequalities, Proportional Thinking, Geometry, and Data. Seventh-grade students are placed in level H. Modules covered are Equations and Inequalities, Proportionality, Geometry and Data, Probability, and Statistics. Eighth-grade students are placed in level I. Modules covered are Foundations, Real Numbers, Equations, Functions Part A, Functions Part B, Transforming Geometry, and Geometry (Voyager Sopris, 2015, para. 4). Built-in support for English Language Learners (ELL) and students with special needs is included. The publishers of this program suggest that the teacher materials and pacing guides make this program easy to implement.

Assessments and progress monitoring are built into the curriculum. Students taking part in the Vmath program are administered an initial assessment, a progress assessment, and a computational fluency assessment before intervention instruction begins. For each of the eight modules within the program, students in this program take a pretest, a computational fluency progress monitor assessment, and a posttest. If necessary, reteach activities for each module are available to be used.

Transmath

Transmath is also a targeted math intervention but is geared toward students in Grades 5-10 as opposed to Vmath, a program geared toward Grades 2-8. Students receiving Transmath are offered this intervention 3-5 days a week during a 45-minute block reserved at WMS for intervention and enrichment classes. Transmath is not intended to replace the regular math class but is used as an extra block of math instruction time to help students develop skills and confidence in their math ability.

> Transmath aims to increase 5th- through 10th-grade students' skills in applied arithmetic, pre-algebra, and pre-geometry. This one-year curriculum also addresses general application to different wordings of problems, types of numbers, and contexts for problems and aims to promote mathematical reading

> skills. The curriculum uses the University of Chicago School Mathematics Project (UCSMP) textbook. The sequence of the topics intends to assist the transition from arithmetic to algebra and geometry. ("Transition mathematics," 2007, para. 1)

According to Voyager Sopris (2015), Transmath works because it helps deepen a student's conceptual understanding of mathematics and builds problem-solving proficiency through the use of explicit instructions and multisensory strategies (para. 5). "Transmath is a comprehensive math intervention curriculum that targets middle and high school students who lack the foundational skills necessary for entry into algebra and are two or more years below grade-level in math" (Woodard, 2015, para. 2). In addition, Transmath helps to guide teachers and strengthen the teachers' background knowledge throughout the program. Finally, Voyager Sopris (2015) stated that Transmath offers digital tools to increase independent and peer learning and provides the teacher and student with eBook access, giving both the teacher and student better ways to communicate (para. 7).

Assessments and progress monitoring are built into the program. Students taking part in the Transmath program are administered a student placement test and a baseline test before intervention instruction begins. Students take a quiz after lesson five, a quiz after lesson 10, and an end-of-unit assessment. If necessary, reteach activities for each occur. Performance assessments for the reteach lessons are also given.

In looking at these two programs, there is a slight difference in how the programs are designed and which group of students is targeted.

> The main difference in the two programs is whom the program is intended for based on a student's ability. Vmath is closely tied to grade level standards for

> each level and will reach back about 2 years to pull students up. This is what we consider to be a Tier 2 intervention. Transmath is ability-level based on a student's math ability. This is generally used for students about 2 years below grade level starting in 5th Grade. This is also a Tier 2 intervention, but could be used as Tier 3 as well. (J. Vincent, personal communication, November 4, 2015)

For years, IS has been attempting to find a program that would address students' mathematical achievement gaps at the elementary and middle school levels. Initially, Transmath was purchased to use with a small group of low-performing students. In many cases, this group consisted only of students in the Exceptional Children's (EC) program. After the initial use of Transmath, Voyager Sopris introduced Vmath (with an online component), and IS chose to adopt this program as well. Several schools, including WMS, chose to use both programs due to the large number of students performing below grade level in mathematics. While both programs are being implemented and used at WMS to help raise student achievement scores, the leadership team at this school is interested in whether the use of either program will lead to improved math achievement and, if so, which one will result in more student achievement growth. This question led to the related literature research.

Deficiencies in the Literature

While there is much literature discussing the lack of achievement in mathematics in the United States and the lack of performance on assessments and grade-level achievement for middle school students, there is less literature to defend the best interventions to help close the achievement gaps. The literature contains a great deal of information on mathematics programs and how they help raise achievement scores on standardized testing verses control groups; however, little literature is available comparing the use of math programs and the amount of growth produced. Much of the literature still focuses on student test performance as opposed to academic growth; for example, according to the Center for Public Education (n.d.), "recent policy discussions about school and teacher accountability are expanding the proficient view of achievement by recognizing that some students have much farther to go to reach proficiency" (para. 1). Final achievement-level scores do not measure the total amount of academic growth a student has achieved, because these scores do not define the starting level of a student. Goss and Hunter (2015) stated, "academic achievement is influenced by many factors, including prior achievement and socio-economic background. By contrast, academic progress, while not perfect, provides a better indication of how much students have actually learned" (para. 4).

Focusing on growth allows for a measure that gives researchers a way to measure the amount a student has learned instead of focusing on the achievement level scores on a test. Due to the knowledge that students do not start at the same beginning achievement levels, schools are determined to develop intervention programs to raise achievement levels of students from their current level. It is imperative to evaluate the effectiveness of programs used in schools in order to help determine instructional strategies that work. Due to the lack of research devoted to intervention programs and their effect on student growth, schools are faced with a multitude of academic intervention decisions and little guidance. Hanover Research (2014) stated that the choice of a mathematics intervention program is of great importance for schools and one that must be decided upon quickly to give students the best opportunity to grow (para.4).

In reference to research available stating the effectiveness of Vmath, according to What Works Clearinghouse (2009),

> No studies of Vmath that fall within the scope of the Elementary School mathematics review protocol meet What Works Clearinghouse (WWC) evidence standards. The lack of studies meeting WWC evidence standards means that, at this time, the WWC is unable to draw any conclusions based on research about the effectiveness or ineffectiveness of Vmath on elementary school students. Additional research is needed to determine the effectiveness or ineffectiveness of this intervention. (para. 1)

Likewise, studies on Transmath's effectiveness, compared to other mathematics programs, have been inconclusive. According to What Works Clearinghouse (2004), the evidence base on effective math intervention programs in middle school is sparse. "There have been few randomized controlled trials of math interventions for middle school students, and those few trials conducted tend to be small" (What Works Clearinghouse, 2004, p. 3).

Conceptual Framework

When students are struggling in the classroom, different levels of interventions may be necessary to help them catch up and close learning gaps. Based on reports of the RTI Action Network (n.d.), RTI is a multi-tier approach that has been developed to identify and support students with learning and behavioral needs (para. 1). In an effort to identify students in need of interventions, RTI (2012) stated that at the beginning of the school year and periodically throughout the year, students should be screened to determine if they are performing at grade level (para. 5). If the student is determined to be below grade level during this screening, they may be placed into a Tier 2 or Tier 3 intervention, depending on the performance gap. According to the RTI Action Network (n.d.), Tier 2 students are those students who need to be provided small-group instruction, usually within the classroom 2-3 times a week, in addition to instruction in the general mathematics classroom. Tier 3 students should receive individualized, intensive interventions that target that student's skill deficits every day, in addition to instruction in the general mathematics classroom (RTI Action Network, n.d., para. 10). An in-depth exploration of the RTI framework is examined in Chapter 2.

Theoretical Framework

One of the theories that led to the development of RTI was Piaget's Theory of Constructivism. Piaget's Theory focused on how learning occurs and the importance of the teacher and delivery of the material ("Piaget's theory," 2015, para. 4). Constructivism is a theory of learning and focuses on the way people learn instead of prescribing how people should learn (Richardson, 1997, p. 3). Math intervention classes allow students to be placed in a class where other students may have similar learning styles and background knowledge as well as having students placed in a class where the teacher will be delivering material in a different format. According to Richardson (1997), constructivists agree that the traditional way of delivering material will not allow struggling students the opportunity to make connections between prior knowledge and internalization and deep understanding of new knowledge (p. 3). Other psychologists, including Lev Vygotsky who developed the theory of Zone of Proximal Development (ZDP), built learning theories beyond Piaget's that led to the development of the RTI framework in schools.

Audiences

The results of this research study will be of interest to middle school math teachers, intervention specialists, and RTI coaches. School-level administration may be interested as well as district-level curriculum developers. All school systems face budget issues and must make appropriate decisions about the way money is allocated. The outcome of this study may help guide some of the decision-making processes within the school system or other school districts or math program creators as well as help establish the best approach to math intervention at the middle school level.

Purpose and Significance of Study

This mixed-methods study addresses and assesses the amount of growth in mathematics achievement when nonrandom, convenience populations of students are immersed in two different mathematics intervention programs. A convergent parallel mixed-methods design was used. This methodology is designed so qualitative and quantitative data are collected in parallel, analyzed separately, and then merged. Creswell (2005) suggested, "collecting quantitative data in is important to test the qualitative explorations of the study" (p. 517). In this study, pre and posttest Moby Max scores were used to test the theory that predicts Vmath and Transmath will positively influence the mathematical academic growth for middle school students at WMS. Moby Max is a completely integrated program for Grades K-8 curriculum with a built-in assessment tool. This tool is completely aligned to the Common Core and identifies skill sets and a breakdown of a student's math proficiency by grade level, domain, and standard ("Moby Max," 2015, para. 8). This program is used to universally screen students three times within the school year and was used to provide a grade equivalent baseline measure, mid-year measure, and end-of-year measure which produced quantitative data to be used in determining whether students displayed growth throughout the year and, if so, how much.

The qualitative data collected during this study consisted of teacher interviews and observations in order to explore the degree of fidelity to which the programs were implemented for middle school students at WMS. "It has been demonstrated that the fidelity with which an intervention is implemented affects whether a lack of impact is due to poor implementation or inadequacies inherent in the program itself" (Carroll et al., 2007, p. 1). This study will provide information about two math intervention programs and which program, if either program, currently used will result in math achievement growth for the students involved in these programs.

Research Questions

This research study combined both quantitative and qualitative data to answer research questions related to a program evaluation. The overarching question leading this study was,

RQ1: How effective are the Transmath and Vmath programs when used as an intervention strategy for struggling middle grade math students?

In order to answer the overarching research question, quantitative data were used to analyze data related to Research Question 2, and qualitative data were used to analyze data related to Research Questions 3 and 4. The three additional questions this study addressed were,

RQ2. What are the differences in the mean scores of the students involved in the Vmath and Transmath intervention classes as measured by Moby Max?

RQ3. To what extent are the Vmath and Transmath programs being implemented with fidelity as measured by fidelity observations and teacher interviews?

RQ4. How do intervention teachers perceive the implementation and effectiveness of Vmath and Transmath?

The program evaluation in this study discovered whether students who are exposed to the intervention programs, Vmath and Transmath, showed growth in their mathematics performance. The growth was measured quantitatively by comparing pre and posttest scores of the Moby Max universal screening tool. The programs were further evaluated by collecting qualitative data through fidelity implementation observations and teacher interviews regarding the implementation and effectiveness of the two programs.

Limitations of Study

While some of the aspects of this study can be controlled, this study posed several limitations that may have affected the outcome of the findings. Limitations are potential threats or weaknesses that are out of the researcher's control, cannot be dismissed, and may affect the final results ("Stating the obvious," 2015, para. 3).

This study took place in one middle school in a rural area of southwestern North Carolina. It was challenging to generalize the findings of this study to other schools of different demographic makeups or different levels of teacher implementation. The researcher was a coworker in this school and acknowledged this may have resulted in bias of data interpretation. Another limitation of this study was the inability to control for the comfort and experience level of the teachers in these intervention classrooms. Two of the teachers who were conducting these intervention classes taught the material before; one taught Transmath for several years; and one of the teachers taught Transmath the prior year and also taught Vmath during this study. The other seven teachers were new to the intervention, which could have caused a difference in the results. The amount of time given to this study possibly limited the results, as it only took place over an academic year of instruction. Finally, past performance of students may have weaken this study, as this performance may have been based on circumstances not related to student ability.

Background of the Role of the Researcher

The role of the researcher in this study was two-fold. The researcher collected and analyzed all of the data as assessments were given. The researcher played a different role in the aspect of the qualitative data collection since the researcher conducted interviews and observations to determine the level of fidelity used in the implementation of both programs. Because the researcher also worked at the school in which the study took place, the potential presence of bias was acknowledged when observing classrooms and conducting teacher interviews. The researcher took steps to prevent this bias by having a coworker perform peer observations of all classrooms an equal number of times using a predesigned instrument by NCDPI and by asking all teachers the same questions from a survey validated by math teachers in the school and district.

Definitions of Relevant Terms

Academic growth. The academic performance of a student or group (a collection of students) over two or more time points (Smith, 2013, p. 13).

Assessment. Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning ("What is assessment," n.d., para. 2).

Differentiated instruction. The way a teacher anticipates and responds to a variety of student needs in the classroom ("What is differentiated instruction," n.d., para. 2).

Fidelity. The degree of accuracy with which sound or images are recorded or reproduced ("Fidelity," n.d. para. 5).

Fidelity of implementation. The degree to which the program is implemented as intended by program developer, including the quality of implementation ("Using fidelity to enhance," n.d., para. 1).

Intervention. An academic intervention is a strategy used to teach a new skill, build fluency in a skill, or encourage a child to apply an existing skill to new situations or settings ("Intervention central," n.d., p. 3).

Mixed-methods research. An approach to inquiry that combines both qualitative and quantitative forms of research. It involves philosophical assumptions, the use of qualitative and quantitative approaches, and the mixing or integrating of both approaches in a study (Creswell & Plano, 2011, p. 244).

No Child Left Behind. A law passed in 2002 with the support of Congress and President George W. Bush which put into place measures that exposed achievement gaps among traditionally underserved and vulnerable students and their peers ("Elementary and Secondary Education Act," n.d., para. 3).

NCEOG. Designed to measure student performance on the goals, objectives, and grade-level competencies specified in the North Carolina Standard Course of Study. ("Accountability services," n.d., para. 1).

Prescreening. To examine or interview before further selection processes occur ("Prescreening," n.d., para. 1).

Qualitative method. Qualitative method is a research approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. This process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data

(Creswell, 2005, p. 4).

Quantitative method. Quantitative method is a research approach for testing objective theories by examining the relationship among variables. These variables, in turn, can be measured, typically on instruments, so numbered data can be analyzed using statistical procedures (Creswell, 2005, p. 4).

RTI. RTI is a multi-tier approach to the early identification and support of students with learning and behavioral needs. The RTI process begins with high-quality instruction and universal screening of all children in the general education classroom (RTI Action Network, n.d., para. 2).

Tiered instruction. Tiered instruction represents a model in which the instruction delivered to students varies on several dimensions that are related to the nature and severity of the student's difficulties ("Tiered instruction," n.d., para. 1).

Transmath. Transmath is a comprehensive mathematics intervention curriculum that teaches a balanced approach of computational skills and problem-solving applications (Transmath Training Manual, 2010, p.1).

Triangulation. Triangulation refers to the use of more than one approach to the investigation of a research question in order to enhance confidence in the ensuing findings ("Reference world," n.d., para.1).

Universal screening. Universal screening is an assessment, which is typically brief, conducted with all students in a grade level and followed by additional testing or short-term progress monitoring to corroborate students' risk status (Center on RTI, 2015, para. 1).

Vmath. Vmath is a math intervention system for students who struggle in the basic concepts of math. Vmath provides targeted math intervention that reinforces essential concepts, skills, and strategies taught in the core math program (Vmath Training Manual, 2012, p. 1).

Organization of the Study

This research study is divided into 5 chapters. Chapter 1, the introduction of this study, presented the statement of the problem, local context of the problem, related literature, deficiencies in the literature, audiences of this study, research questions, conceptual framework of this study, limitations of this study, background of the role of the researcher, and definitions of relevant terms. Chapter 2 contains the review of literature and research related to the problem being investigated. The methodology and procedures used to gather data for the study are presented in Chapter 3. The results of this study are presented in Chapter 4. Chapter 5 contains a summary of the study and findings, conclusions drawn from the findings, and recommendations for further study.

Chapter 2: Literature Review

Overview

Exploring the literature in the areas of math interventions using the RTI framework of tiered instruction allows for an overall view of mathematics intervention strategies. This literature review uses a funnel approach by first addressing the RTI framework and the importance of identifying and addressing academic gaps in students. Next, this review addresses the rising importance of math interventions and the process of how to choose which students to place into a math intervention. An examination of tiered instruction and the learning theories that support it explain the importance of identifying struggling students and placing them into the correct level of intervention. The three levels of tiered instruction are discussed and how the intensity of the intervention would look in each of the levels. As it relates to this study, a focus is placed on two specific math intervention programs: Vmath and Transmath. This literature review provides program information and research-based evidence of success in using these programs as a math intervention. In this literature review, the researcher investigates the importance of fidelity of implementation and the necessity of following a prescriptive program. This literature review discusses the mixed-method approach to research and the importance of triangulation of data. Finally, this literature review addresses the differences in mathematical achievement based on gender and ethnicity of students.

RTI

The importance of RTI in identifying struggling students is undeniable. RTI is an early detection, prevention, and support system that identifies struggling students and assists them before they fall behind (VanDerHeyden, 2015, para. 7). RTI, also known as a Multi-Tiered System of Supports (MTSS) or a three-tiered model, is an approach for redesigning and establishing teaching and learning environments that are effective for students, families, and educators (“Math intervention,” 2015; RTI Action Network, n.d., para. 2). RTI helps schools determine areas of weakness in students and develop strategic plans to close achievement gaps. As stated by Carter-Smith (2015), “Response to Intervention (RTI) is a promising new measure through which learning disabilities can be identified. Students with academic delays are identified through a process of universal screening, and research-based interventions are offered at different tiers of intensity” (para.1).

VanDerHeyden (2015) explained that RTI provides a framework in which student achievement data can be used as a basis for determining who needs help the most and how much help they may need (para. 4). Data must be used to make academic decisions for students when working in the RTI framework. These data can be used to decide who needs intervention, what intervention they need, and if the intervention is working. Burns (2010) also stated that a meta-analysis of RTI research found large positive effects on student achievement when the RTI process was incorporated and found reductions in special education referrals and increased reading scores (para. 4).

As noted by RTI Action Network (n.d.), RTI is a multi-tier approach used to identify and support students with learning needs and begins with the process of universally screening all students to determine those in need of assistance and offering high-quality instruction in the regular classroom (para. 1). According to VanDerHeyden (2015), when properly used and followed, RTI is a way to focus instruction on student needs, gaps, and learning. Burns (2010) stated that RTI is the practice of providing quality instruction and intervention and using student learning in response to that instruction to make instructional and important educational decisions. According to

Burns, practitioners should take great strides to assure that the RTI model is implemented with fidelity, but many are unsure how to best accomplish this important objective (para. 4). If a mathematics program is to be implemented with fidelity following the RTI model, VanDerHeyden stated that a district or school must identify adequate screening and progress-monitoring measures and plan for effective delivery of intervention at Tiers 1, 2, and 3 (para. 9).

Bender and Crane (2010) suggested the RTI process should involve targeting the specific areas in which students are struggling; and once those areas are identified, increasingly intensive research-proven interventions should be applied until the threat to student achievement is alleviated (p. xi). In 2004, the Individuals with Disabilities Education Act (PL 108-446) encouraged all states to use RTI to accurately identify students with learning disabilities and attempt to provide additional supports for students with academic difficulties who were not identified as having a learning disability. Although many states have already begun to implement RTI in the area of reading, RTI initiatives for mathematics are relatively new ("Assisting students struggling," 2009, para. 2).

When students are placed into a Tier 2 or Tier 3 intervention, the instruction becomes more intense and focused on gaps. "Students not making adequate progress in the regular classroom in Tier 1 are provided with increasingly intensive instruction matched to their needs on the basis of levels of performance and rates of progress" ("What is response to intervention, n.d., para. 6).

Concerns. One concern many schools may have about RTI is the number of students who might qualify for intervention using the RTI framework. According to many publications about the three-tier model of RTI, a school's goal is for no more than

15%-20% of students to require additional support beyond Tier 1 curriculum and instruction (Burns, 2010; “Indiana Department of Education,” 2009; Job, n.d.; RTI, 2012; “Response to intervention explained,” 2015; Searle, 2015). Eighty percent of students should be able to perform in the regular core classroom at or above grade level achievement expectations. With these suggested percentages, tiers are not always going to be divided with these specific numbers, and students can move with fluidity from tier to tier. “What is necessary to remember for all tiers is that they are flexible. Students may move from one tier to another and back again depending on their response and their progress” (Job, n.d., para. 9). In addition, Sparks (2015) stated that RTI may be doing students an injustice as students who are in these intervention classes are scoring up to 10% lower than their peers who are not offered interventions. Also according to Sparks, to ensure Tier 2 students are closing the achievement gaps, Tier 2 instruction should be aligned with the core instruction. However, Sparks contended that Tier 2 instruction singles out a particular targeted and explicit component instead of modeling the core instruction to cover a much broader range of skills. Sparks stated in taking part in Tier 2 instruction, students may be missing out on much of the richer and deeper core content (para. 15).

Shapiro (2015) noted tiered instruction is only as good as the collaboration of the staff within the school building, and the advantages to the RTI approach are seen at the highest success rate when teachers engage in discussions about how students are performing during tiered intervention time. Because schools have limited staff, Shapiro suggested each member of the faculty must be actively involved in implementing and carrying out the tiered interventions, and this can lead to concerns about tiered instruction being circulated about in schools. According to Shapiro, many teachers are concerned with the lack of time in the school day for regular classroom instruction, not to mention an extra instructional period for tiered intervention. Another concern Shapiro stated was the question as to whether or not there are sufficient school personnel available to be the tiered instructors and a data expert. Many teachers are still in the era of *my* students and *your* students, another issue that experts feel needs be addressed and solved with strong communication within the school building and between the school and home (Shapiro, 2015, para. 24). Shapiro suggested to successfully implement intervention programs, many of the staff would need to be trained in the delivery of the program or intervention; and then when trained, many times teachers leave the school or the district and new staff is brought in and in need of training (para. 25-26).

Fidelity. RTI Action Network (n.d.) suggested the number of hours, method of delivery, or the way the intervention is set up is completely left up to the discretion of the school and its decision makers, yet there are several components that are necessary to make RTI effective. One of the important qualities of a successful intervention is the degree of fidelity to which the program components are implemented. These intervention components are high-quality instruction, scientifically based classroom instruction, ongoing student assessment, tiered instruction, and parent involvement (para. 3). Further, Bender and Crane (2010) stated there are five foundational principles of the RTI process: "Universal screening to identify students struggling in mathematics, a multitier model of increasingly intensive educational interventions, research-based curriculum in each tier, frequent monitoring of each child's performance, and data-based decision making involving a collaborative team effort" (p. 5). To help guide fidelity, all of these elements should be considered and included in the implementation of any intervention.

Math Intervention

Mathematics achievement scores in the United States are a matter of national concern. National Math Panel Report Endorses Vmath Intervention Program Research Base (2008) discussed the poor showing of students in the United States on international comparisons of mathematics performance. This panel suggested that students in the United States suffered from key mathematical concept deficiencies including aspects of whole number arithmetic, fractions, ratios, and proportion. It was suggested that early intervention might be the key to helping students struggling in mathematics ("Assisting students struggling," 2009, p. 4).

> Mathematics literacy is a serious problem in the United States. According to Philips (2007), 78% of adults cannot explain how to compute the interest paid on a loan, 71% cannot calculate miles per gallon on a trip, and 58% cannot calculate a 10% tip for a lunch bill. Further, it is clear from the research that a broad range of students and adults also have difficulties with fractions, a foundational skill essential to success in algebra. The recent National Assessment of Educational Progress (NAEP, "the Nation's Report Card") shows that 27% of eighth-graders could not correctly shade 1/3 of a rectangle and 45% could not solve a word problem that required dividing fractions. (U.S. Department of Education, 2008, p. 3)

Due to this poor showing, schools in the United States are in need of finding a way to close performance gaps in the mathematics achievement of middle school students. "Researchers have begun to advocate for RTI procedures in mathematics for two specific reasons: (1) many students need help in mathematics, and they can benefit from RTI procedures, and (2) RTI-based instruction works" (Bender & Crane, 2010, p. 7). Burns

(2010) suggested interventions should be highly and correctly targeted to be effective, but students cannot learn to read and do math if they are not receiving quality balanced instruction in addition to supplemental support (para. 2). Bender and Crane (2010) suggested that nearly all of the research on RTI has taken place in the area of reading, because reading and literacy have been major national priorities since the Clinton presidential administration; however, teachers are now beginning to use RTI procedures in mathematics (p. xi).

VanDerHeyden (2015) listed six key findings in the literature highlighting the need to focus on early mathematics instruction. Children who have less exposure to mathematical concepts are at high risk for failure; most American students fail to meet minimum mathematics proficiency at the end of high school; students with identified learning disabilities perform at a lower level and grow at a slower rate than their peers; textbooks do a poor job of relating important mathematical principles; math is highly proceduralized and builds on previous knowledge; and finally, early mathematics intervention can repair and prevent future achievement deficits (para. 3). “As the United States increasingly sets high standards in mathematics, educators will need bold new approaches to teaching to meet those standards, and as the research demonstrates, RTI is an effective instructional process for meeting those demands” (Bender & Crane, 2010, p. xi)

Using VanDerHeyden’s (2015) findings as guidelines to focus on a successful math intervention program, Assisting Students Struggling with Mathematics (2009) reported that the Institute of Education Sciences (IES) recommended eight steps be followed to ensure math intervention is effective. These eight steps are as follows:

Screen all students to identify those that may be at risk; use instructional materials

> that focus on in-depth treatment of whole numbers in K-5th grade and on rational numbers in grades 4-8; instruction during the intervention should be explicit and systematic; include instruction on solving word problems based on common underling structures; intervention materials should include opportunities for students to work with visual representations of mathematical ideas; every grade level of intervention should focus about 10 minutes on building fluent retrieval of basic arithmetic facts; progress monitoring for all students at risk in necessary; and include motivational strategies in tier 2 and 3. (VanDerHeyden, 2015, p. 2)

These recommendations received a rating based on the strength of the research evidence that showed the effectiveness of a recommendation as displayed in Table 4. VanDerHeyden (2015) showed the two strongest indicators for effective math interventions are intervention instruction should be explicit and systematic and instruction in solving word problems should be based on common underlying structures (p. 2).

Table 4

Effectiveness of Recommendations for Math Interventions

Recommendation	Effectiveness
Screen all students to identify those that may be at risk.	Moderate
Use instructional materials that focus on in-depth treatment of whole numbers in K-5th grade and on rational numbers in Grades 4-8.	Low
Instruction during the intervention should be explicit and systematic.	Strong
Include instruction on solving word problems based on common underlying structures.	Strong
Intervention materials should include opportunities for students to work with visual representations of mathematical ideas.	Moderate
Every grade level of intervention should focus about 10 minutes on building fluent retrieval of basic arithmetic facts.	Moderate
Progress monitoring for all students at risk is necessary.	Low
Include motivational strategies in Tier 2 and 3.	Low

What Works Clearinghouse (2009) defined the ratings as displayed in Table 4 (strong, moderate, or low) as follows:

> *Strong* refers to consistent and generalizable evidence that an intervention program causes better outcomes. *Moderate* refers either to evidence from studies that allow strong causal conclusions but cannot be generalized with assurance to the population on which a recommendation is focused (perhaps because the findings have not been widely replicated)—or to evidence from studies that are generalizable but have more causal ambiguity than offered by experimental which the equivalence of the groups at pretest is uncertain). *Low* refers to expert opinion

> based on reasonable extrapolations from research and theory on other topics and evidence from studies that do not meet the standards for moderate or strong evidence. (“Assisting students struggling,” 2009, p. 6)

Placement. Placement of students into intervention groups needs to be based on collected achievement data. Data from universal prescreenings are used to make educational decisions about all students in each level of tiered instruction. Following the collection of screening data, the decision makers must determine whether a student possesses a systemic problem. Where systemic learning problems are identified, the core instruction in the classroom should be evaluated to ensure that a research-supported curriculum is being used, that effective instruction is being delivered for a sufficient time and with sufficient quality, and that adequate resources are available to support effective instruction in the classroom (“What is response to intervention,” n.d., para. 1). Once a student is determined to need an intervention, the correct intervention must be chosen and the student’s progress must be systematically tracked to ensure the continual effectiveness of the intervention. VanDerHeyden (2015) suggested,

> Effective mathematics instruction should include a system for monitoring student learning and adjusting instructional efforts to ensure adequate learning or accelerate it where needed. Other variables of effective instruction that are relevant include a well-sequenced program of instruction that logically builds on existing skills and periodically returns to previously mastered skills to ensure maintenance, demonstration of correct and incorrect responses, and substantial opportunity to practice performing newly learned skills with direct support. (p. 4)

At that point, if it was determined that these criteria are being met, intervention programs can be instituted for students determined to be at risk. VanDerHeyden suggested that these at-risk students' performances might be similar to each other; therefore, they could be grouped and exposed to materials that target the needs of the group. These students might be targeted for Tier 2 or Tier 3 intervention programming.

Tiered Intervention

Prescreening data helps determine those students who may need academic interventions. When these struggling students are identified, instruction can be developed in tiers depending on the level of support the student needs. The argument that mathematics instruction needs to be leveled for students is not new, but the agreement as to how to achieve this is ongoing ("Tiered instruction and assessment," 2007, p. 2). "In the United States the tradition has been to teach mathematics at the same pace and in the same way to all students, and then later on, when some students begin failing, to provide remediation" (Kasten, 2005, p. 2). Intervention must be immediate if a student's individual needs are to be met and the student is to be helped before they fall behind; and researchers agree that a tiered system of intervention is critical to an effective intervention program (Shapiro, 2015, para. 4; "6 critical components," n.d.). According to Bender and Crane (2010), various states have adopted slightly different models, yet the most commonly used RTI model is the three-tier RTI pyramid (p. 3). The three-tiered RTI instructional model represents a way in which the instruction delivered to students varies on several levels that are related to the nature and severity of the individual student's difficulties ("Tiered instruction in a response," n.d., para.1). RTI Action Network (n.d.) defined the three tiers of instruction in the RTI framework as Tiers 1, 2 and 3. Tier 1 consists of regular classroom instruction with each student receiving regular universal screening to progress monitor using a curriculum-based measure, whereas Tier 2 and Tier 3 instruction adds another layer of support for a struggling student. “Tier 2 and Tier 3 instruction differs on the intensity and frequency of instruction, the number of students within the groups and the level of progress monitoring” (Shapiro, 2015, para. 7). Depending on the RTI model chosen by the school system, these dimensions of instruction can be varied and defined accordingly. According to Bender and Crane (2010),

> Tier 1 instruction is the foundation for all instructional interventions in mathematics, and it should be considered the single most important tier in the intervention pyramid, since effective instruction at this level greatly reduces the number of students requiring more intensive instruction at other levels of the pyramid. (p. 3)

According to Shapiro (2015), if Tier 1 instruction is implemented with fidelity by well-trained, certified teachers, when most students receiving this instruction are assessed, they should be achieving at grade level in the measured skill areas (para. 3). When students do not respond to Tier 1, or the regular classroom instruction, this is the time they are moved to Tier 2 status.

Once a student is placed in Tier 2, the intensity of the instruction increases both in time and amount of instruction. These services and interventions are provided in small-group settings in addition to instruction in the general curriculum. “For those students, an RTI model relies on supplemental interventions delivered in small groups for at least 20 to 30 minutes daily” (Burns, 2010, para. 8). It is suggested that Tier 2 classes should be made up of five to eight students and can be taught by a general education teacher or an intervention specialist (Harlacher, n.d., para. 10). In Tier 2, data are used to determine the type of instruction the student may need. Burns (2010) noted Tier 2 interventions are critical for success in math, and there is strong evidence to support the effectiveness of the interventions if they include explicit and systematic instruction and (para. 8). "Tier 2 consists of children who fall below the expected levels of accomplishment (called benchmarks) and are at some risk for academic failure but who are still above levels considered to indicate a high risk for failure" (Shapiro, 2015, para. 9). During Tier 2 instruction, students are progress monitored to measure the effect of the intervention and if a student is not responding to the Tier 2 instruction, they will be moved to Tier 3 intervention. Bender and Crane (2010) suggested,

> The interventions in Tier 2 of the RTI pyramid have been described as targeted, supplemental, systematic interventions for a small group of students who are struggling in mathematics. Unlike the occasional small-group instruction in Tier 1, Tier 2 supplemental instruction is more targeted, and it takes place over a longer period of time, possibly a grading period or two. (p. 3)

Schools implementing effective Tier 1 and Tier 2 instruction should find about 20% of the student population is in need of Tier 2 support and should find no more than 5% of students requiring more intensive interventions than those provided in Tier 2 (Burns, 2010; Shapiro, 2015, para. 13), as displayed in Figure 4.

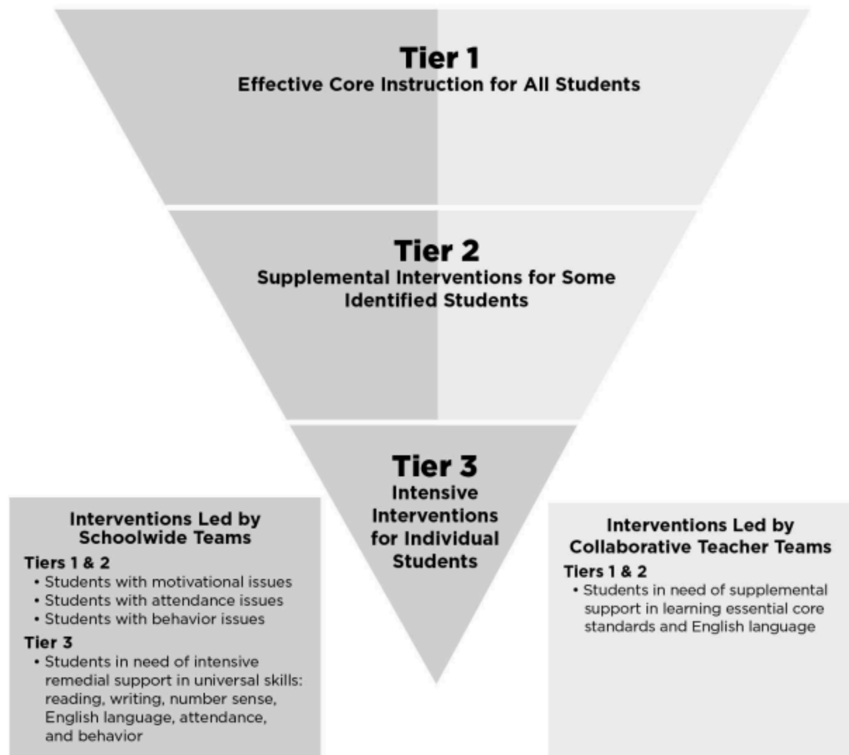

Figure 4. RTI Triangle.

When a student enters Tier 3 intervention, the intensity of the intervention should increase. RTI Action Network (n.d.) suggested that the students who do not achieve the desired level of progress in response to targeted interventions are then referred for a comprehensive evaluation and considered for eligibility for special education services under the Individuals with Disabilities Education Improvement Act of 2004 (para. 7). Tier 3 intervention classes should be made up of one to three students and be taught by an intervention specialist, content specialist, or special education teacher (Harlacher, n.d., para. 10). Shapiro (2015) stated, "Tier 3 consists of children who are considered to be at high risk for failure and, if not responsive, are considered to be candidates for identification as having special education needs" (para. 6). Bender and Crane (2010) described Tier 3 interventions within the three-tier RTI model as highly intensive educational interventions targeted at either one student or a very small group of students (p. 4). Tiered instruction is based on levels of instruction that are based on the needs and difficulties of the specific student; and with each tier, intensity of instruction increases (Bender & Crane, 2010, p. 6). It is important to discover the level where students are working successfully independently and where they are experiencing difficulties, or their ZPD.

Piaget's Theory of Constructivism

Vygotsky's theory of ZPD was developed from studies completed by Jean Piaget. Piaget introduced the idea that interaction and collaboration among students is vital and that the student is central to the learning process. Ozer (2004) suggested one of Piaget's central ideas was that a student's learning is affected by experiences, culture of the day, and physical and mental maturity (para. 1). Piaget explained four stages of psychological development in children and believed teachers should be aware of these stages to maximize learning. These four stages were Sensory-motor Stage, before the age of 2 where sensory and motor activities emerge; Preoperational Stage, from age 2 to age 7, where mental representation emerges; Concrete Operational Stage, from age 7 to age 11, where intelligence is based on concrete references; and the Formal Operational Stage, after age 11, where abstract thinking starts (Ozer, 2004, para. 4). Ozer stated that Piaget believed that children must be able to construct knowledge that is meaningful to them at each level and that classrooms should provide a variety of activities that allow for different stages of student ability within the classroom resulting in individualized learning and comprehension (para. 4-5). Piaget's belief was that a child could not learn until they were psychologically mature enough to do so, leading to a variety of teaching practices used to facilitate and advance student learning or differentiation in the classroom where students are active participants in their own learning (Atherton, 2013, para. 3). Bender and Crane (2010) noted that when the teacher and student can focus on specific skills and areas that challenge the student, the teacher is more able to monitor and provide differentiated instruction. The idea of differentiated instruction, along with the knowledge that some students struggle in the regular classroom setting, led to the development, in part, of the RTI framework.

Vygotsky's ZPD

Lev Vygotsky, unlike Piaget, believed that learning was a lifelong process and could not be placed into specific age ranges. The theory of ZDP, suggested by Vygotsky, stated that learning should be offered to each student that suits each child's readiness level in order to create the best opportunity for achievement and learning (Knestrick, 2012, para. 1). "Psychologist Lev Vygotsky coined the term zone of proximal development (ZPD) in the 1930s to describe the sweet spot where instruction is most beneficial for each student – just beyond his or her current level of independent capability" (Knestrick, 2012, para. 1). Kozulin (2003) referred to the ZPD as defined by Vygotsky as the measured distance between the development level of a child when involved in independent problem solving and the level of potential academic development of a child when involved in problem solving under adult guidance or in collaboration with more capable peers (p. 39).

Further, Vygotsky's theory suggested that when a less competent person interacts with a more competent person, the less competent person becomes more proficient (Kozulin, 2003, p. 41). According to Siyepu (2013), once a student, with assistance, masters a task, the assistance can then be removed and the learner will then be able to complete the task on his or her own (p. 6). When students reach a point of development they cannot overcome without help from a teacher or other person who is proficient in a skill, they are said to have reached that student's ZPD. In reference to teaching students who are struggling with a concept, Vogotsky's theory of ZPD suggested that teaching should focus on

> tasks inside the ZPD which the learner cannot do by him or herself but has the potential to accomplish with the guidance of others. As the learner accomplishes the task, his or her ZPD, or the gap between what he or she can do on their own and what he or she can only accomplish with assistance shrinks. (Shabani, 2010, p. 238)

Vygotsky concluded that social interaction and communication are essential components in a student's learning process (Steele, 1999, para. 1). Communication of mathematical ideas in smaller settings with adults leading the learning helps students solidify the mathematics concepts and abstract ideas by making language connections. According to Siyepu (2013), Vygotsky believed that "when a learner is at the ZPD for a particular task, providing the appropriate assistance will give the learner advancement to achieve the task" (p. 6). Steele (1999) stated,

> the conception of the ZPD suggests that a teacher can assist a child by providing the child with new information to assimilate with present knowledge, thus adding to the child's knowledge base-taking the student from the familiar to the unfamiliar. (para. 30)

The research of Vygotsky and other educational professionals promotes the idea that teachers should provide children in school with experiences that are within their ZPD, thereby encouraging and advancing their individual learning (Culatta, 2011, para. 2).

Along with ZPD, educators may use a method of instruction referred to as scaffolding to offer material to students performing at different levels. According to Knestrick (2012), instruction should focus on skills and knowledge that are attainable for students; and with constant feedback, or scaffolding, we know that students' learning and understanding can continue to develop at an appropriate pace (para. 4). Culatta (2011) described scaffolding as

> a process through which a teacher or more competent peer gives aid to the student in her/his ZPD as necessary, and tapers off this aid as it becomes unnecessary, much as a scaffold is removed from a building during construction. (p. 4)

Scaffolding allows students to master material at an individual pace and reduce the amount of help needed with a particular subject in the future. According to Knestick (2012), instruction focused within each student's ZPD is not too difficult or too easy but just challenging enough to help him or her develop new skills by building on those that have already been established (para. 2). After determining the ZPD of a student and creating a plan for scaffolding material or beginning an intervention program, choosing the correct program will be an important step.

Vmath

Vmath is a math intervention system for students who struggle in the basic concepts of math. "Vmath provides targeted math intervention that reinforces essential concepts, skills and strategies taught in the core math program" (Vmath Training Manual, 2012, p. 1). The program offers a systematic approach to instruction that is aimed at accelerating struggling students toward grade-level achievement. According to the National Math Panel (2008), "explicit instruction involving both teacher modeling and kids going through the steps in the models-in small groups or with the whole class or individually-seems to lead consistently to higher gains for kids that are struggling" (para. 4). The Vmath program is aligned with grade-level expectations and focuses on conceptual understanding, fluency in processes and computation, problem solving, communication and reasoning, mathematics vocabulary, alternative teaching strategies, and real-world connections. Vmath meets the grade-level expectations by providing daily, intensive, targeted math instruction and progress monitoring and a full range of assessments to guide teachers to identify strengths and weaknesses (Vmath Training Manual, 2012, p. 25). Voyager Sopris, the creator of the Vmath program, suggested there are five keys for successful implementation of the Vmath program. The first of these five components is the amount of time instruction is offered. Voyager recommended sessions of 30-45 minutes, 4-5 days a week. The second is the use of assessment to analyze performance, and trajectory of learning is necessary. The third key is the quality of instruction, using the three read process learned during teacher training session. The fourth key is differentiation within small groups in order to meet each child's needs at his or her specific level. Finally, classroom management is a necessity for differentiation and individualized learning to take place (Vmath Training Manual, 2012, p. 115).

Each of the progress monitoring assessments are designed to measure knowledge, progress, and mastery of the concept taught in the Vmath curriculum. The assessments administered are as follows: initial and final assessments, computational fluency benchmarks, computational fluency progress monitoring assessments that are curriculum-based measures of essential computational skills taught throughout the Vmath course, and curriculum-based progress assessments four times a year using pre and posttests for each module.

> One of the biggest challenges mathematics educators face is that some students are unmotivated to participate in math because they've seen so little success throughout their school careers," said George Logue, president of Voyager Sopris Learning. "Vmath Third Edition captures the interest of learners by scaffolding instruction to increase success, engaging them with relevant content, and integrating entertaining online learning components. (PR. N, 2014, para. 3)

Vmath is organized into eight modules, with several lessons contained within each of the modules. Teachers of the program are given explicit instructions in modeling, practice, and feedback. Vmath suggested that the teacher use the three-read practice where the first read is to get the gist of the lesson, the second read allows the teacher to focus on the blue part or scripted part of the text and the black part of the text or what the student should say. The third read focuses only on what the teacher says. All of the lessons have a clear objective and follow a four-step process. At the beginning of each lesson, step one is designed for the teacher to model the new concept, skill, or strategy for the day. Step two is designed for the students and teacher to discuss the problem and talk through the steps to solve the problem. Step three allows students to work on their own and learn through purposeful practice. Step four allows for daily informal assessments for the teacher to use for student understanding. At the beginning of each lesson is a real problem using math strategies to solve. A reteach component and an enrichment center activity is included for each skill (Vmath Training Manual, 2012, p.12). The upper levels of the Vmath program also offer hands-on manipulative lessons to further develop understanding.

Transmath

Transmath is another intervention math program developed by the Voyager Sopris

Company. Transmath is “a comprehensive mathematics intervention curriculum that teaches a balanced approach of computational skills and problem-solving applications” (Transmath Training Manual, 2010, p.1). Transmath is highly structured with multisensory strategies which offer explicit instruction to deepen a student’s conceptual understanding of mathematics skills and targets students who need immediate support lacking foundational skills necessary to enter Algebra or who have difficulty learning math. “Transmath helps students progress from a basic understanding of a concept to conceptual fluency, then a proficiency with that concept” (Transmath Teacher Resource Guide, 2010, p. 5). This program offers intensive intervention instruction, fewer topics in greater depth, conceptual-based verses procedural-based learning, ongoing assessment, conceptual understanding, fluency in key math concepts, communicating and reasoning, visual models, engagement strategies, distributed practice, building of number concepts, and problem solving. Transmath is aligned with the principles and standards of the National Math Panel Report Endorses Vmath Intervention Program Research Base (2008) and meets expectations of research by being daily, intensive, and targeted. This program uses a structured systematic approach to intervention to be used in conjunction with the core grade-level math instruction (Transmath Teacher Resource Guide, 2010, pp. 10-12).

Each lesson in Transmath has two strands, a building number concepts strand and a problem-solving strand with multistep problems and visual representations. In the first half of the lesson, students are taught number concepts and then they apply these concepts to engage in multistep problem solving in the second half of the lesson. Additionally, each Transmath lesson has differentiation strategies embedded into the lessons and *On Track!* extension activities online to allow for optional assignments as teachers see the need to assign.

Assessments are an integral part of the Transmath curriculum. The built-in program assessments place students at the correct entry point of the curriculum, establish a point for measuring student progress throughout the curriculum, provide information for adjusting the instruction or pacing for individual students, measure the critical mathematics skills through curriculum-based measures, and inform the teacher of student success (Transmath Training Manual, 2010, p. 2). The students take a placement and baseline test before they begin the Transmath curriculum and take part in progress-monitoring assessments and formative quizzes during the program. Table 5 displays a comparison of Vmath and Transmath.

Table 5

Comparison of Vmath and Transmath Programs

	Vmath	Transmath
Intended grade levels	Grades 2-8	Grades 5-10
Organization of lessons	Eight modules, with several lessons contained within each of the modules.	Each lesson in has two strands, a building number concepts strand and a problem-solving strand with multistep problems and visual representations.
Focus of program	Aligned with grade level expectations, and focuses on conceptual understanding, fluency in processes and computation, problem solving, communication and reasoning, mathematics vocabulary, alternative teaching strategies, and real-world connections.	Offers intensive intervention instruction, fewer topics in greater depth, conceptual-based verses procedural-based learning, ongoing assessment, conceptual understanding, fluency in key math concepts, communicating and reasoning, visual models, engagement strategies, distributed practice, building of number concepts and problem-solving.
Lesson format	Four-step lesson format. Step one: teacher models. Step two: discussion between students and teacher. Step three: independent practice. Step four: informal assessment.	Two-step lesson format. Step one: focus on number concepts with teacher instruction. Step two: multistep independent problem solving.

Table 5 highlighted that the Vmath and Transmath programs differ in the intended grade level, organization of lessons, focus of lessons, and lesson format. Due to these differences, the daily operation of the classes is slightly different, but the intention of the programs is the same. Even though the programs differ slightly, each program follows a scripted set of instructions and progression of skills. Voyager Sopris, the publisher of Vmath and Transmath, suggested following this script to ensure fidelity of implementation.

Fidelity of Implementation

When any program is implemented, the degree to which it is implemented with fidelity will determine the level of success of the program. "In the field of education, one broadly accepted definition of implementation fidelity does not exist, and often distinctions are made when defining fidelity within efficacy or effectiveness studies" (Crawford, Carpenter, Wilson, Schmeister, & McDonald, 2012, p. 224). In the RTI framework, fidelity of implementation refers to the degree to which the program is implemented as intended by the program developer, including the quality of implementation ("Using fidelity to enhance," n.d., para. 1). According to Fisher, Smith, Finney, and Pinder (2014), five common criteria should be considered when gathering implementation fidelity data: program differentiation, adherence, duration, quality of delivery, and participant responsiveness (p. 2). Program differentiation deals with the specific components and features of the particular program being offered. Adherence means the particular program features are being implemented. Duration refers to the intended time that is allotted for the program and adherence to that allotted time. Quality of delivery deals with the execution of the program and the quality of instruction. The responsiveness of the students deals with how well the students were engaged in the program (Fisher et al., 2014, p. 29). All of these elements are valuable in determining the effectiveness of a program. Achievement level alone cannot determine the effectiveness of a program.

When a teacher is implementing a program, whether for intervention or regular instruction, the ideals, beliefs, and planning strategies of the teacher become important to the success of the program (Crawford et al., 2012, p. 225). It is important to note that whatever program of instruction or intervention is implemented, research data show that deliberate planning and monitoring of implementation fidelity are necessary to ensure the desired outcomes of that program (VanDerHeyden, 2015, para. 16). In discussions developed around implementation fidelity, VanDerHeyden (2015) reported the most efficient way to monitor implementation fidelity is to track student performance. For example, "use the progress-monitoring data, and in areas where student performance is not adequate, conduct a direct observation of instruction in the classroom to determine the percentage of intervention steps that are being completed as planned" (VanDerHeyden, 2015, para. 18). McMaster et al. (2014) suggested when beginning a research-based program, teachers may wish to make minor changes that do not dramatically alter the procedures but rather constitute small "tweaks" to help a practice run more smoothly or to adapt it to a teacher's personal style (p. 178). This practice is acceptable unless the quality of delivery changes the relationship between the intention of the intervention and the fidelity with which it is implemented (Carroll et al., 2007, p. 6).

Implementation fidelity is important to both the intervention and the measured outcome or lack of outcome of that intervention. The importance of implementation fidelity cannot be overlooked. Crawford et al. (2012) suggested weak implementation of a program represents a threat to the validity of the outcomes of a program and at the same time acknowledged that implementing a program with fidelity in a school setting is rarely achieved (p. 225). According to Carroll et al. (2007),

Primary research into interventions and their outcomes should therefore involve

> an evaluation of implementation fidelity if the true effect of the intervention is to be discerned. Moreover, evidence-based practitioners also need to be able to understand and quantify the fidelity with which they are implementing an intervention. (p. 2)

Whether or not the fidelity of implementation can be measured and maximized in an educational setting, the concept cannot be ignored or overlooked. "The concept of implementation fidelity is currently described and defined in the literature in terms of five elements that need to be measured: adherence to an intervention, exposure or dose, quality of delivery, participant responsiveness, and program differentiation" (Carroll et al, 2007, p. 3).

Many programs are implemented in education; and to determine the fidelity of the implementation, assessments may be administered that are frequent, relevant, and actionable. "From an implementation point of view, any intervention is incomplete without a good measure to detect the presence and strength of the intervention as it is used in education practice ("Fidelity assessment," 2015, para. 3). The National Implementation Research Network (2015) suggested, "Evidence that the education innovation is effective when used as intended performance assessment results are highly correlated (e.g. 0.50 or better) with intended outcomes for students, families, and society" (para. 6). According to Carroll et al. (2007), the more that is done to help implementation through monitoring, feedback, and training, the higher the potential level of implementation fidelity achieved (p. 6). The degree of fidelity of implementation of a program can lead to the success or failure of that program. "Researchers have consistently found that students whose teachers implement curriculum with high fidelity made greater gains than their peers in low-fidelity classrooms" (Crawford et al., 2012, p.

225). When a program is implemented with fidelity but differences in student performance and growth still exist, there are other factors that must be considered.

Gender and Ethnicity Differences in Mathematics Achievement

Ignoring the idea that there are differences in the performance of math due to gender or ethnicity would be amiss. Tapia and Marsh (2000) suggested different attitudes and aptitudes exist by gender, ethnicity, cultural background, and instructional methods (p. 4). For many years, teachers have perceived differences and made comparisons between male and female students with regard to mathematical achievement as well as referencing the ethnicity of a student with regard to achievement. For a large percentage of students, teacher perception is true.

> The strongest evidence for the development of such gaps is found in nationally representative data collected by the U.S. Department of Education (D.O.E.). In particular, studies using the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999(ECLS-K) indicate that although the mean achievement of boys and girls is similar in kindergarten, a male advantage of about one quarter of a standard deviation emerges by the spring of third grade. (Robinson-Cimpian, Lubienski, Ganley, & Copur-Gencturk, 2014, p. 1)

Many of these differences may be socially constructed due to expectations placed on the student by the teacher and parents alike. Robinson-Cimpian et al. (2014) suggested research on teachers' interactions with students "identified ways in which boys appeared to be advantaged by teachers. Teachers tended to hold higher expectations for their male students, as was illustrated by the provision of more specific, positive feedback" (p. 2). In reference to teacher expectations, Parry (2012) stated that teachers historically tend to rate White girls' math abilities lower than those of White male students, even when the girls' grades and test scores are comparable to the boys' (para. 2).

For years, there has been a feeling that it is common practice for teachers to call on boys more in class, give preferential seating to the boys in the class, and pick material appealing to the boys in class. Scantlebury (2009) noted more than 2 decades ago that researchers identified and named groups of students who dominated the teacher's time and the classroom resources as target students who were typically white and male (para. 5). According to Scantlebury, many teachers say they are unaware of this disparity but do feel that girls are the better students than the boys, especially in the intermediate grades (para. 4). To keep the boys engaged and attentive, some teachers feel the classroom must be geared toward the males (Parry, 2012, para. 2). "Teachers often give girls less meaningful and less critical praise than boys. Boys' work is described as unique or brilliant, while girls' work is often undervalued, critically ignored, and praised for its appearance" (Scantlebury, 2009, para. 6). Therefore, gender bias is a real phenomenon in classrooms. Scantlebury suggested gender bias is especially prevalent in subjects such as mathematics and the sciences where there are different participation patterns for girls and boys (para. 3). "Gender bias promulgates a myth that boys are naturally better at mathematics and science than girls" (Scantlebury, 2009 para. 3). Parry (2012) stated evidence of a consistent bias against White females, suggesting that teachers hold the belief that math is just easier for White males than it is for White females (para. 3). According to the American Education Research Journal (n.d.), over the past decade, results from the National Assessment of Educational Progress (NAEP) have shown "small but persistent math gender disparities favoring males at fourth, eighth, and twelfth grades, with gaps of roughly 0.1 SDs, or the equivalent of a few months of schooling" (p. 270).

> Although many would argue that gender differences with respect to mathematics achievement are dependent on instructional and classroom environmental factors rather than innate differences between boys and girls, researchers have shown that gender differences in favor of male students continue on standardized mathematics tests and upper-level mathematics courses although there have been recent declines in this gap. (Petty, Wang, & Harbaugh, 2013, p. 1)

With regard to ethnicity and its effects on mathematics achievement, race and ethnicity tend to be the largest contributing factors to a student's achievement in mathematics (Petty et al., 2013, p. 2). "Due to pervasive, systemic barriers in education rooted in racial and gender bias and stereotypes, African American girls are faring worse than the national mean for girls on almost every measure of academic achievement" ("Barriers rooted," 2014, para. 1). Many reasons surfaced to explain the disparity that exists between African-American, Hispanic and White students' mathematics scores, but two arguments which have been around for years are that there is "a discontinuity between the home language and the school language of mathematics and the content of mathematics is so foreign to everyday experiences of the African American and Hispanic children that it makes it irrelevant" (Ladson-Billings, 1997, p. 687). According to ACT Research and Policy (2012), in 2011, Hispanic and African American high school graduates met ACT's College Readiness Benchmarks in mathematics at substantially lower rates than Asian and White graduates (para. 1).

Program Evaluation

Due to low mathematics achievement scores and the existence of the Vmath and Transmath programs already instituted at WMS, this study assessed the success of these two programs through an evaluation of each program individually. Before a program evaluation is performed, it is necessary to understand the purpose of the evaluation. "Evaluation is intended to enhance our understanding of the value of whatever is evaluated" (Fitzpatrick, Sanders, & Worthen, 2011, p. 263). It is crucial for an evaluator to understand the motivation for the program evaluation. Exploring the purpose of the evaluation, how the evaluation will be used, the elements of the program to be evaluated, the program logic or theory, the needed resources and timeframe, and the relevant contextual issues can discover this motivation (Fitzpatrick et al., 2011, pp. 261-262).

Logic models are widely used in program evaluation and help the evaluator make educated decisions. A logic model is used to provide stakeholders with a description of the relationship between the program and the program's results (W. K. Kellogg Foundation, 2004, p. 3). Fitzpatrick et al. (2011) noted, "logic models require evaluators to identify program inputs, activities, outputs, and outcomes, with outcomes reflecting longer-term objectives or goals or the program and outputs representing immediate program impacts" (pp. 159-160). According to the W. K. Kelloog Foundation (2004),

> a logic model is a systematic and visual way to present and share your understanding of the relationships among the resources you have to operate your program, the activities you plan, and the changes or results you hope to achieve. (p. 1)

Summary

Summarizing the literature that was investigated led to a better understanding of the RTI framework and tiered interventions as related to mathematics instruction and the methods that lead to improved student achievement. Two different programs were introduced and discussed as options for mathematics interventions and helping students close performance gaps. The idea of Piaget's Theory of Constructivism and Vygotsky's

ZPD was investigated as a basis for offering interventions to struggling students as well as introducing the evidence of gender and ethnicity as factors determining math performance. Considering the review of literature, a mixed-methods research study on the effectiveness of two mathematics intervention programs was conducted to determine which, if either, program provides evidence of closing gaps in mathematics achievement. A description of the design and methodology of the study follows in Chapter 3, an analysis of the findings in Chapter 4, and the conclusions and recommendations for further research in Chapter 5.

Chapter 3: Methodology

Introduction

According to the Education Commission of the States (2013), many middle school students in the United States are not working on grade level in mathematics. Finding a way to close achievement and performance gaps is an ever-growing and important issue facing educators in this country.

> The Program for International Student Assessment, or PISA, collected test results from 65 countries for its rankings, which come out every three years. The results, from 2012, show that U.S. students ranked below average in math among the world's most-developed countries. (Chappell, 2013, para. 2)

The Education Commission of the States noted that early development of mathematics skills is a greater predictor of future success for students, even in the area of reading achievement; surprisingly better than the development of early reading skills (para. 1). For many years, schools have taken on the challenge of improving reading and math skills and achievement scores in both areas. It is important for schools, especially elementary and middle schools, to increase the focus on mathematics instruction to ensure interventions are offered to struggling students. According to What Works Clearinghouse (2004),

> The call to improve mathematics education has also been driven by the widespread belief that competence in mathematics enables individuals to become informed and competent in a technology-dependent society. But that call for improvement has not been accompanied by evidence based recommendations for how to achieve it. (p. 5)

Even though many students benefit from differentiated instruction in the regular classroom setting or alternative assignments given by the classroom teacher ("Differentiating," 2005; Ferrara, 2010; Scott, 2012; Williams 2012), many other students need a focused mathematics intervention program to help them be successful and close gaps. According to Clements and Sarama (2015),

> High-quality education can help children mathematize. Without such education beginning in preschool, too many children, especially from low-resource communities, follow a path of failure in mathematics. However, present-day early childhood classrooms in many countries do not provide high quality mathematics experiences, with many children learning little over the course of an entire academic year and some regressing on certain skills. (para. 4)

To assure that all students are receiving adequate mathematics instruction, mathematics intervention programs are becoming more important and prevalent in many elementary, middle, and even high schools.

Research Questions

This research study combined both quantitative and qualitative data to answer research questions related to a program evaluation. The overarching question leading this study was,

> RQ1: How effective are the Transmath and Vmath programs when used as an intervention strategy for struggling middle grade math students?

In order to answer the overarching research question, quantitative data were used to analyze data related to Research Question 2, and qualitative data were used to analyze data related to Research Questions 3 and 4. The three additional questions this study addressed were,

> RQ2. What are the differences in the mean scores of the students involved in the

Vmath and Transmath intervention classes as measured by Moby Max?

RQ3. To what extent are the Vmath and Transmath programs being implemented with fidelity as measured by fidelity observations and teacher interviews?

RQ4. How do intervention teachers perceive the implementation and effectiveness of Vmath and Transmath?

Research Question 2 was measured quantitatively by comparing pre and posttest scores of the Moby Max universal screening tool. While comparing quantitative data, gender and ethnicity were considered. Table 6 highlights the demographic breakdown of WMS.

Table 6

Demographics of WMS

Asian	African American	Hispanic	American Indian	Two or More	Native Hawaiian	White	Other
2%	18%	12%	0%	3%	0%	63%	0%

Qualitative data were gathered through observations and teacher interviews in order to measure the extent to which the programs were implemented with fidelity.

This study involved both independent and dependent variables. An independent variable stands alone and is not changed by other measurable variables ("What are independent," n.d., para. 2). The independent variables in this study were the math intervention program, Vmath or Transmath; the grade level; the gender; and the ethnicity described as Majority or Minority of the selected students. This study measured the impact of these independent variables on the dependent variables. A dependent variable "is something that depends on other factors" (What are independent," n.d., para. 4). The dependent variable for this study was Moby Max assessment scores. These scores were used to measure growth from the beginning Moby Max assessment given at the beginning of the school year to successive Moby Max assessments given at the midpoint of the program and then at the end of the program.

Program Evaluation

Purpose. Programs implemented in any setting are only as valuable as can be measured by the intended purpose of that program. Fitzpatrick et al. (2011) noted the main reason a program evaluation is performed is to lead the researcher to make decisions about the value of the programs being evaluated (p. 13). The researcher performed a program evaluation of both Vmath and Transmath. According to Fitzpatrick et al., "if an evaluation were examining whether a program achieved its goals and that program failed, it was important to know whether the failure was an implementation failure or a theory failure" (p. 161). Program evaluation is a valuable tool for program managers who are seeking to strengthen the quality of their programs and improve outcomes for the children and youth they serve ("Research-to-results," n.d., para. 2). According to Research to Results (n.d.), a program evaluation is a systematic method for collecting, analyzing, and using information to answer basic questions about a program (para. 3). "Evaluation's primary purpose is to provide useful information to those who hold a stake in whatever is being evaluated (stakeholders), often helping them make a judgment or decision" (Fitzpatrick et al., 2011, p. 9). Because a portion of this study was to determine which, if either, of these programs yielded the most mathematics achievement growth for middle school students, program evaluation was a necessity. As this study determined, one of the programs was measured as more successful than the other; and the program evaluation was used as a valuable tool to present the findings to the stakeholders and decision makers within the school district.

Evaluation plan and procedures. The logic model was used as a framework for evaluating each of the two programs used in this study. “Logic models require program planners or evaluators to identify program inputs, activities, outputs and outcomes, with outcomes reflecting longer-term objectives or goals of the program and outputs representing immediate program impacts” (Fitzpatrick et al., 2011, pp. 159-160). Figure 5 outlines the evaluation method for Vmath.

Inputs	**Outputs**		**Outcomes—Impact**		
	Activities	*Participation*	*Short*	*Medium*	*Long*
*Training-2 sessions of program training after school for all teachers. *Teachers *Vmath grade level materials and online access to Voyager Sopris *Class schedules *NCEOG and pretest scores *Teacher recommendation *Bi-Weekly fidelity checks *Class observations *Teacher interviews	*Teacher Training *Monthly meetings to discuss progress monitoring *Bi-weekly fidelity observations *Teacher interviews *Class observations *Progress monitoring per program requirements *Baseline assessment *Moby Max Assessment (Pre, mid and post) *Benchmark assessment (Nov., and March)	*Teachers *Students placed in program *Researcher *Administration	*Awareness of gap areas in math achievement *Awareness of students who are in need of intervention *Knowledge of Vmath program, assessments, and program guidelines	*Closing of gaps as measured on mid-year Moby Max and Benchmark assessments	*Higher achievement on assessments and NCEOG *Students achieving on grade level math assignments

Assumptions	**External Factors**
Program is deployed with fidelity Teachers are trained Students are appropriately placed Pre and posttest are accurate measures of student achievement	District support for findings Trained teachers remain in current positions Students placed do not drop out of program Administration supports program research

Figure 5. Vmath Logic Model.

Figure 6 outlines the evaluation model for Transmath.

Inputs	Outputs		Outcomes—Impact		
	Activities	*Participation*	*Short*	*Medium*	*Long*
*Training-2 sessions of program training after school for all teachers. *Teachers *Transmath grade level materials and online access to Voyager Sopris *Class schedules *NCEOG and pretest scores *Teacher recommendation *Bi-Weekly fidelity checks *Class observations *Teacher interviews	*Teacher Training *Monthly meetings to discuss progress monitoring *Bi-weekly fidelity observations *Teacher interviews *Class observations *Progress monitoring per program requirements *Baseline assessment *Moby Max Assessment (Pre, mid and post) *Benchmark assessment (Nov., and March)	*Teachers *Students placed in program *Researcher *Administration	*Awareness of gap areas in math achievement *Awareness of students who are in need of intervention *Knowledge of Transmath program, assessments, and program guidelines	*Closing of gaps as measured on mid-year Moby Max and Benchmark assessments	*Higher achievement on assessments and NCEOG *Students achieving on grade level math assignments

Assumptions	External Factors
Program is deployed with fidelity Teachers are trained Students are appropriately placed Pre and posttest are accurate measures of student achievement	District support for findings Trained teachers remain in current positions Students placed do not drop out of program Administration supports program research

Figure 6. Transmath Logic Model.

Mixed-Methods Approach

Mixed-method research is conducted when both qualitative and quantitative data are analyzed to provide the researcher with information needed to better understand a problem (Creswell, 2005, p. 510). Creswell and Plano (2011) suggested there are several definitions for mixed-methods research that can be traced back to as early as 1989; however, they also suggested that the present definition should incorporate many diverse viewpoints (p. 5). Creswell and Plano mentioned key components in a mixed-methods study to which a researcher should adhere:

> Collecting and analyzing both qualitative and quantitative data, based on research questions, mixing the two forms of data by combining them, giving priority to one or both forms of data, using these procedures in a single study, framing these procedures within philosophical worldviews and theoretical lenses, and combining the procedures into specific research designs that direct the plan for conducting the study. (p. 5)

Acccording to Hesse-Biber (2010), in earlier research by Greene, Caracelli and Graham, there were five specific reasons researchers should consider using mixed methods. The first reason is triangulation of data. Triangulation "refers to the use of more than one method while studying the same research question in order to examine the same dimension of a research problem" (Hesse-Biber, 2010, p. 3). The second reason for conducting a mixed-methods study is complementarity. "Complementarity allows the researcher to gain a fuller understanding of the research problem and/or to clarify a given research result" (Hesse-Biber, 2010, p. 4). The third reason for using mixed methods is development. Mixed methods often aid in the development of a research project by creating a synergistic effect, whereby the "results from one method help develop or inform the other method" (Hesse-Biber, 2010, p. 5). The fourth reason for using mixed methods is initiation. "A study's findings may raise questions or contradictions that will require clarification, thus initiating a new study" (Hesse-Biber, 2010, p. 5). And finally, a fifth reason to use mixed methods is expansion. Expansion is intended to "extend the breadth and range of the inquiry" (Hesse-Biber, 2010, p. 5). According to Spillman (2014), comparing qualitative and quantitative data "enables the researcher to simultaneously answer confirmatory and exploratory questions, and therefore verify and generate theory at the same time" (p. 197).

Research Participants and Settings

The participants in this research project were sixth, seventh, and eighth grade middle school students at a traditional middle school located in rural western IS in North Carolina. There were 662 sixth through eighth graders, 42 classroom teachers, four exceptional education teachers, one low incidence self-contained exceptional education teacher, two teacher assistants in the LI classroom, one media specialist, one principal, one assistant principal, one Instructional Facilitator, one Blended Learning Coach hired to facilitate the deployment of the MacBook Airs, one Student Assistance Program coordinator, one full-time school counselor, and one School Resource Officer at this school. The 2014-2015 test scores were lower than the district and the state in all grade levels in reading and math. All of the subgroups at this school scored well below the district and state mean. This school had students who fell into each of the race/ethnicity subgroups except Pacific Islanders, with the largest subgroups being White, African American, and Hispanic/Latino.

The 134 students, 21% of the student population, placed in the Vmath and Transmath intervention classes historically scored below grade level on the NCEOG mathematics assessment as well as local benchmark and common assessments. The process for placing students in an intervention class at this school used several data points. The data used to place intervention students was NCEOG mathematics scores, scores on the placement test in Moby Max, scores of the district level Baseline Assessment, and teacher recommendation. Table 7 notes the gender and ethnic breakdown of the students placed in Vmath classes.

Table 7

Gender and Ethnicity of Students Placed in Vmath

Grade Level	Gender (Male/Female)	Ethnicity (Majority/Minority)	Total
Sixth Grade	15/11	14/12	26
Seventh Grade	13/15	12/16	28
Eighth Grade	10/15	15/10	25

Table 7 included data that described gender and ethnicity of the students placed in Vmath, indicating 15 of the 26 sixth graders (or 58%) were male, and 14 (or 54%) fell in the Majority ethnic group. Thirteen of the 28 seventh graders (or 47%) were male, and 12 (or 43%) fell in the Majority ethnic group. Ten of the 25 eighth graders (or 40%) were male, and 15 (or 60%) fell in the Majority ethnic group.

Table 8 highlights the gender and ethnicity breakdown of students placed in Transmath classes.

Table 8

Gender and Ethnicity of Students Placed in Transmath

Grade Level	Gender (Male/Female)	Ethnicity (Majority/Minority)	Total
		1	
Sixth Grade	10/11	4/7	21
Seventh Grade	8/7	5/10	15
Eighth Grade	9/10	9/10	19

Table 8 indicated when observing gender and ethnicity of the students placed in Transmath, 10 of the 21 sixth graders (or 48%) were male, and 14 (or 67%) fell in the

Majority ethnic group. Eight of the 15 seventh graders (or 53%) were male, and five (or 33%) fell in the Majority ethnic group. Nine of the 19 eight graders (or 47%) were male, and nine (or 47%) fell in the Majority ethnic group.

Research Procedures

The students placed in the Vmath and Transmath classes were identified using the same procedure the school uses to place students in any intervention class. Growth in the students' achievement scores in Vmath and Transmath were based on pre and posttest scores from Moby Max. Using Moby Max as a universal screening tool, a grade level equivalency score for each student was determined. Moby Max measured student achievement by year and month in school. For example, a student who scored a 3.2 achieved at a third grade, second month level in mathematics.

Because there were so many students who were below grade-level expectations, (423 of the 662 students, or 64% of the student body), it was decided to take students whose scores placed them at third-grade level or below and place them in an intervention. Two classes of Vmath and two classes of Transmath were created per grade level. Moby Max scores fell into a broad range, so the students were placed into Vmath or Transmath based on ranges. The Moby Max scores used to place students in each intervention class are displayed in Table 9.

Table 9

Moby Max Scores Used to Place Students in Transmath and Vmath

Transmath	Vmath
0-1.5	>1.5-3.0

Table 9 highlighted that the students who received a Moby Max score of 0-1.5

were placed in Transmath, and those who scored greater than 1.5-3.0 were placed in Vmath. The Transmath students were placed in this program because Transmath was developed for students in Grades 5-10 and offered fewer topics within the curriculum, taught in greater depth. Transmath also offered lessons focused on foundational material from earlier grades. For the lowest achieving students, "the content of interventions should include foundational concepts and skills introduced earlier in the student's career but not fully understood and mastered" ("Assisting students struggling," 2009, p. 7).

Students who received a Moby Max score of greater than 1.5 to 3.0 were placed in Vmath, a program designed for Grades 2-8. Vmath is aligned with grade-level expectations (i.e., if a student was in sixth grade, they would be placed in a level for sixth-grade intervention) and focuses on conceptual understanding, fluency in processes and computation, problem solving, communication and reasoning, mathematics vocabulary, alternative teaching strategies, and real-world connections. "Whenever possible, links should be made between foundational mathematical concepts in the intervention and grade-level material" ("Assisting students struggling," 2009, p. 7). Transmath is a program that focuses on conceptual skills and therefore takes a student who is multiple grade levels behind and reteaches math concepts. This program is used with students who are identified as the most at risk. Both of these interventions have been used in this school district and in this particular middle school, but school officials have not determined which program provides the best opportunity to allow for student growth.

Intervention Times

Vmath and Transmath were offered each day during Mustang Time and Discovery Time. Mustang Time was a 45-minute period during the regular school day set aside for intervention and enrichment classes. During Mustang Time, every student in the school was placed in an enrichment class he or she chose such as Chess, Robotics, or Battle of the Books. Students who met the criteria were placed in an intervention class such as Vmath, Transmath or Language Live. The students who were placed in these intervention Mustang Time classes were not allowed to choose an enrichment class; however, 80% of the student population at WMS was placed in an intervention Mustang Time, either reading or math; so this lack of choice did not cause these students to feel singled out or like they were denied an opportunity to take another class. Discovery Time was another 45-minute period during the regular school day created during an extended lunch period. During the lunch period, time was protected to be able to implement more intervention classes taught by the computer, P.E., and music teachers (enhancement teachers). There were two Vmath classes and two Transmath classes per grade level.

All teachers assigned a Mustang Time class were assigned based on individual strengths or interests. The Mustang Time intervention classes were assigned by the principal based on the teachers' willingness and ability to teach an intervention. The Discovery Time teachers were given the option to teach a Discovery Time class or cover cafeteria duty during Discovery Time. The enhancement teachers who chose to teach a class were assigned by the principal to teach either Vmath or Transmath. The three EC teachers were assigned Transmath, only because they had some knowledge of the program since it had been previously used in the EC program. Not all of the Transmath teachers, however, had specifically taught the program. All of the other classes were assigned randomly. Once all of the teachers were assigned classes, the Instructional Facilitator trained the teachers who were chosen to teach each class in the respective programs.

Intervention Teachers

Teacher A. Teacher A had been teaching for 8 years. He was an EC teacher with a background in elementary and secondary education. He taught both reading and math in the inclusion setting in sixth grade as well as a pullout resource math class. He taught sixth-grade Transmath during Mustang Time.

Teacher B. Teacher B had not been in a classroom before. This year was his first year teaching as the band director. He recently graduated from college with a Bachelor's degree in Music Education. He was teaching sixth-grade Transmath during Mustang Time.

Teacher C. Teacher C had been teaching for 17 years. She was a Career and Technical Education (CTE) teacher with middle and high school experience in the classroom. She had never taught any other subject, but she had taught Vmath in the past. She was teaching sixth-grade Vmath during Mustang Time.

Teacher D. Teacher D had been teaching for 2 years. She was a sixth grade science teacher who had elementary experience as a teacher assistant. She was teaching sixth-grade Vmath during Mustang Time.

Teacher E. Teacher E had been teaching for 11 years. She was a CTE teacher with only middle school experience in the CTE classroom. She was teaching seventh-grade Transmath during Discovery Time.

Teacher F. Teacher F had been teaching for 7 years. She was an EC teacher with a background in elementary and secondary education. She taught both reading and math in the inclusion setting in seventh grade and resource reading in a small pullout classroom setting in seventh grade. She taught seventh-grade Transmath during Mustang

Time.

Teacher G. Teacher G had been teaching for 29 years. She was a seventh grade social studies teacher with middle and high school experience. She was teaching seventh-grade Vmath during Mustang Time.

Teacher H. Teacher H had been teaching for 12 years. She was a CTE teacher with middle and high school experience in the classroom. She had never taught any other subject, but she had taught Vmath in the past. She was teaching seventh-grade Vmath during Mustang Time and eighth-grade Vmath during Discovery Time.

Teacher J. Teacher J had been teaching for 6 years. She was an EC teacher with a background in elementary and secondary education. She taught both reading and math in the inclusion setting in eighth grade and resource math in a small pullout classroom setting in eighth grade. She taught eighth-grade Transmath during Mustang Time.

Teacher K. Teacher K had been teaching for 25 years. She was an eighth grade science teacher with experience in middle school science and math. She was teaching eighth-grade Vmath during Mustang Time.

Teacher L. Teacher L had been teaching for 30 years. He was an eighth grade science teacher with middle and high school experience in science. He taught Transmath last year and was teaching eighth-grade Transmath this past year during Mustang Time. A summary of these teachers and their responsibilities is displayed in Table 10.

Table 10

Vmath and Transmath Teachers

Teacher	Teaching experience	Teaching Area	Experience with intervention	Grade level and intervention	Class period
A	8 years	EC reading and math	None	6th Transmath	Mustang Time
B	1st Year	Band	None	6th Transmath	Mustang Time
C	17 years	CTE	2 years Vmath	6th Vmath	Mustang Time
D	2 years	Science	None	6th Vmath	Mustang Time
E	11 years	CTE	None	7th Transmath	Discovery Time
F	7 years	EC reading and math	None	7th Transmath	Mustang Time
G	29 years	Social Studies	None	7th Vmath	Mustang Time
H	12 years	CTE	1 year Vmath	7th Vmath 8th Vmath	Mustang Time Discovery Time
J	6 years	EC reading and math	None	8th Transmath	Mustang Time
K	25 years	Science	None	8th Vmath	Mustang Time
L	30 years	Science	1 year Transmath	8th Transmath	Mustang Time

The information displayed in Table 10 noted that the teachers assigned to teach the Vmath and Transmath intervention classes had varying amounts of teaching experience, teaching background, exposure to math concepts, and experience teaching interventions. While the knowledge that the differing levels of experience with this program may have effected growth scores, the researcher acknowledged the inability to control the teachers who were chosen to teach the classes. In response to the different experience levels, all of the teachers received the same training and preparation to teach the classes.

Research Instrumentation

This research study triangulated both quantitative and qualitative data. "The purpose of a triangulation mixed methods design is to collect both quantitative and qualitative data, merge the data, and use the results to understand a research problem" (Creswell, 2005, p. 514). The instruments used during this study produced data that were used to compare the achievement level of students at the beginning of the intervention to the achievement level at the end of intervention. "Using data to inform instructional decisions leads to improved student outcomes" ("2x learning," n.d., para. 1).

Quantitative instrument. The instrument that the researcher used to collect comparable quantitative data was Moby Max.

Moby Max. Moby Max is a completely integrated program for Grades K-8 curriculum. Within Moby Max is an assessment tool based on Common Core standards. This assessment measures the performance level and grade-level equivalency of the student. Reliability and validity are important aspects of any measurement tool. Reliability of a tool is concerned with whether the use of the tool yields consistent and stable results over time. Validity refers to the degree to which what is being measured is what is hoped to be measured (QMSS, n.d., para. 3-5). When asked about the validity of the Moby Max program, a representative from the company stated, "Moby Max is not currently peer reviewed; although this has been heavily requested so it's definitely on our radar. However, Moby Max's research-based pedagogy incorporates multiple cognitive techniques that have proven highly effective in thousands of research studies" (J. Jehanna, personal communication, December 14, 2015).

Qualitative instruments. The researcher collected two forms of qualitative data.

Program fidelity data were compiled every 2 weeks by using a fidelity observation form (Appendix A); and a teacher interview form (Appendix B) was used at the end of implementation to perform interviews with each intervention teacher. The math department at WMS and district intervention personnel in IS reviewed both of these forms to validate the content.

NCDPI fidelity observation form. The Voyager Math form (Appendix A) was available through NCDPI and was created specifically to determine the fidelity of implementation for both Vmath and Transmath. This form was used each time the researcher observed the classroom. The observations focused on the quality of instruction, the use of the curriculum, student engagement, the amount of time instruction was offered, the use of the program assessment materials, and differentiation within the classroom. The researcher received permission to use the NCDPI fidelity form.

Teacher interview form. The teacher interview performed by the researcher focused on the specific curriculum and the teacher's experience with the class, the implementation of the curriculum and how successful each teacher felt, the support each teacher received during the training and implementation of the class, and the beliefs and educational practices of the teacher. Dawn Davis, as part of her dissertation, developed the form used as the teacher interview protocol. The researcher received permission to use the teacher interview form (Appendix B). Results from the interviews were compared to the observational data to determine the degree to which the programs were being implemented with fidelity.

Research Design

This study was a mixed-methods design and addressed and compared the amount of growth in mathematics achievement when nonrandom, convenience populations of students were immersed in two different mathematics intervention programs, Vmath and Transmath. A convergent parallel mixed-methods design was used where qualitative and quantitative data were collected in parallel, analyzed separately, and then merged. In this study, pre and posttest scores as measured by Moby Max scores were used to test the theory that predicted Vmath and Transmath would positively influence the academic growth for middle school students at WMS. The Moby Max assessment was given three times during the study. This assessment was cumulative and measured the same skills at each scheduled assessment. The initial assessment was given at the beginning of the year, and subsequent assessments were given twice more throughout the school year. The fidelity observations explored the degree of fidelity to which the programs were implemented for middle school students at this school, and the teacher interviews measured the perceptions of the intervention teachers with respect to implementation and effectiveness of the programs. Implementation fidelity cannot guarantee success of a program; but when a program is not implemented with fidelity, any success or failure of the program cannot be determined due to inconsistencies in the intended presentation of the program. The reason for collecting both quantitative and qualitative data was to triangulate the data and determine if a correlation was present between academic growth using a particular intervention program and the fidelity of implementation of the program. "The purpose of a triangulation mixed methods design is to simultaneously collect both quantitative and qualitative data, merge the data, and use the results to understand a research problem" (Creswell, 2005, p. 514).

Role of the Researcher

The researcher was an Instructional Facilitator and Media Coordinator at the school where this study was taking place. The duties of the Instructional Facilitator were to oversee all of the instructional practices in the school, coach and instruct teachers on best practices, and oversee all of the RtI processes and school-wide interventions. The duties of the Media Coordinator were to operate the media center, purchase and manage the collection of resources within the school, co-teach with core and enhancement teachers, and manage the technology within the school building. The researcher was present in the school and was therefore able to observe teachers and students during the intervention times and collect needed data. At no time was the researcher in a position to evaluate the job performance of the teachers involved in this study, and at no time was the researcher a participant in the instruction during the intervention classes. The researcher trained all of the teachers involved in these intervention classes, only after being trained by a representative from the Voyager Sopris Company. During the training, the researcher, along with a coworker also trained by the company, used the training manual as a guide to insure all teachers were receiving the same information and guidance in carrying out the math intervention. The researcher kept all of the data and responses confidential. All of the teachers and students involved in the study were informed of their right to agree or not to take part in the study. Additionally, the researcher received approval from the principal of the middle school where this study took place and the Institutional Review Board (IRB) from IS (Appendix C).

Data Analysis

To analyze the collected quantitative data, the researcher ran an analysis of covariance (ANCOVA). Urdan (2010) defined ANCOVA as the idea to test whether there are differences between groups on a dependent variable after controlling for the effects of a different variable or set of variables (p. 125). Due to the student selection process, the Vmath and Transmath groups of students were unequal. The disparity at the beginning was statistically corrected using an ANCOVA, with the pretest being the covariate. A covariate is a "continuous control variable that is observed rather than manipulated but can affect the outcome of an experiment or study" (ANOVA, n.d., para. 2). According to Field (2012), an ANCOVA looks at the relationship between the dependent variable and the covariate (p. 1). The researcher compared the dependent variable assessment scores in Moby Max for both math intervention programs, Vmath and Transmath. This research study combined both quantitative and qualitative data to answer research questions related to a program evaluation. The overarching question leading this study was,

RQ1: How effective are the Transmath and Vmath programs when used as an intervention strategy for struggling middle grade math students?

In order to answer the overarching research question, quantitative data were used to analyze data related to Research Question 2, and qualitative data were used to analyze data related to Research Questions 3 and 4. The three additional questions this study addressed were,

RQ2. What are the differences in the mean scores of the students involved in the Vmath and Transmath intervention classes as measured by Moby Max?

RQ3. To what extent are the Vmath and Transmath programs being implemented with fidelity as measured by fidelity observations and teacher interviews?

RQ4. How do intervention teachers perceive the implementation and effectiveness of Vmath and Transmath?

The fidelity form rated each aspect of program implementation fidelity on a scale of 0 (skill not demonstrated) to 3 (appropriately implemented), giving the researcher a scale to analyze and data to answer Research Question 3. The teacher interviews were used to evaluate teacher perceptions of Vmath and Transmath with respect to implementation and effectiveness. The interviews answered the fourth research question. The interviews were recorded and later transcribed and theme coded by the researcher.

Limitations

Limitations are influences that the researcher cannot control. During the timespan of this study, there were several issues that could be limitations to the validity of the outcome of this study. First, there were students who left the intervention class due to movement from the school, offering an issue of mortality. Mortality can cause a threat to the validity of the research if an unequal or large number of students leave the study. There were several issues with teachers not following the scripted program or the schedule of assessments leading to a lack of fidelity. The researcher's observations were a valuable tool in recording the level of fidelity to which each teacher was implementing the program with reference to the script and assessment schedule.

Delimitations

Delimitations are choices made by the researcher. The identity of all participants, students, and teachers was protected. The researcher received information from tests using a coding system where only the intervention teacher had names of students and assessment information. All interviews were anonymous, taped, transcribed, and theme coded by the researcher; and observations were made with a coworker trained on the observation tool to prevent researcher bias. All data were stored in a locked cabinet at the researcher's home, and all work was saved on the researcher's home computer and flash drive away from the school setting.

Summary

At the completion of this study, information gathered produced data that helped administrators and intervention specialists within IS choose the most effective math intervention program, Vmath or Transmath, to use at the middle school level. These two programs have been purchased by the school system, Transmath for the past 5 years and Vmath for the past 3 years; however, with the most recent budget issues, it was important to choose the most effective programs to continue to fund. At the conclusion of this study, decision makers have more concrete information they need to make a determination on the intervention program that can yield the highest mathematics achievement growth in middle school students or if these programs are not valuable to use as intervention strategies and other options need to be explored.

Chapter 4: The Results

Introduction

For this study, the researcher evaluated two math intervention programs to determine the effectiveness of each with regard to implementation fidelity, teacher perception, and student growth. Overall, the purpose of the dissertation was to analyze how the perceptions of teachers regarding factors of the math intervention programs affected the implementation, the level of implementation fidelity, and the actual student growth as measured by Moby Max. This chapter first provides information about the research questions and participants in the study. Next, each research question is answered with a description of the quantitative and qualitative data analysis related to each question, using tables and figures and accompanied by narrative. Finally, this chapter concludes with a summary of the analyses and findings.

Research Questions

This research study combined both quantitative and qualitative data to answer research questions related to a program evaluation of two middle school math intervention programs. The overarching question leading this study was,

RQ1: How effective are the Transmath and Vmath programs when used as an intervention strategy for struggling middle grade math students?

In order to answer the overarching research question, quantitative data were used to analyze data related to Research Question 2, and qualitative data were used to analyze data related to Research Questions 3 and 4. The three additional questions this study addressed were,

RQ2. What are the differences in the mean scores of the students involved in the Vmath and Transmath intervention classes as measured by Moby Max?

RQ3. To what extent are the Vmath and Transmath programs being implemented with fidelity as measured by fidelity observations and teacher interviews?

RQ4. How do intervention teachers perceive the implementation and effectiveness of Vmath and Transmath?

The researcher collected the quantitative data used to answer Research Question 2 by conducting a pretest and posttest using Moby Max as the assessment tool. The qualitative data used to answer Research Questions 3 and 4 were collected by gathering data related to individual teacher interviews and classroom observations. All of the data reported in this study were verified by a Ph.D. student in Statistical and Measurement Methods from the Department of Research and Evaluation Methodology at the University of Florida.

Participant Demographics

The participants included in this study were 11 middle school teachers and 132 middle school students. Table 11 highlights each teacher's experience level with the intervention programs as well as years of teaching experience, intervention taught, and grade level taught.

Table 11

Vmath and Transmath Teachers

Teacher	Teaching experience	Teaching area	Experience with intervention	Grade level and intervention	Class period
A	8 years	EC reading and math	None	6th Transmath	Mustang Time
B	1st Year	Band	None	6th Transmath	Mustang Time
C	17 years	CTE	2 years Vmath	6th Vmath	Mustang Time
D	2 years	Science	None	6th Vmath	Mustang Time
E	11 years	CTE	None	7th Transmath	Discovery Time
F	7 years	EC reading and math	None	7th Transmath	Mustang Time
G	29 years	Social Studies	None	7th Vmath	Mustang Time
H	12 years	CTE	1 year Vmath	7th Vmath 8th Vmath	Mustang Time Discovery Time
J	6 years	EC reading and math	None	8th Transmath	Mustang Time
K	25 years	Science	None	8th Vmath	Mustang Time
L	30 years	Science	1 year Transmath	8th Transmath	Mustang Time

Table 11 highlighted the fact that the teachers involved in this study were diverse in their concentrations and their years of experience. The gender and ethnicity for each student included in Vmath is reported in Table 12.

Table 12

Gender and Ethnicity of Students Placed in Vmath

Grade Level	Total	Gender (Male/Female)	Ethnicity (Majority/Minority)
Sixth Grade	26	15/11	14/12
Seventh Grade	28	13/15	12/16
Eighth Grade	24	9/15	14/10

The study began with a total of 25 eighth-grade students; however, one student was removed from the study due to relocation to another school. Male students outnumbered female students in sixth grade only, and the ethnicity of both sixth and eighth grade consisted of a higher number of White (classified as Majority students) as compared to African American and Hispanic (classified as Minority students). For each student included in Transmath, the gender and ethnicity is reported in Table 13.

Table 13

Gender and Ethnicity of Students Placed in Transmath

Grade Level	Total	Gender (Male/Female)	Ethnicity (Majority/Minority)
Sixth Grade	21	10/11	14/7
Seventh Grade	15	8/7	5/10
Eighth Grade	18	9/9	8/10

This study began with 19 eighth-grade students; however, one student was removed from the intervention group because the teacher and the principal felt the student no longer needed the intervention based on progress monitoring assessments. Male students outnumbered female students in seventh grade only, and the ethnicity of both seventh and eighth grade consisted of a higher number of African American and Hispanic, or Minority students, as compared to White, or Majority, students. Students participated in the Vmath or Transmath intervention for the school year 2015-2016, beginning in September 2015 and ending in April 2016.

Quantitative Data Collection and Analysis

The researcher used collected data from Moby Max, teacher interviews, and classroom observations to answer the research questions for this study. The Moby Max data were collected as a pre and postassessment to measure growth for the year of instruction. Teacher interviews were performed from March to April 2016, and classroom observations were performed every 2 weeks from February to April 2016, for a total of six observations per class.

The overarching question for this study was,

RQ1: How effective are the Transmath and Vmath programs when used as an intervention strategy for struggling middle grade math students?

To answer this question and determine if Research Question 2 (What are the differences in the mean scores of the students involved in the Vmath and Transmath intervention classes as measured by Moby Max?) could be answered, a paired-sample *t* test was conducted to compare the Moby Max pre and postassessment outcomes.

A *t* test was performed because it shows the differences between scores for two groups and the measure of variability of the scores (Trochim, 2006, par.4). This *t* test was used to compare the Moby Max pre and postassessments to determine if there was a significant difference. A significance level, or alpha (α), is the probability (p value) of rejecting the null hypothesis when it is true (Runkel, 2015, para. 3). A significance level of α=0.05 indicates a 5% chance that something is not likely to happen. The choice of a p value at α=0.05 follows a common rule and is commonly selected in social science. Students were assessed at the beginning of the school year using the assessment module in Moby Max. Once all students were tested, they were placed in either Vmath or Transmath. These same students were assessed at the end of the program, again using the assessment module in Moby Max. Table 14 shows the mean pre and postassessment scores and mean change in scores for Vmath students in Grades 6, 7 and 8.

Table 14

Vmath Mean Pre and Postassessment Scores

Grade	Mean Preassessment Score	Mean Postassessment Score	Total Change
6	2.7	4.2	+1.5
7	2.7	4.7	+2.0
8	2.8	4.5	+1.7

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper			
Pair 1	MM1 - MM2	-1.7192	.5954	.0674	-1.8535	-1.5850	-25.500	77	.000

Figure 7. Paired-Sample *t* Test for Vmath.

As noted in Table 14, each grade level experienced growth according to Moby

Max scores. The data were statistically analyzed using a paired-sample *t* test to determine if the difference in the scores were significant. The results of this statistical analysis are shown in Figure 7. The paired-sample *t* test, seen in Figure 7, was conducted with Vmath to compare the pre and postassessment scores for sixth-, seventh-, and eighth-grade students. The analysis produced a significant *t* value ($t_{(77)}$=-25.500, p=0.00). A closer examination of the difference in mean scores showed a growth of 1.7192 grade levels for the Vmath students between the pre and postassessment and a significant *t* value. The descriptive statistics suggested a significant difference existed in the pre and posttest means of Vmath students in sixth, seventh and eighth grades.

Table 15 shows the mean pre and post Moby Max assessment scores and mean change in scores for Transmath students in Grades 6, 7 and 8.

Table 15

Transmath Mean Pre and Postassessment Scores

Grade	Mean Preassessment Score	Mean Postassessment Score	Total Change
6	1.3	4	+2.7
7	1.3	3.9	+2.6
8	1.3	3.9	+2.6

Table 15 highlighted that each grade level experienced growth according to Moby Max scores. The data were statistically analyzed using a paired-sample *t* test to determine if the difference in the scores were significant. The results of this statistical analysis are shown in Figure 8.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	MM1 - MM2	-2.7167	.5709	.0777	-2.8725	-2.5608	-34.967	53	.000

Figure 8. Paired-Sample *t* Test for Transmath.

The paired-sampled *t* test seen in Figure 8 was conducted with Transmath to compare the pre and postassessment scores for sixth-, seventh- and eighth-grade students. The analysis produced a significant *t* value ($t_{(53)}$=-34.967, p=0.00). A closer examination of the difference in mean scores showed a growth of 2.7167 grade levels for the Transmath students between the pre and postassessment and a significant *t* value.

RQ2. What are the differences in the mean scores of the students involved in the Vmath and Transmath intervention classes as measured by Moby Max?

A one-way ANCOVA was conducted using the Vmath and Transmath data to answer Research Question 2. An ANCOVA was chosen over an analysis of variance (ANOVA) due to the disparity of scores at the beginning of this study. This disparity was statistically corrected with the pretest being the covariate. A covariate is a "continuous control variable that is observed rather than controlled but can affect the outcome of an experiment or study" (ANOVA, n.d., para. 2). According to Field (2012), an ANCOVA looks at the relationship between the dependent variable and the covariate (p. 1).

The independent variables for this ANCOVA were the Moby Max preassessment scores (MM1) and the two different intervention groups, Transmath and Vmath. The dependent variable for this ANCOVA was the Moby Max postassessment scores (MM2) for the two intervention groups, Transmath and Vmath. Figure 9, ANCOVA of between-subjects effects, notes the overall growth of both groups of students.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13.519[a]	2	6.760	19.646	.000
Intercept	13.514	1	13.514	39.277	.000
MM1	6.339	1	6.339	18.424	.000
Group	**2.177**	**1**	**2.177**	**6.327**	**.013**
Error	44.386	129	.344		
Total	2457.480	132			
Corrected Total	57.905	131			

Figure 9. ANCOVA of Between-Subject Effects.

The data reported in Figure 9 indicated the differences in pre and postassessment scores between Transmath and Vmath were significant for $F(1, 132)=6.327$, $p=.013$, and showed overall growth for all students in both of the math intervention programs. The next step was to determine if there was a significant difference in the student scores at different grade levels in either Transmath or Vmath. Figure 10 notes the growth per grade level for the Transmath students.

Grade	Mean	Std. Deviation	N
6	2.652	.5046	21
7	2.593	.4026	15
8	2.894	.7288	18
Total	2.717	.5709	54

Figure 10. Transmath Growth per Grade Level.

Figure 10 showed the growth in pre and postassessment scores for the Transmath students in Grade 6 (n=21, mean=2.65, sd=.50), Grade 7 (n=15, mean=2.59, sd=.40) and Grade 8 (n=18, mean=2.89, sd=.72). Figure 10 shows there was growth in each grade level for the Transmath students. Because there was growth indicated by the pre and postassessment scores in each grade level, an ANOVA was conducted to examine whether there were significant differences in the growth among the students in Transmath in different grades. Figure 11 displays the ANOVA for Transmath.

Parameter	B	Std. Error	T	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	2.894	.134	21.661	.000	2.626	3.163
[Grade=6]	-.242	.182	-1.329	.190	-.608	.124
[Grade=7]	-.301	.198	-1.519	.135	-.699	.097
[Grade=8]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Figure 11. Transmath ANOVA.

The *t* tests for each parameter were not statistically significant, as seen in Figure 11. It was concluded that there were no significant differences in the growth between the pre and postassessment scores based on the grade level, Grade 6, 7 or 8, for the students in Transmath. This ANOVA was used to examine whether there were significant differences among the students in the different grade levels, 6, 7, and 8. Because this comparison is between-groups, the differences among the groups are relative values instead of absolute values. To compare among the groups, one grade level, in this case eighth grade, was set as a baseline, setting the parameter at 0; and then the other groups were compared with the baseline.

Figure 12 shows the growth in pre and postassessment scores for the Vmath students in Grade 6 (n=26, mean=1.454, sd=.63), Grade 7 (n=28, mean=1.929, sd=.55), and Grade 8 (n=24, mean=1.763, sd=.52).

Grade	Mean	Std. Deviation	N
6	1.454	.6288	26
7	1.929	.5463	28
8	1.763	.5215	24
Total	1.719	.5954	78

Figure 12. Vmath Growth per Grade Level.

Figure 12 highlighted that there was growth in each grade level for the Vmath students. Because growth was indicated by the pre and postassessment scores in each grade level, an ANOVA was conducted to examine whether there were significant differences in the growth among the students in Vmath in different grades as seen in Figure 13.

					95% Confidence Interval	
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound
Intercept	1.763	.116	15.201	.000	1.532	1.993
[Grade=6]	-.309	.161	-1.920	.059	-.629	.012
[Grade=7]	.166	.158	1.051	.297	-.149	.481
[Grade=8]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Figure 13. Vmath ANOVA.

Figure 13 showed that even though overall growth occurred in the Vmath intervention groups, the *t* tests for each parameter were not statistically significant. For the students in Vmath, it was concluded that no significant differences in the growth between the pre and postassessment scores occurred between the sixth-, seventh-, or eighth-grade levels. This ANOVA was used to examine whether there were significant differences among the students in the different grade levels, 6, 7, and 8. Because this was a between-group comparison, the differences among the groups were relative values instead of absolute values. To compare among the groups, one grade level, in this case eighth grade, was set as a baseline, setting the parameter at 0; and then the other groups were compared with the baseline.

Next, the researcher determined if there was a significant difference in the student scores for the different ethnic groups, Black, Hispanic or White, at the different grade levels, Grades 6, 7 and 8, in either Transmath or Vmath. Figure 14 highlights the analysis of Transmath students by ethnicity: Black (n=18, mean=2.722, sd=.63), Hispanic (n=8 mean=2.613, sd=.75), and White (n=28, mean=2.743, sd=.49).

Ethnicity	Mean	Std. Deviation	N
B	2.722	.6292	18
H	2.613	.7473	8
W	2.743	.4917	28
Total	2.717	.5709	54

Figure 14. Transmath Growth per Ethnicity.

Figure 14 highlighted that there was growth observed in the pre and postassessment scores for the students in Transmath. An ANOVA, Figure 15, was conducted with these growth scores to examine whether there were significant differences among the growth scores of the Transmath students based on ethnic groups: Black, Hispanic, or White.

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	2.743	.110	25.015	.000	2.523	2.963
[Ethnicity=B]	-.021	.175	-.118	.907	-.373	.331
[Ethnicity=H]	-.130	.233	-.560	.578	-.597	.337
[Ethnicity=W]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant

Figure 15. Transmath Ethnic Groups ANOVA.

Figure 15 showed that the *t* test for each parameter was not statistically significant. It was concluded that there were no significant differences in the pre and postassessment scores in Transmath based on the different ethnic groups for the students whether they were Black, Hispanic, or White. This ANOVA was used to examine whether there were significant differences among the students in the different ethnic groups: Black, Hispanic, or White. Because this was a between-group comparison, the differences among the groups were relative values instead of absolute values. To compare among the groups, one ethnicity, in this case White, was set as a baseline, setting the parameter at 0; and then the other ethnic groups were compared with the baseline.

Figure 16 highlights the analysis of the Vmath students by ethnicity: Black (n=18, mean=1.917, sd=.63), Hispanic (n=14 mean=1.657, sd=.54), White (n=41, mean=1.644, sd=.61), and Asian (n=5, mean=1.800, sd=.42).

Ethnicity	Mean	Std. Deviation	N
A	1.800	.4183	5
B	1.917	.6280	18
H	1.657	.5445	14
W	1.644	.6128	41
Total	1.719	.5954	78

Figure 16. Vmath Growth per Ethnicity.

Figure 16 noted there was growth observed in the pre and postassessment scores for the students in Vmath. An ANOVA, Figure 17, was conducted to examine whether there were significant differences among the growth scores of the Vmath students based on ethnic groups: Black, Hispanic, Asian, or White.

					95% Confidence Interval	
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound
Intercept	1.644	.093	17.663	.000	1.458	1.829
[Ethnicity=A]	.156	.282	.553	.582	-.406	.719
[Ethnicity=B]	.273	.168	1.619	.110	-.063	.609
[Ethnicity=H]	.013	.184	.072	.943	-.354	.381
[Ethnicity=W]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Figure 17. Vmath Ethnic Groups ANOVA.

The *t* tests for each parameter were not statistically significant, as noted in Figure 17. It was concluded that there were no significant differences in the pre and postassessment scores in Vmath based on ethnicity. This ANOVA was used to examine whether there were significant differences among the students in the different ethnic groups: Black, Hispanic, Asian, or White. Because this was a between-group comparison, the differences among the groups were relative values instead of absolute values. To compare among the groups, one ethnicity, in this case White, was set as a baseline, setting the parameter at 0; and then the other ethnic groups were compared with the baseline.

Next, the researcher used the data to determine if there was a significant difference in the student scores for the different genders, male or female, in either Transmath or Vmath. As seen in Figure 18, Transmath student growth in pre and postassessment scores were analyzed by gender: Female (n=28, mean=2.689, sd=.52) and Male (n=26, mean=2.746, sd=.63).

Gender	Mean	Std. Deviation	N
F	2.689	.5231	28
M	2.746	.6275	26
Total	2.717	.5709	54

Figure 18. Transmath Growth per Gender.

Figure 18 determined that there was growth observed in both male and female students in the Transmath intervention classes. An ANOVA, Figure 19, was conducted to examine whether there were significant differences among the Transmath student scores based on gender: male or female.

					95% Confidence Interval	
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound
Intercept	2.746	.113	24.325	.000	2.520	2.973
[Gender=F]	-.057	.157	-.363	.718	-.371	.258
[Gender=M]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Figure 19. Transmath Gender ANOVA.

The *t* test for each parameter was not statistically significant as seen in Figure 19. This ANOVA was used to examine whether there were significant differences among the students in the different gender groups: male or female. Because this was a between-group comparison, the differences among the groups were relative values instead of absolute values. To compare among the groups, one gender, in this case male, was set as a baseline, setting the parameter at 0; and then the other ethnic groups were compared with the baseline.

Figure 20 shows the analysis of Vmath student growth in pre and postassessment scores by gender: female (n=68, mean=2.185, sd=.74) and nale (n=64, mean+2.066, sd=.79).

Gender	Mean	Std. Deviation	N
F	2.185	.7371	68
M	2.066	.7913	64
Total	2.127	.7633	132

Figure 20. Vmath Growth per Gender.

As determined by Figure 20, there was growth observed in both male and female students in the Vmath intervention classes. An ANOVA was conducted to examine whether there were significant differences among the Vmath student scores based on gender: male or female. The *t* tests for each parameter were not statistically significant, as seen in Figure 21.

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	2.066	.095	21.634	.000	1.877	2.255
[Gender=F]	.120	.133	.900	.370	-.144	.383
[Gender=M]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Figure 21. Vmath Gender ANOVA.

It was concluded, as seen in Figure 21, that there were no significant differences in the pre and postassessment scores based on gender for the students in Vmath. This ANOVA was used to examine whether there were significant differences among the students in the different gender groups. Because this was a between-group comparison, the differences among the groups were relative values instead of absolute values. To compare among the groups, one gender, in this case male, was set as a baseline, setting the parameter at 0; and then the other ethnic groups were compared with the baseline.

Finally, the researcher used the data to determine if there were any significant differences based on the teacher of the intervention class. As seen in Figure 22, Transmath and Vmath student scores were analyzed based on the teacher of each intervention class. Transmath and Vmath teachers are separated based on the subject they taught.

Teacher	Mean	Std. Deviation	N
Transmath			
A	2.743	.4791	7
B	2.500	.5416	7
E	2.714	.5336	7
F	2.488	.3441	8
J	3.057	.4721	7
L	1.575	.3646	12
Vmath			
C	1.947	.8815	19
D	1.414	.5275	14
G	1.853	.5111	15
H	2.371	.8127	24
K	1.950	.5992	12
Total	2.127	.7633	132

Figure 22. Growth per Teacher.

As noted in Figure 22, there was measured growth in pre and postassessment scores for each teacher's class. An ANOVA, Figure 23, was conducted to examine whether there were significant differences among the student pre and postassessment scores based on the teacher in Transmath and Vmath.

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	1.575	.183	8.585	.000	1.212	1.938
[Teacher=A]	1.168	.302	3.864	.000	.569	1.766
[Teacher=B]	.925	.302	3.060	.003	.327	1.523
[Teacher=C]	.372	.234	1.589	.115	-.092	.836
[Teacher=D]	-.161	.250	-.643	.522	-.656	.334
[Teacher=E]	1.139	.302	3.769	.000	.541	1.738
[Teacher=F]	.913	.290	3.146	.002	.338	1.487
[Teacher=G]	.278	.246	1.131	.260	-.209	.766
[Teacher=H]	.796	.225	3.542	.001	.351	1.241
[Teacher=J]	1.482	.302	4.903	.000	.884	2.081
[Teacher=K]	.375	.259	1.445	.151	-.139	.889
[Teacher=L]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

Figure 23. Teacher ANOVA.

This ANOVA, Figure 23, was used to examine whether there were significant differences among the students in the different teachers' classes: Teachers A-L. Because this was a between-group comparison, the differences among the groups were relative values instead of absolute values. To compare among the groups, one teacher in this case Teacher L, was set as a baseline, setting the parameter at 0; and then the other classes were compared with the baseline. The researcher concluded that Teachers A, B, E, F, H, and J showed significant differences in pre and postassessment scores, whereas Teachers C, D, G, K, and L showed statistically insignificant growth. Once the quantitative data were analyzed and the growth for each of the intervention programs was determined, it was necessary to include collected data on the fidelity of implementation and teacher perceptions to determine whether or not the growth could be related to the intervention program. These qualitative data were used to answer Research Questions 3 and 4.

Qualitative Data Collection

Observation data collection. Qualitative data were collected by conducting classroom observations every 2 weeks beginning in February and ending in April 2016 and by conducting teacher interviews from March-April 2016. Classroom observations were performed every other week for 12 weeks, resulting in six observations of each classroom. The researcher used the Fidelity Observation Form specifically created by NCDPI to measure implementation fidelity of the Transmath and Vmath programs. The Fidelity Observation Form is divided into major categories. Within the categories, there are several concepts delineated. These concepts are highlighted in Table 16.

Table 16

Major Categories and Concepts Observed Using Fidelity Observation Form

Major Category	Concept
Quality of Instruction-Organization	Materials close at hand Sufficient materials Three-Read process used in planning Small group area clearly identified
Use of Curriculum Guide	Curriculum Guide closely referenced Explicit language and instructional models followed Brisk pace Deliberate and intentional instruction Skills modeled correctly Correction procedure steps followed for immediate feedback
Student Engagement	Clear expectations established Automaticity and fluency reinforced Students responded chorally and individually
Amount of Instruction	Delivered 4-5 days a week Delivered based on daily minimums Lesson is within 5 of pacing calendar Other students are engaged in independent activities Interruptions are minimal
Use of Assessments	Benchmarks are administered accurately Placement tests are used to determine appropriate lesson Progress monitoring is administered regularly Assessments are administered as designed Assessment scores are entered online Classroom data is analyzed to inform instruction
Differentiation	Assessment data is used to differentiate Small groups used appropriately Progress monitoring guides instruction Reteaching resources are used to intensify instruction Curriculum features are used as designed Online component is used as designed

Table 16 shows there were several concepts that were used to identify each major category. The Fidelity of Observation Form was divided into six categories, each resulting in a score from 0-3. The scores, 0-3, were assigned to each concept based on whether or not it was observed and to what degree it was observed. If the concept was not observed at all, a score of 0 was assigned to that concept. If the concept was observed but for less than 25 minutes of the 45 minute class, a score of 1 was assigned to the concept. If the concept was observed for 25 minutes or more, a score of 2 was assigned to the concept. If the concept was observed for the entire class period, a score of 3 was assigned to the concept. If the concept was one that was either present or not, a score of 0 was assigned if it was not observed; and a 3 was assigned if it was observed. Table 17 notes the criteria for assigning each concept a score.

Table 17

Criteria for Assigning Observation Scores

Score	Criteria
0	Not Observed
1	Observed less than 25 minutes
2	Observed more than 25 minutes
3	Observed the entire class period

After discussions with NCDPI, the researcher was advised that it was appropriate to assign a mean score to each teacher measuring each major category. After six observations had been conducted in each classroom, the researcher determined the overall mean for each concept from the Fidelity Observation Form measured for each teacher. These means are noted in Table 18.

Table 18

Intervention Teachers' Mean Scores after Six Classroom Observations

Teacher	Quality of Instruction-Organization	Use of Curriculum Guide	Student Engagement	Amount of Instruction	Use of Assessments	Differentiation	Grand Mean
Transmath Teachers							
A	2.17	2.41	2.12	2.44	2.10	.54	1.96
B	2.25	2.11	2.73	2.45	2.62	1.85	2.34
E	2.12	2.42	2.85	2.44	2.83	2.15	2.47
F	1.53	2.45	2.25	2.65	2.43	1.33	2.11
J	1.51	2.53	2.70	2.22	2.53	1.51	2.17
L	2.35	.39	1.71	1.15	.25	1.32	1.20
Vmath Teachers							
C	1.92	2.22	1.35	2.33	2.92	1.81	2.10
D	1.53	1.92	1.55	2.34	2.73	1.25	1.89
G	2.25	2.65	2.46	2.34	2.73	1.52	2.33
H	1.75	1.75	1.85	1.91	2.21	1.93	1.90
H	1.61	1.95	1.76	2.05	2.15	1.98	1.92
K	2.05	2.22	2.51	2.10	1.73	1.44	2.01
Grand Mean	1.92	2.09	2.15	2.20	2.27	1.55	2.03

Table 18 represents the teacher means taken from all of the observations in each category of the fidelity observations. After consultation with a Ph.D. student in Statistical and Measurement Methods from the Department of Research and Evaluation Methodology at the University of Florida and verifying that the calculation of the grand means was valid, the grand means were calculated using the means from each category from the observation form with a mean of 0-.99 representing "not implemented," a mean of 1-1.99 representing "improperly implemented," a mean of 2-2.99 representing "somewhat properly implemented," and a mean of 3 to represent "appropriately implemented." There were a total of seven teachers with means that qualified them to fall into the "somewhat properly implemented" category. The lowest areas of implementation overall were in Quality of Instruction-Organization and Differentiation and the highest areas of implementation were Student Engagement, Amount of Instruction, and Use of Assessments. Teachers B (Transmath), C (Vmath), E (Transmath), F (Transmath), G (Vmath), J (Transmath), and K (Vmath) all measured between 2-2.99. When combined with the quantitative data from the Moby Max assessments, Teachers B, E, F, and J, all Transmath teachers, also showed significant differences in their pre and postassessment scores. Table 19 notes the comparison of the classroom observation means and significance of the measured growth scores from Moby Max.

Table 19

Observation Mean and Measured Growth Scores Significance

Teacher	Observation Mean	Growth Significance
Transmath Teachers		
A	1.96	.000**
B	2.34*	.003**
E	2.47*	.000**
F	2.11*	.002**
J	2.17*	.000**
L	1.20	a. This parameter is set to zero because it is redundant.
Vmath Teachers		
C	2.10*	.115
D	1.89	.522
G	2.33*	.260
H	1.90	.001**
K	2.01*	.151

Note. *indicates appropriate implementation; **indicates significant growth.

To measure significance in the growth scores, the more significant the growth between the pre and postscore, the significance value will be lower, using a significance value of .05. To compare among the groups, one teacher, in this case Teacher L, was set as a baseline, setting the parameter at 0; and then the other teachers were compared with the baseline. Table 19 displays Teachers A, D, H, and L implemented the program improperly with a mean score between 1-1.99 on the Fidelity Observation Form and Teachers B, C, E, F, G, J, and K implemented the program somewhat properly with a mean between 2-2.99 on the Fidelity Observation Form. Teachers B, E, F, and J, all Transmath teachers, met both the criteria of growth significance of less than .05 and the mean of observation scores between 2-2.99. Even though Teachers A (Transmath) and H (Vmath) showed significant growth, their observation means fell within the "improperly implemented" range; and Teachers C, G, and K, all Vmath teachers, received means that placed them in the "properly implemented" category, but their scores did not show significant growth.

Interview data collection. Follow-up interviews with each of the intervention teachers were performed after the third quarter of instruction to collect information on teacher perception of the program and the intervention class. Collecting this perceptive teacher data was necessary to triangulate the classroom observation data and the Moby Max assessment data and further identify the discrepancies in growth scores among teachers. These interviews helped expand beyond the observed and qualitative data to include the perceptions of the teachers in relation to the implementation and success of the intervention program. Data were gathered from the 11 teachers involved in Transmath and Vmath intervention classes by interviewing each teacher using a face-to-face, one-time interview. Table 20 highlights the interview questions and how they aligned with the research questions.

Table 20

Interview Questions Alignment Table with Research Questions

Interview Question	Question	Research Question
1	How would you describe the Vmath/Transmath Curriculum?	4
2	How do you feel about Vmath/Transmath	4
3	How successful do you think Vmath/Transmath has been?	4
4	Do you feel the curriculum impacted student learning? How?	4
5	Tell me about your experience with Vmath/Transmath.	4
6	Describe your implementation of Vmath/Transmath.	3, 4
7	How fully do you feel you implemented the program? Why?	3, 4
8	Were there parts of the curriculum you did not implement? Why?	3, 4
9	Was there anything that made a difference or influenced your implementation? What?	3
10	Did you use the assessment information to influence your planning?	3
11	Were there certain barriers that effected the implementation of the program?	4
12	Is there anything else about this program you would like to comment on?	4

Table 20 displays the interview questions that were used to help answer Research Question 3 and Research Question 4. All of the interviews were performed within a 3-week period. Each interview lasted from 13 minutes to 25 minutes. All of the interviews were transcribed using *Transcribe,* an online audio player integrated with a same screen text editor. Each interview transcript was then coded by theme to identify the perceptions of the teachers related to the program they taught. Table 21 notes the teacher perceptions, definitions, and the number of times each coded theme response was repeated during the teacher interviews.

Table 21

Coded Themed Responses of Teacher Perception Interviews

Coded Theme	Explanation of Term	Number of Times Repeated by Transmath Teachers	Number of Times Repeated by Vmath Teachers
Script	A manuscript or document used as a guide	14	11
Aligned Assessments	The instrument used for evaluating	18	30
Reteach	To give instruction on the same skill again	16	2
Growth	Academic progress made over a period of time	12	23
Basic Math Facts and Skills	Knowledge of basic rules and applications of math, for example addition and subtraction rules	8	20
Boring	Students complained and lost interest easily	28	4
Uneasy flow of modules	Modules were not in a logical order	47	0
Second Math Class	Many students left one math class to come to this math class	18	3
Individualized	Plan for each student instead of following a script	5	34

Table 21 highlights several common themes that emerged from the teacher interviews. These themes were used in explanation of corresponding areas of the qualitative data and classroom observations. Noted in Table 21, the majority of the negative themes were expressed during the interviews by the Vmath teachers, whereas the Transmath teachers expressed the majority of positive themes during the interviews. Table 22 notes the interview questions relating to Research Question 3 and Research Question 4 and the reoccurring themes that emerged from the teachers' responses.

Table 22

Interview Questions and Reoccurring Themes Relating to Fidelity of Implementation and Teacher Perceptions

Question	Reoccurring Themes Stated by Transmath Teachers	Reoccurring Themes Stated by Vmath Teachers
How would you describe the Vmath/Transmath Curriculum?	Individualized	Scripted, Boring, Uneasy flow of modules
How do you feel about Vmath/Transmath as an intervention program?	Aligned Assesments	Scripted, Boring, Uneasy flow of modules, Second math class
How successful do you think Vmath/Transmath has been?	Growth, Basic Math Facts	Lack of Growth
Do you feel the curriculum impacted student learning? How?	Growth, Basic Math Facts	Lack of Growth
Tell me about your experience with Vmath/Transmath.	Individualized	Boring, Script, Second Math Class
Describe your implementation of Vmath/Transmath.	Individualized, Aligned Assessments	Script, Reteach
How fully do you feel you implemented the program? Why?	Individualized, Aligned Assessments	Boring, Script, Reteach
Were there parts of the curriculum you did not implement? Why?	Individualized	Assessments, Script, Boring, Reteach
Was there anything that made a difference or influenced your implementation? What?	Boring, Reteach, Script	Boring, Reteach, Script
Did you use the assessment information to influence your planning?	Script	Script

Table 22 revealed that the Transmath intervention teachers were very reliant on the assessment data; and the Vmath intervention teachers were very reliant on the scripted program, yet many of them did not like the script and flow of the program. The program assessment data were used to individualize daily lessons, and many of the teachers added daily exercises on basic math facts in their classrooms as the assessment results showed that students lacked many of the basic math skills. During the face-to-face interviews, it was discovered that all of the Transmath teachers used the program assessments to help group their students and measure the amount of growth their students were showing. In the process of interviewing the Vmath teachers, it became apparent that they did not like the way the script was written; and they felt like the flow and order of the modules was out of order. All of the teachers stated that they did not always follow the script as it was written during the intervention. They did not follow the sequence of the program as it was written because they felt it was not in a logical order.

Teacher A (Transmath), an EC teacher with no past experience teaching Transmath, revealed in the face-to-face interview that many times he would "veer from the script to spend more time on lessons and pull extra reteach activities that were not in the program when the students were struggling" (Teacher A, personal communication, March 10, 2016). Teacher A felt that an EC background was beneficial in choosing alternate activities to enhance the scripted program. This deviation from the script was observed as well by the researcher on several occasions during the classroom observations. Even with this lack of implementation fidelity, the students in Teacher A's class showed significant growth. Differentiation was one of the lowest areas on Teacher A's classroom observations. It was determined that these lower level students may have all been on a similar level and differentiation may not have been needed. Teacher H

(Vmath), a CTE teacher with 1 year of experience teaching Vmath, also showed significant growth in scores but was not within the “properly implemented” range from the Fidelity Observation Form. In a face-to-face interview with Teacher H, it was discovered that in attempting to individualize for each student, the teacher was not able to cover as much material as was prescribed in the program and, therefore, was observed as not following the program with fidelity. Teacher H (personal communication, March 15, 2016) stated,

> the students were lacking in basic math facts and the information I received from the assessments showed me that I needed to move at a slower pace. I also realized the students were getting bored with the scripted lessons so I took information from the script and created my own lessons that I had used last year, incorporating online materials and programs I use in my computer class, along with the scripted materials.

Teachers C, G, and K, all Vmath teachers, proved to “properly implement” based on classroom observations; however, their students did not show significant growth in scores. Teacher C, a CTE teacher with 2 prior years of experience teaching Vmath, was observed attempting to implement the program with fidelity during each observation. During the face-to-face interview with Teacher C (personal communication, March 9, 2016), it was stated, “the students would not listen and I had a lot of trouble out of several of my girls.” Teacher G, a social studies teacher with no experience with math or the Vmath intervention, was consistently observed following the script and the program guidelines. In the face-to-face interview, it was apparent that Teacher G (personal communication, March 30, 2016) felt very uncomfortable teaching a math intervention:

> I studied the script every night and followed it word for word. My students were

> very bored and I was not able to help them with questions they had if it was not in the script. I tried to help them with basic math facts but beyond that, I was not equipped to answer other Math questions. I felt very uncomfortable teaching this intervention.

When Teacher K, a science teacher with no prior Vmath experience was interviewed, the researcher discovered that even though the classroom observations led to a score of "properly implemented," there were many occasions when the class was using an online program this teacher had used at another school.

> I used a program called *Sumdog* at my prior school and observed growth so I used this program with my students instead of several of the lessons in the book. My students really liked this program so we started using it more and more. (Teacher J, personal communication, April 1, 2016)

Teachers B, E, F, and J, all Transmath teachers, showed significant growth as well as mean scores that placed them in the "properly implemented" category during fidelity observations. Of these four teachers, none have had past experience with any Math interventions. Teachers F and J were both EC teachers, therefore they had experience working with students who do not perform at grade level; yet Teacher B was a first year band teacher and Teacher E was a CTE teacher. In face-to-face interviews, all four of these teachers indicated they followed the script and used assessment data to group, individualize lessons, and group their students. They all used the reteach lessons in the program as they were intended based on collected assessment data. Teacher B (personal communication, March 21, 2016) stated,

> I tried to keep this class as fun as I could. My kids were bored at times and for many of them, they came from their regular Math class to my class, back to back.

> When I felt they were struggling, I veered from the script and I would spend a bit more time working one on one with the individual students while the others used the online component.

Teacher E was consistently following the lessons in the book and working through the script.

> I knew my math knowledge was not strong so I counted on the script and the lessons to give me what I needed to help my students. There were some times I took a few days to work on basic math facts when I saw they were struggling with a lesson, but for the most part I followed the lessons like I was supposed to. (Teacher E, personal communication, March 21, 2016).

Teacher F and J both followed up with the researcher on a consistent basis sharing assessment data and progress monitoring. Classroom observation and interview data indicated that these teachers were experienced in using programs and intervention materials as well as consistent progress monitoring.

> I thought the script was easy to follow, the directions were good. I would work with a group of students while the rest were online and then we would switch. This gave me a better chance to work with individual students. I generally had to go back and reteach but I liked that the program was scripted. (Teacher J, personal communication, March 23, 2016).

> I did not go in the same order of the lessons in the book. If I felt like another lesson needed to go first, I will do it and then go back and get the first lesson, but I followed the script as I did this. I feel like I still fully implemented the program as long as I was using the correct materials. (Teacher F, personal communication, March 23, 2016).

The coded themed responses from the teacher interviews were compiled and each teacher was assigned an overall positive or negative perception of the intervention program based on their responses. There were five Vmath teachers and six Transmath teachers interviewed. The number of teachers who expressed an overall positive or negative perception of the intervention program according to the content, pacing, implementation, and effectiveness was determined and is displayed in Table 23.

Table 23

Overall Teacher Perceptions of the Programs as Determined Through Interviews

General Perception	Vmath	Transmath
Positive	0	5
Negative	5	1

Table 23 indicated that the overall general perception according to content, pacing, implementation, and effectiveness of the Transmath teachers was positive; whereas the overall general perception of the Vmath teachers according to content, implementation, and effectiveness was negative. Table 24 summarizes the findings of this study when combining the quantitative and qualitative data.

Table 24

Summary of Quantitative and Qualitative Data

Intervention Class	Teacher	Grade Level	Teacher Perception	Observation Mean	Growth Significance
Transmath	A	6	Positive	1.96	.000**
Transmath	B	6	Positive	2.34*	.003**
Transmath	E	7	Positive	2.47*	.000**
Transmath	F	7	Positive	2.11*	.002**
Transmath	J	8	Positive	2.17*	.000**
Transmath	L	8	Negative	1.20	a.
Vmath	C	6	Negative	2.10*	.115
Vmath	D	6	Negative	1.89	.522
Vmath	G	7	Negative	2.33*	.260
Vmath	H	7	Negative	1.90	.001**
Vmath	K	8	Negative	2.01*	.151
Vmath	H	8	Negative	1.90	.001**

a. This parameter is set to zero because it is redundant.
*indicates appropriate implementation; **indicates significant growth.

Based on information contained in Table 24, in all three grade levels, teacher perception of the intervention programs based on coded themed responses from teacher interviews was overall positive for Transmath and negative for Vmath with all of the Vmath teachers having a negative perception and all but one Transmath teacher having a positive perception. Information gathered from classroom observations that rated the teacher on the level of implementation could be sorted into three categories: 0-.99, "improperly implemented"; 1.00-1.99, "somewhat properly implemented"; and 2.00-3.00, "appropriately implemented." Table 24 shows that the means were higher for both sixth and seventh grade Transmath classes, both in the "somewhat properly implemeted" category compared to the Vmath classes where only one of the groups was in the "somewhat properly implemented" category. The observation mean for eighth-grade

Vmath was higher than Transmath; however, both were in the "improperly implemented" category. Finally, when observing the significance of the growth scores when the significance level is <.05, Transmath scores in all three grade levels show significant growth, whereas only one Vmath teacher, Teacher H, shows significant growth.

Summary

Chapter 4 included details of the data obtained from Moby Max pre and postassessments, Classroom Fidelity Observations, and teacher interviews. The presentation of the findings included the collected data and the research questions that were developed to guide the exploration. As seen in the reported data, significant growth was reported based on the pre and posttests according to Moby Max for both Vmath and Transmath students. When the data were further reviewed, there was no significant difference in the growth between the pre and postassessment scores according to grade level, ethnic group, or gender. When implementation fidelity and teacher perception was included, Teachers B, E, F, and J showed high levels of implementation fidelity and positive teacher perception. All of these teachers were Transmath teachers and showed the highest statistically significant growth in scores. Teachers C, G, and K, Vmath teachers, "properly implemented" the program but did not show significant growth. Teachers A and H showed growth but did not "properly implement," according to the Fidelity Observation Form. Teacher A taught Transmath and teacher H taught Vmath. During classroom observations of Teacher A, his observation mean was in the "improperly implemented" category; however, his interview revealed that his background as an EC teacher was advantageous in his instruction in the classroom. Teacher L did not show growth nor did this teacher "properly implement" the intervention program. During the observations of Teacher L's classroom, it was apparent that he was not implementing the program with fidelity due to the scores received on the Fidelity Observation Form. When he was interviewed, it became apparent that he did not like the Transmath program and did not implement the program with fidelity due to this fact. This teacher scored the lowest on the implementation scale from the Fidelity Observation Form and during the face-to-face interview expressed a negative perception regarding the program. “This has been a waste of my time this year. I liked the program I taught last year that was completely individualized and online. It guided the students to the next lesson independently. There was no whole class instruction” (Teacher L, personal communication, March 24, 2016). This teacher stopped teaching the Transmath program in mid-February and used *Sumdog* with his students the rest of the year. Teacher D, a Vmath teacher, measured the second lowest on the mean scores for implementation and the pre and postscore growth was not significant. This teacher suffered from classroom management issues as well as Teacher C.

The combined and reported data show that Transmath was more effective than Vmath. Implementation fidelity was a very important aspect of the significant growth scores; however, even without the high level of implementation, Transmath still produced higher growth scores as seen with Teacher A. Teacher A’s mean score on the Fidelity Observation Form was very close to being in the “properly implemented” category; therefore, these students were still exposed to a measurable degree of implementation fidelity. Teacher L did not implement with fidelity, and the growth scores were not significant. Chapter 5 of this study presents inferences about the important findings of these data and present recommendations for further research.

Chapter 5: Discussion

Introduction and Overview of the Problem

According to National Math Panel Report Endorses Vmath Intervention Program Research Base (2008), based on international comparisons of mathematics performance, students in the United States have shown poor performance for many consecutive years (“Assisting students struggling,” 2009, p. 4). The Education Commission of the United States (2013) stated that many middle school students in the United States are not working on grade level in mathematics. “Students’ low achievement in mathematics is a matter of national concern” (“Assisting students struggling,” 2009, p. 4). For many years, schools have taken on the challenge of improving reading and math skills and achievement scores in both areas. It is important for schools, especially elementary and middle schools, to increase the focus on mathematics instruction to ensure effective interventions are offered to struggling students. To assure that all students are receiving adequate mathematics instruction, mathematics intervention programs are becoming more important and prevalent in many elementary, middle, and even high schools. National Math Panel Report Endorses Vmath Intervention Program Research Base believed schools can follow the RTI framework to provide help to students struggling in mathematics and help prepare them for future success. This study intended to determine the effectiveness of two particular math intervention programs, Transmath and Vmath, currently being used in the middle school setting to allow decision makers to make a better informed decision as to effective mathematics intervention programs to help close the achievement gap in mathematics.

This research study combined both quantitative and qualitative data to answer research questions related to a program evaluation of these two math intervention programs. The overarching question leading this study was,

RQ1: How effective are the Transmath and Vmath programs when used as an intervention strategy for struggling middle grade math students?

In order to answer the overarching research question, quantitative data were used to analyze data related to Research Question 2, and qualitative data were used to analyze data related to Research Questions 3 and 4. The three additional questions this study addressed were,

RQ2. What are the differences in the mean scores of the students involved in the Vmath and Transmath intervention classes as measured by Moby Max?

RQ3. To what extent are the Vmath and Transmath programs being implemented with fidelity as measured by fidelity observations and teacher interviews?

RQ4. How do intervention teachers perceive the implementation and effectiveness of Vmath and Transmath?

Purpose of the Study

The purpose of this study was to perform a program evaluation on two math intervention programs, Transmath and Vmath, being used at the middle school level to determine whether either program would produce significant growth for the students involved in the intervention and if teacher perception and fidelity of implementation were factors in the outcome. Because a portion of this study was to determine which, if either, of these programs yielded the most mathematics achievement growth for middle school students who were performing below grade level in mathematics, program evaluation was a necessity. Programs implemented in any setting are only as valuable as can be measured by the intended purpose of that program.

According to Fitzpatrick et al. (2011), a program evaluation is valuable when used as a guide for a researcher to make decisions about the value of the programs being evaluated (p. 13). “Program evaluation is a valuable tool for program managers who are seeking to strengthen their programs and improve outcomes for the children and youth they serve” (Metz, 2007, p. 1). In this study, it was important to determine if significant student achievement growth occurred and, if it did, to determine if it was the program alone that led to the growth or if the implementation and teacher perceptions had ramifications on the outcome. The information gathered from this study was used as a valuable tool to present the findings to the involved stakeholders for curriculum decision-making purposes. According to Metz (2007), a program evaluation is “a systematic method for collecting, analyzing and using information to answer basic questions about a program” (p. 1). A program evaluation can help find out what works and what does not work, and it can show the effectiveness of a program.

Participant Demographics

The participants included in this study were 11 middle school teachers and 132 middle school students. Table 25 highlights each teacher’s number of years of teaching experience and their area of teaching expertise.

Table 25

Vmath and Transmath Teachers

Teacher	Teaching experience	Teaching area
A	8 years	EC reading and math
B	1st Year	Band
C	17 years	CTE
D	2 years	Science
E	11 years	CTE
F	7 years	EC reading and math
G	29 years	Social Studies
H	12 years	CTE
J	6 years	EC reading and math
K	25 years	Science
L	30 years	Science

Table 25 highlighted the fact that the teachers involved in this study were diverse in their concentrations and their years of experience. The gender and ethnicity for each student included in Vmath is reported in Table 26.

Table 26

Gender and Ethnicity of Students Placed in Vmath

Grade Level	Total	Gender (Male/Female)	Ethnicity (Majority/Minority)
Sixth Grade	26	15/11	14/12
Seventh Grade	28	13/15	12/16
Eighth Grade	24	9/15	14/10

The study began with a total of 25 eighth-grade students; however, one student was removed from the study due to relocation to another school. For each student included in Transmath, the gender and ethnicity are reported in Table 27.

Table 27

Gender and Ethnicity of Students Placed in Transmath

Grade Level	Total	Gender (Male/Female)	Ethnicity (Majority/Minority)
Sixth Grade	21	10/11	14/7
Seventh Grade	15	8/7	5/10
Eighth Grade	18	9/9	8/10

This study began with 19 eighth-grade students; however, one student was removed from the intervention group because the teacher and the principal felt the student no longer needed the intervention based on the progress monitoring of assessments.

Interpretation and Overview of Study and Results

This study was conducted as a program evaluation of two mathematics intervention programs. Both intervention programs were planned and evaluated using a logic model. A logic model was used as a systematic and visual way to present and share understandings of the relationships among the resources used to operate the program, the activities conducted within the program, and the results that were hoped to be achieved (W. K. Kellogg Foundation, 2004, p. 1). The logic model includes the resources that will be used; inputs; planned activities and participants in those activities; outputs; short-, medium-, and long-range goals; and outcomes. There are also assumptions that are made that may or may not be a reality as well as external factors that could affect the outcome of the program.

The logic model used for the Vmath intervention program is highlighted in Figure 24.

Inputs	Outputs: Activities	Outputs: Participation	Outcomes—Impact: Short	Outcomes—Impact: Medium	Outcomes—Impact: Long
*Training-2 sessions of program training after school for all teachers. *Teachers *Vmath grade level materials and online access to Voyager Sopris *Class schedules *NCEOG and pretest scores *Teacher recommendation *Bi-Weekly fidelity checks *Class observations *Teacher interviews	*Teacher Training *Monthly meetings to discuss progress monitoring *Bi-weekly fidelity observations *Teacher interviews *Class observations *Progress monitoring per program requirements *Baseline assessment *Moby Max Assessment (Pre, mid and post) *Benchmark assessment (Nov., and March)	*Teachers *Students placed in program *Researcher *Administration	*Awareness of gap areas in math achievement *Awareness of students who are in need of intervention *Knowledge of Vmath program, assessments, and program guidelines	*Closing of gaps as measured on midyear Moby Max and Benchmark assessments	*Higher achievement on assessments and NCEOG *Students achieving on grade level math assignments

Assumptions	External Factors
Program is deployed with fidelity Teachers are trained Students are appropriately placed Pre and posttest are accurate measures of student achievement	District support for findings Trained teachers remain in current positions Students placed do not drop out of program Administration supports program research

Figure 24. Vmath Logic Model.

In reviewing the Vmath Logic Model in Figure 24, the inputs and outputs were all part of the implementation of the program. However, when the outcomes were reviewed, the researcher discovered that while gap areas were identified and addressed by the Vmath program, those gap areas were not closed as quickly as was the intended goal. The assumptions and external factors of this program were also evaluated, and the researcher discovered that negative teacher perception and a lack of implementation fidelity of the Vmath program were important factors in the level of success. These factors are discussed later in Chapter 5.

The logic model used for the Transmath intervention program is highlighted in Figure 25.

Inputs	**Outputs** — *Activities*	**Outputs** — *Participation*	**Outcomes—Impact** — *Short*	**Outcomes—Impact** — *Medium*	**Outcomes—Impact** — *Long*
*Training-2 sessions of program training after school for all teachers. *Teachers *Transmath grade level materials and online access to Voyager Sopris *Class schedules *NCEOG and pretest scores *Teacher recommendation *Bi-Weekly fidelity checks *Class observations *Teacher interviews	*Teacher Training *Monthly meetings to discuss progress monitoring *Bi-weekly fidelity observations *Teacher interviews *Class observations *Progress monitoring per program requirements *Baseline assessment *Moby Max Assessment (Pre, mid and post) *Benchmark assessment (Nov., and March)	*Teachers *Students placed in program *Researcher *Administration	*Awareness of gap areas in math achievement *Awareness of students who are in need of intervention *Knowledge of Transmath program, assessments, and program guidelines	*Closing of gaps as measured on midyear Moby Max and Benchmark assessments	*Higher achievement on assessments and NCEOG *Students achieving on grade level math assignments

Assumptions	**External Factors**
Program is deployed with fidelity Teachers are trained Students are appropriately placed Pre and posttest are accurate measures of student achievement	District support for findings Trained teachers remain in current positions Students placed do not drop out of program Administration supports program research

Figure 25. Transmath Logic Model.

In reviewing the Transmath Logic Model in Figure 25, the inputs and outputs were all part of the implementation of the program. When the outcomes were reviewed, the researcher discovered that gap areas were identified and addressed by the Transmath program more effectively than with the Vmath program. The assumptions and external factors of this program were also evaluated, and the researcher discovered that implementation fidelity and positive teacher perceptions of the Transmath program were important factors in the level of success. These factors are discussed later in Chapter 5.

This study took place over the course of 1 school year. The results were determined by combining quantitative data and qualitative data. The quantitative data were gathered by Moby Max pre and postassessment scores. Qualitative data gathered were from teacher observations and interviews. This study determined that both of the intervention programs, Transmath and Vmath, resulted in significant growth for students; however, the growth produced by the Transmath program was significantly more successful than Vmath. When the pre and postassessment data were collected, the growth for the Transmath students in all three grade levels resulted in over 2 years of growth, as seen in Table 28.

Table 28

Transmath Mean Pre and Postassessment Scores

Grade	Mean Preassessment Score	Mean Postassessment Score	Total Change
6	1.3	4	+2.7
7	1.3	3.9	+2.6
8	1.3	3.9	+2.6

The growth for Transmath was much higher than for Vmath. The growth for Vmath students resulted in more than a year's growth for sixth- and eighth-grade students and exactly 2 years' growth for seventh-grade students, as seen in Table 29.

Table 29

Vmath Mean Pre and Postassessment Scores

Grade	Mean Preassessment Score	Mean Postassessment Score	Total Change
6	2.7	4.2	+1.5
7	2.7	4.7	+2.0
8	2.8	4.5	+1.7

The growth for both Transmath and Vmath were also statistically analyzed in relation to quantitative scores from classroom observations. Qualitative data from teacher interviews were also analyzed to determine the overall effectiveness of each program. This analysis is discussed later in Chapter 5.

The quantitative data collected showed significant growth overall for the students in both Transmath and Vmath; however, it was not possible to make a statement as to the effectiveness of either program on its own merit. Implementation fidelity and teacher perception also had to be considered. “Implementation with fidelity is using the curriculum and instructional practices consistently and accurately, as they were intended to be used” (Mellard, 2010, p. 3). It must be insured that the program was implemented the way it was intended to be able to explain whether the student growth was related to the program or other factors. Teacher perception of the programs and their related materials has a direct effect on the way the teacher implements the program as well. Therefore, the qualitative data were necessary to determine the overall effectiveness of each intervention program.

Brief Overview

Analysis of the quantitative and qualitative data was organized into three parts.

Part one consisted of a statistical analysis of the Moby Max pre and posttest scores to determine student academic growth from the beginning to the end of the school year. Part two consisted of six classroom observations of each individual intervention teacher. The observations were conducted to measure implementation fidelity of the two programs. Part three consisted of teacher interviews, conducted with each intervention teacher, focusing on teacher perception and implementation of the programs.

Data Collection and Analysis

The Moby Max pre and postassessment scores were compared for the Vmath intervention classes. All three grade levels showed growth, as seen in Table 29. When the results from Table 29 were compared with a paired-sample *t* test, Vmath was determined to show statistically significant growth, as highlighted in Figure 26.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	MM1 - MM2	-1.7192	.5954	.0674	-1.8535	-1.5850	-25.500	77	.000

Figure 26. Paired-Sample *t* Test for Vmath.

Moby Max pre and postassessment scores were compared for Transmath intervention classes. All three grade levels showed growth, as seen in Table 28. When the results from Table 28 were compared with a paired-sample *t* test, Transmath was determined to show statistically significant growth, as highlighted in Figure 27.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	MM1 - MM2	-2.7167	.5709	.0777	-2.8725	-2.5608	-34.967	53	.000

Figure 27. Paired-Sample *t* Test for Transmath.

Although the scores in both Vmath and Transmath showed significant growth, the researcher also wanted to determine if either program was more effective for a specific grade level, gender, or ethnicity. After statistically comparing the Moby Max pre and postassessment scores of all of these aspects, no significant growth was discovered based on the grade level, gender, or ethnicity.

Part two of this study involved determining the level of implementation fidelity for each teacher through classroom observations. The researcher observed each intervention class every 2 weeks over the course of 12 weeks, for a total of six observations per class. The researcher used a form created by NCDPI that was specifically designed for use in measuring the level of implantation fidelity for the Transmath and Vmath programs. Each category was given a score between 0 and 3, and each category was averaged for a grand mean. After all six of the observations were completed, each teacher was given a grand mean, representing the level of implementation fidelity. Information gathered from classroom observations that rated the teacher on the level of implementation could be sorted into three categories: 0-.99, “improperly implemented”; 1.00-1.99, “somewhat properly implemented”; and 2.00-3.00, “appropriately implemented.” After the implementation mean was determined, it was compared with the statistically-determined growth scores from part one of the study, as seen in Table 30.

Table 30

Transmath Observation Means and Measured Growth Scores Significance

Teacher	Observation Mean	Growth Significance
A	1.96	.000**
B	2.34*	.003**
E	2.47*	.000**
F	2.11*	.002**
J	2.17*	.000**
L	1.20	a. This parameter is set to zero because it is redundant.

*indicates appropriate implementation; **indicates significant growth.

To compare among the groups, one teacher, in this case Teacher L, was set as a baseline, setting the parameter at 0; and then the other teachers were compared with the baseline. Of the six Transmath classes seen in Table 30, four of the Transmath teachers measured in the "appropriately implemented" category with a grand mean of 2.00-3.00. There were two additional Transmath teachers, Teacher A and Teacher L, who did not measure "appropriately implemented." Teacher A's observation mean from his six classroom observations was 1.96, placing him in the "somewhat properly implemented" category; however, interview data from this teacher indicated experience as an EC teacher gave him the confidence to deviate from the scripted program at times and add previously used material. This experience may have been a factor in the significant growth his students showed. Teacher L did not implement the program with fidelity, as his grand mean was 1.20, placing him the "somewhat properly implemented" category and well below any of the other Transmath teachers. When he was interviewed, his displeasure with the program was apparent; and he admitted to not only ignoring the script and lessons most of the time but also ending the program in mid-February, well before the study was over. After all of the quantitative and qualitative data were collected and analyzed, a close connection was discovered between the growth in Moby Max scores and the level of implementation fidelity for Transmath.

Each Vmath teacher was observed six times to determine the level of implementation score. A mean was calculated and compared with the statistically determined growth scores from part 1 of the study, as seen in Table 31. Teacher L is not included in Table 31 highlighting Vmath teachers due to the statistical test run. In order to compare among the groups, one teacher, in this case Teacher L, was set as a baseline, setting the parameter at 0; and then the other teachers were compared with the baseline.

Table 31

Vmath Observation Means and Measured Growth Scores Significance

Teacher	Observation Mean	Growth Significance
C	2.10**	.115
D	1.89	.522
G	2.33**	.260
H	1.90	.001*
K	2.01**	.151

*indicates significant growth.

Of the five Vmath teachers, Teachers C, G, and K scored in the “properly implemented” category; however, only Teacher H showed significant growth. Teacher H showed significant growth but scored in the “somewhat properly implemented” category. Teacher D showed neither significant growth nor a high level of implementation fidelity. After all of the data were collected and compared, the researcher could not determine a correlation with the level of implementation fidelity and growth with the Vmath program.

For this reason, the researcher determined that the Vmath program was less effective than the Transmath program.

Part three of this study collected teacher perception data related to the program and the level of implementation. When overall teacher perception, as seen in Table 32, was added to the other collected data, the researcher discovered all but one of the Transmath teachers had a positive perception of the program.

Table 32

Overall Teacher Perceptions of the Programs as Determined Through Interviews

Intervention Class	Teacher	Teacher Perception
Transmath	A	Positive
Transmath	B	Positive
Transmath	E	Positive
Transmath	F	Positive
Transmath	J	Positive
Transmath	L	Negative
Vmath	C	Negative
Vmath	D	Negative
Vmath	G	Negative
Vmath	H	Negative
Vmath	K	Negative
Vmath	H	Negative

Table 32 highlighted the fact that Teacher L, with a negative perception, was the outlier of the Transmath teachers. All of the Vmath teachers had a negative perception of the program. The teacher perceptions from Table 32 were combined to show an overall perception of each intervention program, as seen in Table 33.

Table 33

Overall Teacher Perception of Transmath and Vmath

General Perception	Vmath	Transmath
Positive	0	5
Negative	5	1

The researcher determined that this negative teacher perception had an impact on both the lower levels of implementation fidelity and the lower rate of success for the Vmath intervention program.

Connections to Theoretical and Conceptual Frameworks

RTI framework. The RTI model states that the primary instruction level should include quality core instruction; yet when students are not making adequate progress in core instruction, intervention programs should be added as tiered level instruction. "An intervention program could be implemented with this subset of students to provide them with more explicit instruction and more practice opportunities, so that they can make adequate progress to meet grade level standards" ("Use highly specific," n.d., para. 2). Unless intervention programs are successful at providing low-achieving students with the essential components of more practice and explicit instruction, they will continue to fall further behind their peers.

This study was used to determine whether Vmath and Transmath were useful intervention programs to help struggling middle-grade students make adequate progress in mathematics. Both Vmath and Transmath are considered Tier 2 math intervention programs in the RTI model. Once a student is placed in Tier 2, the intensity of the instruction increases both in time and amount of instruction. "Tier 2 consists of children who fall below the expected levels of accomplishments and are at some risk for academic failure" (Shapiro, 2015, para. 1). For the Transmath and Vmath students, they received this intervention for 45 minutes a day, every day of the week. These services and interventions are provided in small-group settings in addition to instruction in the general curriculum. Each class of Transmath and Vmath interventions included 15 students or less.

In Tier 2, data are used to determine the type of instruction the student may need. During Tier 2 instruction, students are progress monitored to measure the effect of the intervention. If a student is not responding to the Tier 2 instruction, he or she will be moved to Tier 3 intervention. Progress monitoring was an important part of both intervention programs and was part of the fidelity implementation observation. The findings of this study showed that both the Vmath and Transmath programs resulted in growth. However, when further investigated through teacher interviews and classroom observations, the level of implementation fidelity was not appropriate within the Vmath intervention program. Appropriate progress monitoring and administration of assessments are essential elements in the RTI framework, and the information from this study indicated that the Vmath teachers did not implement with fidelity. The fact that the Vmath intervention program was not as successful as Transmath gives credence to the role implementation fidelity plays in programs being used in schools.

Theory of Constructivism. Piaget's Theory of Constructivism is important in curriculum and education because teachers have to enhance a student's understanding and conceptual growth in a subject (Piaget's Theory, 2015, para. 2). According to Richardson (1997), Constructivism is a theory of learning and focuses on the way people learn (p. 3). The two math intervention classes, Transmath and Vmath, allowed students to be placed in a class with other students who had similar learning styles and background knowledge as well as with a teacher who delivered material in a different way than the regular classroom teacher. In this situation, students have another opportunity to make connections between prior and new knowledge that they were unable to make in the traditional delivery method. One reason for the success of the Transmath program may be that it was developed so the delivery of the scripted material is in alternate formats from the traditional.

The researcher discovered through classroom observations and teacher interviews that the delivery of the intervention material and the teacher perception were important elements relating to the success of the intervention program. In classes where the level of implementation fidelity was measured as “appropriately implemented,” which means the teacher was following the script and suggested method of delivery of material, and the teacher perception was positive, the growth measured in assessment scores for the program was directly related.

Through observations and interviews, the researcher discovered that the teachers in the Vmath classes did not like the elements of the lessons. Even though three of the five Vmath teachers implemented with fidelity, their negative perception of the program and materials may have influenced how they delivered the material. Their perceptions of the effectiveness of the program may have impacted students’ engagement with the lessons, resulting in less growth than the students in the Transmath classes. Five of the six Transmath teachers’ perceptions were positive, and four of the six Transmath teachers also implemented the program with fidelity. Their perceptions of the effectiveness of the program may have impacted their students’ engagement, resulting in more growth than the students in the Vmath students.

The observations and teacher interviews were related to Piaget's Theory of Constructivism that focused on how learning occurs and the importance of the teacher and delivery of the material. The delivery of the material is essential to the student gaining understanding; and as seen in the perceptual data, teachers who have a negative perception of a curriculum are not as effective at presenting the material. As such, the students are not as successful at learning the material.

Vygotzgy's ZPD. Vygotsky's ZPD stated that communication of mathematical ideas in smaller settings helps students solidify the mathematics concepts and abstract ideas. When a student has reached ZDP, giving him or her appropriate assistance will allow that student to achieve a task (Siyepu, 2013, p. 6). When students reach the point where they can advance in a skill with the help of a teacher, they will begin to grow academically. Helping a student reach this ZPD is the goal of intervention classes. When an intervention teacher is not willing or able to deliver material to a student who has reached ZPD, the student will not advance in skills and knowledge. The individual Transmath and Vmath classes that did not show significant growth were led by teachers who, due to the negative perception of the program, did not deliver the information with fidelity in a way that was helpful for the students to achieve at a higher level.

John Hattie's hinge point. John Hattie (2009) developed a way of ranking influences related to learning and achievement according to their effect sizes ("Hattie effect," 2016, para. 1). He ranked 138 educational influences or activities and found that the average effect size was .40, which he called his 'hinge point." He stated that any influence that resulted in an effect size of .40 or higher would produce positive effects on learning. Some of the influences Hattie reported on his effect sizes table that also relate to this study are highlighted in Table 34.

Table 34

Hattie's Effect Sizes of Influences

Influence	Effect Size
Teacher Estimates of Achievement (Perception)	1.62
Teacher Efficacy (Perception)	1.57
RTI	1.07
Instructional Quality	1.04
Direct Instruction	.82
Remediation/Feedback	.65

Table 34 highlighted effects on student success and achievement. Hattie studied six areas that he felt contributed to learning; three of those are included in this study: the curriculum, the teacher, and teaching and learning approaches. The curriculum alone will not result in positive effects on learning. Using Piaget, Vygotsky, and Hattie as academic references, the researcher's goal was to determine if Transmath and Vmath, when administered with fidelity, would result in significant academic growth for students who are identified as needing Tier 2 intervention according to the RTI framework. The results from this study agree with Piaget, Vygotsky, and Hattie in their ideas that the way a teacher delivers material to the class will affect the way a student responds to that material and whether that student does or does not experience success. A program's success cannot rely on growth scores alone. The fidelity of implementation and the perception of the teacher delivering the material must be considered when deciding on the use of a particular program.

Limitations and Suggestions for Improving this Study

If this study were to be performed again, it would be important to collect data for more than a school year. The students who are placed in the Transmath intervention program should be tracked for their entire middle school career to determine if the growth is sustained and continued. Because the students in this study were significantly below grade level, it would be a suggestion to offer Transmath to all grade levels but to track sixth-grade students in this program and continue the program with them through seventh and eighth grade or until they reach grade-level performance. The mean growth for the Transmath students was more than 2 years. Therefore, if students who were more than 2 years below grade level continued this program for 1 or 2 more years, there is a possibility that they might move to grade-level performance before they were promoted to high school. If a student is placed in this program in seventh or eighth grade and more than two grade levels behind, there may not be enough time to raise their math scores to the appropriate grade level.

Two important implications that could be produced from this study would first be the discussion between administrators, school officials, and teachers of placing too much emphasis on high stakes testing scores and not taking into account growth scores. If a program or curriculum can produce 2 or more years of growth per year of teaching, such as the Transmath program in this study, the students involved in these programs or classes could eventually close the academic achievement gap and catch up to their grade-level peers. Second, it is important that teacher perceptions of programs they are asked to teach are positive. From the data collected in this study, it was shown that when teachers like the program they are teaching and believe in the quality of the curriculum, they will follow the curriculum and implement with a higher level of fidelity. A higher level of implementation fidelity could lead to more student achievement growth, once again closing the academic achievement gap.

Recommendations for Further Research

This study provided a starting point for an area of research that could take place in the future. First, because both the Transmath and Vmath interventions are classified as Tier 2 and target some of the lower performing students, tracking the improvement in scores over several years would be an important study.

Another suggestion for further study is to include student perceptions of the program. Only including teacher perceptions gave the researcher a well-rounded view of the administration and content of the intervention material, but there was no information about the students' ideas and feelings about the material, pace of instruction, or class in general. The teacher perception for Transmath was positive and there was significant growth for the Transmath students; however, it would be valuable information to understand student perceptions and how they felt about having two math classes a day. Gaining student insight into the Vmath program could also lead to more evidence of why the program was not as effective as Transmath, or it may lead the researcher to conduct another study on the program with different teachers to discover if those teachers also had a negative perception of the program.

Summary

The researcher spent several months tracking data, observing classrooms, and interviewing teachers to determine the effectiveness of the math intervention programs being used at a particular middle school. After the completion of this study, the collected data and findings were presented to the administration at this school and were used to determine whether or not these intervention programs would be offered to students the next school year. Due to the information collected and the outcome of this study, Transmath will be included in the math intervention programs for the following school year, and Vmath will be replaced with another program.

References

2x Learning. (n.d.). Retrieved from http://data.mobymax.com/mc/documents/MaxMax%20Research-Based%20Pedagogy.pdf

6 Critical Components of a Strong Math Intervention Program. (n.d.). 1-12. Retrieved August 2, 2015, from http://ascendmath.com/PDFs/Ascend_Math_Six_Components.pdf

About Us. (2015). Retrieved July 21, 2015, from http://www.voyagersopris.com/about-us

Accountability Services. (n.d.). Retrieved from http://www.ncpublicschools.org/accountability/testing/eog/

ACT Research and Policy. (2012). Retrieved from https://www.act.org/research/policymakers/pdf/RaceEthnicityReport.pdf

American Education Research Journal. (n.d.). Retrieved from http://aer.sagepub.com.ezproxy.gardner-webb.edu/content/48/2/268.full.pdf+html

ANOVA - Statistics Solutions. (n.d.). Retrieved from http://www.statisticssolutions.com/?s=ANOVA

Assisting Students Struggling with Mathematics: Response to Intervention (RtI) for Elementary and Middle Schools. (2009). *IES practice guide,* 1-98. Retrieved August 15, 2015, from http://ies.ed.gov/ncee/wwc/pdf/practice_guides/rti_math_pg_042109.pdf

Atherton, J. S. (2013). *Learning and teaching: Piaget's developmental theory* [On-line: UK]. Retrieved January 16, 2016, from http://www.learningandteaching.info/learning/piaget.htm

Barriers Rooted in Race and Gender Bias Harm Educational Outcomes of African American Girls and Must Be Addressed, New Report Shows | NAACP LDF. (2014, September 23). Retrieved from http://www.naacpldf.org/press-release/barriers-rooted-race-and-gender-bias-harm-educational-outcomes-african-american-girls

Bender, W. N., & Crane, D. N. (2010). *RTI in math: Practical guidelines for elementary teachers.* Bloomington, IN: Solution Tree Press. Retrieved from http://www.ebrary.com.ezproxy.gardner-webb.edu

Burns, M. (2010). Response-to-intervention research: Is the sum of the parts as great as the whole? Retrieved August 4, 2015, from http://www.rtinetwork.org/learn/research/response-to-intervention-is-the-sum-of-the-parts-as-good-as-the-whole

Cambium Learning. (2010). Retrieved from http://www.voyagerlearning.com/docs/default-source/white-papers/wp_vmath.pdf

Carroll, C., Patterson, M., Wood, S., Booth, A., Rick, J., & Balain, S. (2007, November 30). A conceptual framework for implementation fidelity. Retrieved August 25, 2015, from http://www.implementationscience.com/content/pdf/1748-5908-2-40.pdf

Carter-Smith, K. (2015). Response to intervention (RTI). *Research starters: Education (Online Edition)*. Retrieved from http://connection.ebscohost.com/c/articles/31962649/response-intervention-rti

Center for Public Education. (n.d.). Measuring student growth: A guide to informed decision making. Retrieved from http://www.centerforpubliceducation.org/Main-Menu/Policies/Measuring-student-growth-At-a-glance/Measuring-student-growth-A-guide-to-informed-decision-making.html

Center on Response to Intervention. (2015). Universal Screening | Center on Response to Intervention. Retrieved from http://www.rti4success.org/essential-components-rti/universal-screening

Chappell, B. (2013, Dec.3). U.S. students slide in global ranking on math, reading, science. (Blog). Retrieved from http://www.npr.org/sections/thetwo-way/2013/12/03/248329823/u-s-high-school-students-slide-in-math-reading-science

Clements, D. H., & Sarama, J. (2015). Early childhood mathematics intervention. *Science, 333*(6045), 968-970. Retrieved from http://www.sciencemag.org/content/333/6045/968.full.pdf?sid=48869210-fbcb-4972-907c-a41f540eb3ed

Cooper, C. (2015, October 1). Instructional interventions that have proven to be successful with low achieving students. Retrieved from http://www.doe.virginia.gov/federal_programs/esea/title1/part_a/instructional_interventions.pdf

Crawford, L., Carpenter, D. I., Wilson, M. T., Schmeister, M., & McDonald, M. (2012). Testing the relation between fidelity of implementation and student outcomes in math. *Assessment for Effective Intervention*, *37*(4), 224-235.

Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Merrill.

Creswell, J. W., & Plano, C. V. (2011). *Designing and conducting mixed methods research*. Los Angeles: SAGE Publications.

Culatta, R. (2011). Zone of proximal development. Retrieved from http://www.innovativelearning.com/educational_psychology/development/zone-of-proximal-development.html

Differentiating Instruction in the Mathematics Classroom, Teaching Today, Glencoe Online. (2005). Retrieved June 24, 2015, from http://www.glencoe.com/sec/teachingtoday/subject/dimath.phtml

Education Commission of the States. (2013). *Math in the early years: A strong predictor for later school success.* Retrieved from http://www.du.edu/kennedyinstitute/media/documents/math-in-the-early-years.pdf

Elementary and Secondary Education Act | U.S. Department of Education. (n.d.). Retrieved from http://www.ed.gov/esea

Ferrara, J. (2010). *The effect of learning styles strategies on benchmark eighth grade middle school mathematics achievement* (Doctoral Dissertation). Retrieved from ScholarWorks. (3397130).

Fidelity | Define Fidelity at Dictionary.com. (n.d.). Retrieved from http://dictionary.reference.com/browse/fidelity

Fidelity Assessment and Usable Interventions. (2015). Retrieved August 25, 2015, from http://implementation.fpg.unc.edu/module-7/active-implementation-frameworks/fidelity-assessment-and-usable-interventions

Field, A. (2012). Analysis of covariance (ANCOVA). Retrieved from http://www.statisticshell.com/docs/ancova.pdf

Fisher, R., Smith, K., Finney, S., & Pinder, K. (2014). The importance of implementation fidelity data for evaluating program effectiveness. *About Campus*, *19*(5), 28. doi:10.1002/abc.21171

Fitzpatrick, J. L., Sanders, J. R., Worthen, B. R. (2011). *Program evaluation: Alternative approaches and practical guidelines*. Upper Saddle River, NJ: Pearson Education.

Goss, P., & Hunter, J. (2015, January). Achievement matters but what about tracking learning progress? | Grattan Institute. Retrieved from http://grattan.edu.au/news/achievement-matters-but-what-about-tracking-learning-progress/

Hanover Research. (2014, August). Retrieved from https://www.mbaea.org/documents/filelibrary/numeracy/Best_Practices_in_Math_Intervention_53D80FEED7650.pdf

Harlacher, J. (n.d.). Distinguishing between Tier 2 and Tier 3 instruction in order to support implementation of RTI | RTI Action Network. Retrieved from http://www.rtinetwork.org/essential/tieredinstruction/tier3/distinguishing-between-tier-2-and-tier-3-instruction-in-order-to-support-implementation-of-rti

Hattie effect size list - 195 Influences Related To Achievement. (2016). Retrieved from http://visible-learning.org/hattie-ranking-influences-effect-sizes-learning-achievement/

Hesse-Biber, S. N. (2010). *Mixed methods research: Merging theory with practice.* New York, NY: Guilford Press. Retrieved from http://www.ebrary.com.ezproxy.gardner-webb.edu

Indiana Department of Education. (2009). Retrieved from http://notebook.lausd.net/pls/ptl/docs/PAGE/CA_LAUSD/LAUSDNET/OFFICES/RESPONSE_INTERVENTION_HOME/RTI_RESOURCES/PUPIL%20SERVICES,%20MY DATA,%20AND%20RTI.PDF

Intervention Central. (n.d.). Retrieved from http://www.fehb.org/CSE/CCSEConference2012/wright_CCSE_Pre_Conference_Tchr_First_Responder_14_Mar_2012.pdf

Job, J. (n.d.). Response to intervention (RTI). Retrieved from http://www.learnnc.org/lp/pages/6880

Kasten, M. (2005). *Prime: Prompt intervention in mathematics education*. S. Wagner (Ed.). Retrieved from http://pages.uoregon.edu/projdata/assets/Koontz_104-135.pdf

Knestrick, J. (2012, November). The zone of proximal development (ZPD) and why it matters for early childhood learning. Retrieved from https://www.nwea.org/blog/2012/the-zone-of-proximal-development-zpd-and-why-it-matters-for-early-childhood-learning/

Kozulin, A. (2003). *Vygotsky's educational theory in cultural context*. UK: Cambridge University Press.

Ladson-Billings, G. (1997). It doesn't add up: African American students' mathematics achievement. *Journal for Research in Mathematics Education, 28*(6), 697-708.

Math Intervention - DreamBox Learning. (2015). Retrieved August 12, 2015, from http://www.dreambox.com/math-intervention

McMaster, K. L., Jung, P., Brandes, D., Pinto, V., Fuchs, D., Kearns, D., . . . Yen, L. (2014). Customizing a research-based reading practice: Balancing the importance of implementation fidelity with professional judgment. *The Reading Teacher*, *68*(3), 173.

Mellard, D. (2010). Fidelity of implementation within a response to intervention (RTI) framework. Retrieved from http://ped.state.nm.us/ped/RtIdocs/Fidelity%20of%20Implementation%20guidev5.pdf

Metz, A. (2007, October). Research to results. Retrieved from https://cyfar.org/sites/default/files/Child_Trends-2007_10_01_RB_WhyProgEval.pdf

Moby Max Makes Individualized, Adaptive Learning a Reality for Grades K-8—Emerging. (2015). Retrieved from http://www.emergingedtech.com/2015/03/moby-max-individualized-adaptive-learning-

NAEP Nations Report Card – National Assessment of Educational Progress – NAEP. (n.d.). Retrieved from http://nces.ed.gov/nationsreportcard/

National Implementation Research Network, NIRN project site. (2015). Retrieved from http://nirn.fpg.unc.edu/

National Math Panel Report Endorses Vmath Intervention Program Research Base. (2008, April 29). *PR Newswire*. Retrieved from http://ezproxy.gardner-webb.edu/login?url=http://go.galegroup.com.ezproxy.gardner-webb.edu/ps/i.do?id=GALE%7CA178409461&v=2.1&u=nclivegwu&it=r&p=AONE&sw=w&asid=c802984515747c5b95b1c47da42174f5

North Carolina Public Schools. (n.d.). Retrieved from http://ec.ncpublicschools.gov/instructional-resources/behavior-support/resources/researchinterventions.pdf

Ozer, O. (2004). Constructivsm in Piaget and Vygotsky. *Fountain on Life, Knowledge and Belief*, *2*(48).

Parry, W. (2012, April 9). Livescience. Retrieved from http://www.livescience.com/19552-girls-math-teachers-bias.html

Petty, T., Wang, C., & Harbaugh, A. P. (2013). Relationships between student, teacher, and school characteristics and mathematics achievement. *School Science and Mathematics*, *113*(7), 333-344.

Piaget's theory on constructivism. (2015). Retrieved from http://www.teach-nology.com/currenttrends/constructivism/piaget/

PR, N. (2014, August 28). Voyager Sopris Learning releases new edition of Vmath: Math instruction built specifically to support the 21st century student. *PR Newswire US*. Retrieved from http://www.prnewswire.com/news-releases/voyager-sopris-learning-releases-new-edition-of-vmath-math-instruction-built-specifically-to-support-the-21st-century-student-273036571.html

Prescreening - definition of prescreening by The Free Dictionary. (n.d.). Retrieved from http://www.thefreedictionary.com/prescreening

QMSS e-Lessons | Validity and Reliability. (n.d.). Retrieved from http://ccnmtl.columbia.edu/projects/qmss/measurement/validity_and_reliability.html

Reference World. (n.d.). Retrieved from http://www.referenceworld.com/sage/socialscience/triangulation.pdf

Research-to-Results. (n.d.). Retrieved from https://cyfernetsearch.org/sites/default/files/Child_Trends-2007_10_01_RB_WhyProgEval.pdf

Response to Intervention. (2012). Retrieved August 16, 2015, from http://old.benchmarkeducation.com/rti-solution-center/rti-response-to-intervention.html

Response to Intervention Explained | Special Education Guide. (2015). Retrieved from http://www.specialeducationguide.com/pre-k-12/response-to-intervention/

Richardson, V. (1997). *Constructivist teacher education: Building new understandings*. London, England: Falmer Press.

Robinson-Cimpian, J. P., Lubienski, S. T., Ganley, C. M., & Copur-Gencturk, Y. (2014). Teachers' perceptions of students' mathematics proficiency may exacerbate early gender gaps in achievement. *Developmental Psychology*, *50*(4), 1262-1281.

RTI Action Network. (n.d.). RTI and math instruction. Retrieved from http://www.rtinetwork.org/learn/what/rtiandmath

Runkel, P. (2015, January 27). *Understanding hypothesis tests: Significance levels (Alpha) and P values in statistics*. Retrieved from http://blog.minitab.com/blog/adventures-in-statistics/understanding-hypothesis-tests%3A-significance-levels-alpha-and-p-values-in-statistics

Scantlebury, K. (2009, December 23). Gender bias in teaching | Education.com. Retrieved from http://www.education.com/reference/article/gender-bias-in-teaching/

Scott, B. (2012). *The effectiveness of differentiated instruction in the elementary mathematics classroom.* (Doctoral Dissertation). Retrieved from http://cardinalscholar.bsu.edu/bitstream/handle/123456789/195872/ScottB_201;jsessionid=08681E4A8DFB266A6D1AF94D7D184D80?sequence=1

Searle, M. (2015). *A study guide for what every school leader needs to know about RTI*. Retrieved from http://www.ascd.org/publications/books/109097/chapters/What-Is-RTI-and-Why-Should-We-Care¢.aspx

Shabani, K. (2010). Vygotsky's zone of proximal development: Instructional implications and teachers' professional development. *English Language Teaching*, *3*(4), 237-248. Retrieved from http://dx.doi.org/10.5539/elt.v3n4p237

Shapiro, E. (2015). Tiered instruction and intervention in a response-to-intervention model. Retrieved August 16, 2015, from http://www.rtinetwork.org/essential/tieredinstruction/tiered-instruction-and-intervention-rti-model

Siyepu, S. (2013). The zone of proximal development in the learning of mathematics. *South African Journal of Education*, *33*(2), 1-14. Retrieved from http://www.sajournalofeducation.co.za

Smith, S. K. (Demographer), author. (2013). *A practioner's guide to state and local population projections*. Retrieved from http://www.springer.com/us/book/9789400775503

Sparks, S. (2015). Study: RTI practice falls short of promise. *Education Week*. Retrieved from http://mobile.edweek.org/c.jsp?cid=25919761&bcid=25919761&rssid=25919751&item=http%3A%2F%2Fapi.edweek.org%2Fv1%2Few%2F%3Fuuid%3D97B7BF42-84C0-11E5-B0E4-71C9B3743667&cmp=soc-edit-tw-tm

Spillman, L. (2014). Mixed methods and the logic of qualitative inference. *Qualitative Sociology*, *37*(2), 189-205. doi:10.1007/s11133-014-9273-0

Stating the Obvious: Writing Assumptions, Limitations, and Delimitations | Choosing a Research Design | Thesis and Dissertation Survival. (2015). Retrieved from http://www.phdstudent.com/Choosing-a-Research-Design/stating-the-obvious-writing-assumptions-limitations-and-delimitations

Steele, D. F. (1999). Learning mathematical language in the zone of proximal development. *Teaching Children Mathematics, 6*(1), 38. Retrieved from http://ezproxy.gardner-webb.edu/login?url=http://search.proquest.com.ezproxy.gardner-webb.edu/docview/214138784?accountid=11041

Tapia, M., & Marsh, G. I. (2000). Effect of gender, achievement in mathematics, and ethnicity on attitudes toward mathematics. Retrieved from http://eric.ed.gov/?id=ED449044

Tiered Instruction and Assessment. (2007, September 23). Retrieved August 16, 2015, from https://challengebychoice.wordpress.com/tiered-instruction-and-assessment/

Tiered Instruction in a Response-to-Intervention Model | RTI Action Network. (n.d.). Retrieved from http://www.rtinetwork.org/essential/tieredinstruction/tiered-instruction-and-intervention-rti-model

Transition Mathematics. (2007, March 12). Retrieved July 21, 2015, from http://ies.ed.gov/ncee/wwc/pdf/intervention_reports/WWC_Transition_Math_031207.pdf

Transmath Teacher Resource Guide. (2010). Longmont, CO: Cambium.

Transmath Training Manual. (2010). Longmont, CO: Cambium.

Trochim, W. (2006, October 20). The t-test. Retrieved from http://www.socialresearchmethods.net/kb/stat_t.php

Understanding Response to Intervention | What Is RTI? - Understood. (2015). Retrieved from https://www.understood.org/en/school-learning/special-services/rti/understanding-response-to-intervention#item

United States Department of Education. (2008). Foundations for success. Retrieved from http://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

Universal Screening | Center on Response to Intervention. (n.d.). Retrieved from http://www.rti4success.org/essential-components-rti/universal-screening

Urdan, T. C. (2010). *Statistics in plain English*. New York: Routledge.

Use highly explicit and systematic intervention materials for students significantly below grade level | Oregon Literacy Professional Development. (n.d.). Retrieved from http://oregonliteracypd.uoregon.edu/topic/use-highly-explicit-and-systematic-intervention-materials-students-significantly-below-grade-l

Using Fidelity to Enhance Program Implementation Within an RTI Framework. (n.d.). Retrieved September 7, 2015, from http://www.rti4success.org/sites/default/files/Using Fidelity to Enhance Program Implementation_PPTSlides.pdf

VanDerHeyden, A. (2015). RTI and math instruction. Retrieved August 15, 2015, from http://www.rtinetwork.org/learn/what/rtiandmath

Vmath Training Manual. (2012). Cambium. Retrieved from http://cdn2.hubspot.net/hub/208815/file-400880872-pdf/2013_projects/vmath_live/vmathlive_extended_training_guide.pdf

Voyager Learning. (2009). Retrieved from http://www.voyagersopris.com/info/polk-county/docs/research-docs/VmathWhitePaper.pdf

Voyager Sopris. (2015). Vmath Third Edition. (2015). Retrieved from http://www.voyagersopris.com/curriculum/subject/math/vmath-third-edition

What are Independent and Dependent Variables?-NCES Kids' Zone. (n.d.). Retrieved from https://nces.ed.gov/nceskids/help/user_guide/graph/variables.asp

What Is Assessment? › Assessment › University of Connecticut. (n.d.). Retrieved from http://assessment.uconn.edu/what/index.html

What is Differentiated Instruction? – Examples, Definition & Activities, Study.com. (n.d.). Retrieved from http://study.com/acadmey/lesson/what-is-dofferentiated-instruction-examples-definition-activities.html

What is Response to Intervention (RTI)? | RTI Action Network. (n.d.). Retrieved from http://www.rtinetwork.org/learn/what/whatisrti

What Works Clearinghouse. (2004, December 1). Retrieved July 7, 2015. Retrieved from http://ies.ed.gov/ncee/wwc/

What Works Clearinghouse. (2009, April 1). Assisting students struggling with mathematics: Response to intervention (RTI) for elementary and middle schools. Retrieved July 11, 2015, from http://ies.ed.gov/ncee/wwc/pdf/practice_guides/rti_math_pg_042109.pdf

Why Do Students Struggle With Mathematics | Education.com. (n.d.). Retrieved from http://www.education.com/reference/article/why-students-struggle-mathematics/

Williams, K. G. (2012). *The effect of differentiated instruction on standardized assessment performance of students in the middle school mathematics classroom.* (Doctoral Dissertation). Retrieved from http://cardinalscholar.bsu.edu/bitstream/handle/123456789/195872/ScottB_201?sequence=1

W. K. Kellogg Foundation (2004, January). Logic model development guide. Retrieved from http://www.smartgivers.org/uploads/logicmodelguidepdf.pdf

Woodard, J. (2015). TransMath Third Edition. Retrieved July 21, 2015, from http://www.voyagersopris.com/curriculum/subject/math/transmath/overview

Wright, J. (2015). From Jim Wright: Intervention Ideas for MATHEMATICS. Retrieved from http://www.jimwrightonline.com/php/interventionista/interventionista_intv_list.php?prob_type=mathematics

Appendix A

NCDPI Fidelity Form

Voyager Math

Fidelity Observation Form

SCHOOL DISTRICT:

SCHOOL NAME:

TEACHER''S NAME (LAST):

TEACHER''S NAME (FIRST):

Is this the first school year that the teacher has implemented the instructional model?

Yes

No

OBSERVER:

Observer Email:

Has the observer established inter-rater reliability with someone trained in this program?

Yes

No

DATE OF OBSERVATION:

START TIME:

END TIME:

PROGRAM LEVEL:

LESSON Number:

NUMBER OF STUDENTS OBSERVED:

GRADE LEVEL(S) OF STUDENTS OBSERVED:

NUMBER OF LESSONS TAUGHT TO DATE THIS SCHOOL YEAR:

____

Read the following statements and use the rating scale below to best describe your observation of the IMPLEMENTATION of each instructional skill. The observation should last through the entire reading lesson. Space is provided at the end of this form for comments. SCALE Rating 0 = Skill not demonstrated Rating 1 = Improperly Implemented Rating 2 = Somewhat Properly Implemented Rating 3 = Appropriately Implemented Leave the rating BLANK if the skill was NOT APPLICABLE to the

Quality of Instruction-Organization

	Rating
1. Intervention materials are close at hand.	______
2. Sufficient instructional and student materials are present.	______
3. The Three-Read Process is utilized to plan for instruction.	______
4. Small group instructional area is clearly identified.	______

Use of Curriculum Guide

	Rating
5. Curriculum Guide is closely referenced during instruction.	______
6. Explicit language is used and instructional models are followed closely	______
7. Pace is brisk and business-like, yet personal.	______
8. Instruction is deliberate and intentional.	______
9. Skills are modeled correctly.	______
10. The steps of the correction procedures are followed to provide immediate feedback,redirect, and check for mastery.	______

Student Engagement

	Rating
11. Clear reading/math behaviors andexpectations are established.	______
12. Automaticity and fluency are reinforced as students respond.	______
13. Students respond chorally and individually	______

Amount of Instruction

	Rating
14. Instruction delivered 4-5 days a week.	______
15. Instruction is delivered based on dailyminimums. (Passport and Vmath 30 mins/day., PRJ 50 mins/day.)	______
16. Current lesson is within five lessons of pacing calendar.	______

Classroom Management

	Rating
17. Other students in class are engaged in independent activities.	____________
18. Interruptions are minimal.	____________

Use of Assessments

	Rating
19. Benchmark measures are administered accurately.	____________
20. Placement Tests are administered todetermine appropriate lesson placement whenapplicable.-Adventure Placement Test – Passport-Word Study Placement Test – PRJ-Initial Assessment - Vmath.	____________
21.Progress Monitoring is administered regularly.	____________
22.Assessments are administered as designed.	____________
23. All assessment scores are entered online.	____________
24. Classroom data is analyzed to informinstruction.	____________

Differentiation

	Rating
25. Assessment data used to determinedifferentiated instruction.	____________
26. Small group instruction is used appropriately.	____________
27. Progress Monitoring is used to guideinstruction.	____________
28. Resources for re-teaching are used to intensifyinstruction for students that do not demonstrate mastery.	____________
29. Curriculum Features are used as designed.	____________
30.Online component used as designed.	____________

Please rate using the following scale: Not At All (0) Needs Improvement (1) Satisfactory (2) Outstanding (3)

	Rating
The time allocated for the lesson was sufficient.	____________
The teacher covered an appropriate amount of material for the time allocated.	____________
The delivery of the lesson was paced to students' needs.	____________

COMMENTS:

TOTAL NUMBER OF BLANK RATINGS:

Appendix B

Teacher Interview Form

Vmath and Transmath Teacher Perception
Guided Interview Questions and Procedures

Modified from Dawn Davis, University of Nebraska-Lincoln, with permission
Davis, D. L. (2014). Intervention Fidelity, Teacher perceptions and Child Outcomes of a Literacy Curriculum in a Head Start Program: A Mixed methods Study. Unpublished doctoral thesis. University of Nebraska – Lincoln.

This interview will be a discussion about the implementation and effectiveness of the intervention mathematics program. Responses will be confidential; no names will be used or reported.

Implementation RQ3	Effectiveness RQ4
1. Tell me about your experience with Vmath/Transmath.	8. How would you describe Vmath/Transmath curriculum?
2. Describe your implementation of Vmath/Transmath.	9. How do you feel about Vmath/Transmath?
3. How fully do you feel you implemented the program? Why?	10. How successful do you think Vmath/Transmath has been?
4. Are there parts of the curriculum you did not implement? Why?	11. Do you feel the curriculum impacted student learning ? How?
5. Was there anything that made a difference or influenced your implementation? What?	
6. Did you use the assessment information to influence your planning?	
7. Were there certain barriers that affected the implementation of the program?	

12. Is there anything else about this program you would like to comment on?

Appendix C

IRB Request and Approval from Intercontinental Schools

On Wed, Nov 18, 2015 at 4:21 PM, Angela Hines wrote:

Good afternoon. I am in the process of writing my dissertation and I am planning to defend my proposal in late December or early January. I need to get permission from the district to perform the research and Kelly Cooper advised me that I need to go through you. What is that process?
Thank you

Angela Hines
B.A., M.L.S., N.B.C.T.
Instructional Facilitator

--
Angela Hines
B.A., M.L.S., N.B.C.T.
Instructional Facilitator

Angela Hines <ahines@ Mon, Nov 23, 2015 at 11:56 AM
To: Melanie Taylor

Thank you so much.
[Quoted text hidden]

Igniting A Passion for Learning

Angela Hines <ahines@ nc.us>

Re: Dissertation Question

2 messages

Melanie Taylor <mtaylor
To: Angela Hines <ahine
Cc: David Ivey <divey(

Mon, Nov 23, 2015 at 11:50 AM

Angela

We discussed this today at Cabinet and it was approved for you to conduct your research at WMS with Mr. Ivey's approval as you move forward. As you noted in your summary, all district, school, teacher and student info should be blind data so as not to identify the individual, school or district.

Best of luck to you and let me know if you have any further questions.

Melanie Taylor, Ed.D
Deputy Superintendent of Curriculum and Instruction

On Thu, Nov 19, 2015 at 3:46 PM, Angela Hines wrote:

> I am attaching an executive summary of my dissertation proposal and the fidelity checks I will be using for the qualitative data. I will also be using Moby Max screening scores and Baseline and Benchmark scores for the quantitative data.
> If I need to send anything else to you, please let me know.
> Thank you
>
> Angela Hines
> B.A., M.L.S., N.B.C.T.
> Instructional Facilitator
>
> On Wed, Nov 18, 2015 at 4:42 PM, Angela Hines > wrote:
>
> > Great. I will be working on that and get it to you by the end of the week. Thank you
> >
> > On Wednesday, November 18, 2015, Melanie Taylor wrote:
> >
> > > Congratulations. You are close to the end. You would need to send me an executive summary of your proposed research and a copy of any surveys, etc that you would plan on using. I would then take to Cabinet for approval to move forward.
> > >
> > > Melanie Taylor, Ed.D
> > > Deputy Superintendent of Curriculum and Instruction