SUPPLEMENTAL NUMERACY INSTRUCTION FOR MIDDLE SCHOOL STUDENTS WITH SPECIAL NEEDS

A Record of Study

by

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Submitted to the Graduate and Professional School of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

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December 2021

Major Subject: Curriculum and Instruction

ABSTRACT

The purpose of the study was to explore the effects of focused numeracy instruction on the ratio in a middle school mathematics class and the lived experiences of students with special needs as they underwent the intervention. The intervention focused on using numeracy embedded into the intervention, specifically focusing on rational number learning. The study was discussed both quantitatively and qualitatively. The quantitative section studied the effects of focused numeracy instruction using the *Objective* and *Subjective Numeracy Scales.* Pre- (N = 53) and post-tests (N = 50) were used to test for a difference in students' numeracy and mathematics self-efficacy. The *Objective Numeracy Scales* focused on students' academic achievement while the *Subjective Numeracy Scales* focused on students' mathematical self-efficacy. The results were analyzed via a two-sample t-test. There was statistically significant growth in students' academic achievement. In the qualitative section of the study, seven middle school students with special needs were selected to participate in a descriptive phenomenology. Students with special needs were selected at random for interview questions. The analysis of the interviews initially showed growth in their own mathematical self-efficacy and competence in the topics discussed during the intervention. The themes derived from student interviews included: initially overwhelmed, math is not student's favorite subject, confidence after the lesson, an average day, real world applications, without prompting to solve, large number were difficult, did not like math, unknown topic, adding an activity, and misunderstood words. Initially, all students felt overwhelmed. Although, by the end of the lesson, students with special needs demonstrated their competence and growth during the interview process.

Results from the study show a growth in students' self-efficacy and numeracy. This was further confirmed during the interviews with students with special needs. Students with special needs shared some common suggestions during the interviews for improving future lessons. The interviews provided great insight into the artifact generated from this record of study.

DEDICATION

This study is dedicated to my wife and daughter. Without the consistent support of family, this study would have never come to fruition.

ACKNOWLEDGEMENTS

I would like to thank my committee chairs, Dr. Mary Margret Capraro and Dr. Robert Capraro, and my committee members, Dr. Bugrahan Yalvac, and Dr. Jennifer Whitfield, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience.

A special thank you to my school district and campus level administration for with your support and encouragement.

Finally, thanks to my wife, family, friends, and coworkers for their encouragement and for their patience and love.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a dissertation committee consisting of Professor Mary Margret Capraro and Professor Robert Capraro of the Department of Teaching Learning and Culture and Professor Bugrahan Yalvac of the Department of Teaching Learning and Culture, and Professor Jennifer Whitfield of the Department of Mathematics. All other work conducted for the dissertation was completed by the student independently.

Funding Sources

Partial funding for graduate study was supported by a scholarship for Online Ed.D. students from the Department of Teaching, Learning and Culture during the Fall 2019 and Spring 2020 semesters.

NOMENCLATURE

CCMR	College, Career, and Military Readiness
ELLs	English Language Learners
LEP	Limited English Proficient
NCTM	National Council of Teachers of Mathematics
NRC	National Research Council
OECD	Organization for Economic Cooperation and Development
ONS	*Objective Numeracy Scales*
SNS	*Subjective Numeracy Scales*
STAAR	State of Texas Assessment of Academic Readiness
STEM	Science, Technology, Engineering, and Mathematics
TAPR	Texas Academic Progress Report
TEA	Texas Education Agency
TEC	Texas Education Code
TEKS	Texas Essentials of Knowledge and Skills
TSIA	Texas Success Initiative Assessment
UIL	University Interscholastic League

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CHAPTER I

INTRODUCTION

The Context

Over the last three decades, more attention has been given to numeracy and fundamental questions about it have been posed. What is numeracy and what does it imply? Can we teach numeracy, and if so, how do we teach it? According to Wium and Louw (2012), numeracy is "the ability to understand and reason with numbers, to act wisely in daily living activities, and to participate in civic life. It also allows one to use mathematics to solve problems" (p. 8). With the given definition, numeracy's scope is beyond the mathematics classroom and can affect other content areas. Numeracy, much like literacy, should not be taught exclusively in the mathematics classroom. Currently, there is no clear unified curriculum to guide instructors on teaching numeracy. More interestingly, students who have a natural talent for numeracy will derive formulas and procedures themselves (National Research Council [NRC], 2001). Students who do not have an innate talent for mathematics need curriculum and instruction to address their lack of numeracy. Providing instructors with a viable curriculum that directly addresses numeracy could have a significant impact on not only students' educational career but hold substantial value when they enter the workforce and become productive members of society.

National Context

Numeracy, or quantitative literacy, has come to the forefront of recent research and importance. In 2008, the research journal, *Numeracy,* was created to address and advance education in quantitative literacy. Numeracy is becoming more apparent with a greater push toward fields of Science, Technology, Engineering, and Mathematics (STEM). The onset of the information age is an age of data analysis. Every degree field is filled with data-based decision making. There is no avoiding the fact that numeracy is important both in the local classroom and at the national level.

Most students who graduate high school are well below the expectations not only in mathematics but in quantitative literacy as well. Crowther (1959) noticed a gap in expectations for quantitative literacy in the Great Britain community. Because of the gap in quantitative literacy, specifically data analysis, the term numeracy was instituted to better clarify and define numeracy (Crowther, 1959; Craig, 2018). The gap for those who are numerate and those who are not numerate is not localized to Great Britain, and it affects all nations who use data to make decisions. A startling statistic is when examining numeracy proficiency scores amongst national rankings, the United States performed the lowest of 29 countries (Organization for Economic Cooperation and Development [OECD], 2016). An increased emphasis will help mathematics proficiency for students with a high school level of education.

The National Council of Teachers of Mathematics (NCTM) recognizes the importance of numeracy as well. Quantitative literacy is a frequent topic in their journals. NCTM's, *Teaching Children Mathematics*, and Australian National Curriculum highly recommend that literacy and numeracy be taught together regularly (Marston et al., 2013). Beaudine (2018), in an NCTM article, addressed both written forms and collaborative forms of quantitative literacy. Numeracy is of the utmost importance. It is fundamental to the development of a quality mathematics student and is correlated with literacy (Gurganus, 2004). The NCTM has published numerous yearbooks and research studies surrounding numeracy, quantitative literacy, and number sense in the last 30 years.

NCTM has made it a point to work on standards that create a more nationally unified curriculum. One of the reasons for this is because the U.S. Government gives control of curriculum to the state level of government. As of 1999, states model their own standards based on what NCTM has published (NRC, 2001). Yet, the differences among the states are still causing many issues. With each unique set of curriculum comes government-mandated examinations. These examinations have consequences for teachers and campus and district staff if standards are not met. Students are affected as well, because if they do not meet the standards, they may not graduate or move on the next grade level. While a more unified curriculum has been written, states can choose to follow or not.

Standards across the nation address content surrounding mathematical analysis and quantitative reasoning. The Common Core State Standards Initiative (2020) stated in their first-grade standards that students will “develop strategies” and “develop meaning.” Granted this is for addition and subtraction; however, every subsequent grade contains some form of the development of algorithms and strategies to continue to support student understanding in these mathematical topics. After understanding comes generalizing, which is at the core of algorithms. The quantitative portion of the American College Test (ACT) (2020) contains similar standards as well. “Analyze and draw conclusions” is used multiple times as the bar to reach if students want to score between 33-36 (ACT, 2020). Standards emphasize the need for quantitative literacy, but how are these standards being implemented and enacted in classrooms across the country is the issue. Often, educators fall into the trap of focusing on getting students to “pass the test,” although when they teach to the standards, the test, readiness exams, or college placement exams take care of themselves.

The focus of curriculum should no longer be rooted in computation of problems to pass tests but to better understand the reasoning behind the problems. In the past, the emphasis in mathematics classrooms was often on memorizing, or “drilling and killing.” with multiplication tables and simple arithmetic problems. A greater emphasis should be placed on both computational knowledge and understanding. These will continue to be more important with the rise of more technology-based jobs (NRC, 2001). Most basic computation becomes easier as a student develops flexibility in their mathematical abilities, and this allows for growth in other areas. If a student truly understands the processes of computation, they can translate what is happening into more advanced concepts. Students who can compute and understand a problem simply perform better.

Students naturally develop strategies to address rules that come from learning whole number operations that can scaffold into future concepts. Elementary students will often create visualizations and try to model a given equation so that they can create idiosyncratic strategies of their own (NRC, 2001). One of many aspects of being numerate is the ability to know multiple strategies and apply the best, most efficient strategy (Mcintosh et al., 1992). It is through repeated practice that students become fluent in strategies and algorithms (NRC, 2001). Educators should provide students every opportunity to reinforce and practice these learned strategies or algorithms.

There are multiple strategies that exist to help a student solve any one problem. These strategies cannot be learned by going through multiple examples (NRC, 2001). The best way to teach these strategies is to explain why and through a conceptual approach. As mentioned previously, through this conceptual approach, multiple strategies can be developed; and if these strategies are taught properly, students will begin to see that while one strategy may work this time, in the next situation that may not be the case. It is especially true for students who have special needs or who are learning English as a second language. Students with special needs and English Language Learners (ELLs) use similar processes with the only difference being that it may take a little longer to fully grasp certain strategies (NRC, 2001). When teaching mathematics, it is best to teach though a conceptual framework that further develops multiple strategies.

What makes learning mathematics unique at any level is that mathematics overall is purely abstract. We use abstract symbols to represent physical objects. A single digit can be represented in copious formats both in arbitrary and physical forms (NRC, 2001). More so, the symbols for operations such as addition, subtraction, division, and multiplication are all constructs formalized through abstract thought. To help students understand the abstractions of mathematics, physical models should be implemented to conceptualize meaning.

Students who are proficient have more than an innate talent for mathematics; they are "flexible, adaptive, and appropriate use of algorithms, all of which contribute to efficiency, problem solving, and transfer of ideas to new situations" (Star & Newton, 2009, p. 4). From elementary to post-secondary, mathematics concepts need to be taught conceptually for a student to generate flexibility and understanding.

The NRC has summed up proficiency in mathematics with five strands. The first being conceptual understanding, which is the understanding of mathematical concepts, algorithms, and the relationship of numbers (NCR, 2001). The second is being procedural fluency, which is the ability to apply algorithms and strategies in the most efficient way possible (NCR, 2001). Thirdly, is strategic competence, which is the ability to solve problems and represent the solutions (NRC, 2001). Fourthly, is adaptive reasoning, which is the ability to explain the reasoning behind the solution (NRC, 2001). Lastly, is productive disposition, which is the ability to see mathematics importance outside the context of the mathematics classroom (NRC, 2001) each of which are connected to numeracy. If students embody these five strands, they have a high mathematical proficiency.

Teaching supplemental numeracy can serve as one element that can assist students in obtaining deeper numeracy skills and closing gaps. Innumeracy is rampant in our nation, and we have the standards to address the issues. If this is the case, why does the United States continue to rank so low on international exams? Maybe standards are not comprehensive enough or are the gaps not being addressed? Do students embody the five strands? Through this record of study, I plan to address this issue of innumeracy, specifically with students with special needs.

Personal Context

My curiosity in exploring this study is twofold. The first part stems from my master's thesis in which the focus was improving secondary students' numeracy. The second piece comes from being a number sense coach for the last seven years. After my first two years of teaching both AP Mathematics and general education Algebra II, I worked toward getting a master's in mathematics education to further my education and become a better instructor. Through this, I began the inevitable obsession with number sense. In my second year of teaching, I became a coach for University Interscholastic League (UIL) events. I have had the joy of coaching three events: Calculator, Mathematics, and Number Sense. Topics in these three events include pre-algebra to geometry, calculus, and even number theory. Each event has made me a better mathematician, coach, and learner.

Researcher's Roles and Personal Histories

My career in education has been brief although broad at the secondary level. For the last nine years, I have taught Algebra I inclusion, Algebra II general education courses, Advance Placement (AP) Calculus AB, AP Calculus BC, AP Statistics, Dual Credit Pre-Calculus, and Dual Credit Statistics. I have also assisted in writing the Algebra II curriculum and assisted in the creation of a unified curriculum for kinder through fifth grade levels for my current district. I have taught in two school districts: one inner city and the current in a rural environment. My current school district although rural is transiting into a suburban district. Being in both districts has allowed me to work with economically disadvantaged, at risk, special needs, ELLs, and a variety of students. These experiences have given me the opportunity to observe and to fully engage in the mathematics Texas Essentials of Knowledge and Skills (TEKS) for the secondary level and kinder through fifth grade core classes.

I have served on many committees that are pertinent to my growth as an educational professional. Each committee has provided a more global view of education. The first committee was the site-based decision-making committee, where local decisions were made to policy and procedures at the high school level. I was a member of the site-based decision-making committee for four years. After that short tenure, I moved to the district-wide advisory committee. While on this committee, I served as a member for the first year and for two subsequent years as the committee chair. In this committee, both community members and district staff advise the superintendent and his assistants on policies and procedures that affect the district as a whole. While serving as the chair of the district-wide advisory council, I was given the opportunity to work on a district of innovation planning committee, of which I was also the chair. In the district of innovation committee, I was able to experience how the community and district staff work together to make improvements for the district. District of innovation allows for a public school to adopt some of the policies of a charter school given that the district meets all the state standards. While working as a teacher, I do not necessarily get a global view of education, although with my work on these committees I am able to achieve that view.

Why Numeracy?

While working on my master's degree in 2014 to 2015 and working on my thesis topics, I was trying to find a way to address mathematical deficiencies of students in my own classroom. I noticed that students who were able to work through a test without a calculator were often better than those who relied on them. I realized that the issue was much deeper and fundamental than previously thought. Success was not based on using a calculator or the calculator being used as a crutch. The problem was the lack of numeracy. Whether a student is in AP Calculus AB or a general education Algebra II course, those who struggled often lacked numeracy. Therefore, my master's thesis focused on trying to improve a student's level of numeracy at the secondary level (Brown, 2015). In progressing through my doctoral program, I realized the original design of my thesis needed to be enhanced to address the needs of students with special needs and have a focus on a high needs area given the district progress report.

District instructors often have the complaint that students are not up to par in mathematics but especially in numeracy. This is a difficult task to address because it is not the elementary teacher's fault that they are teaching the material, nor is it the middle school teachers' fault. The fact of the matter is that students have gaps, and some are larger than others. Instructors need to find a pathway or a strategy to address gaps, sometimes even in the middle of instructional time. The artifact I designed was supplementary instruction to target the gaps the student may have in numeracy.

Currently as a Dual Credit Statistics, Dual Credit Pre-Calculus, AP Calculus AB, and Calculus BC teacher, I try to address lower-level gaps in numeracy at minimum once a week. This is done either through pattern recognition or having students research a problem and generalize it even if it has nothing to do with what we are studying. In my opinion, this helps a student become a better mathematician and helps students solve problems that would otherwise be considered difficult. Using elementary TEKS ultimately helps solidify a crumbling foundation in mathematics.

Instructors data-mined for gaps using assessments that are based on course TEKS. The problem is that TEKS-driven data do not always reveal deficiencies in numeracy. To be clear, data mining using the TEKS is a sound process, just not for numeracy. Therefore, contrary to the data mining and working on troubled TEKS, my students and I worked on basic skills that stem from elementary TEKS. The TEKS for numeracy are there; they are just considered to be supporting standards or overarching standards. For example, in Kindergarten 8: A-C:

> (8) Data analysis. The student applies mathematical process standards to collect and organize data to make it useful for interpreting information. The student is expected to: (A) collect, sort, and organize data into two or three categories; (B) use data to create real-object and picture graphs; and (C) draw conclusions from real-object and picture graphs (TEKS, 2020).

Kinder students are required to organize their thoughts and make inferences from given situations. Making inferences as a kindergartener seems to be advanced, but it is a hallmark of numeracy. Similar concepts can be found at the first-grade level as well. An example from the first grade TEKS is:

> (8) Data analysis. The student applies mathematical process standards to organize data to make it useful for interpreting information and solving problems. The student is expected to: (A) collect, sort, and organize data in up to three categories using models representations such as tally marks or T-charts; (B) use data to create picture and bar-type graphs; and (C) draw conclusions and generate and answer questions using information from picture and bar-type graphs (TEKS, 2020).

Each subsequent grade level through the fifth-grade addresses numeracy in some form or facet. I feel that through my internship, I am obtaining the knowledge and skills that helped carry this practice of supplemental numeracy though the middle school and high school programs.

Situational Context

District Demographics

The district where I work has a student population of 5,424 and growing. The district currently has five elementary, two middle, and one high school campus. All schools in the district are located due west of San Antonio and centered in Castroville, Texas. The district is considered a fast-growth district. Texas Education Agency (TEA) defines a fast-growth district as one whose student enrollment is increasing in the top quartile of the state over the last three years (Texas Education Code [TEC], §48.111). The second middle school opened just three years ago. The demographic composition is 0.6% Asian, 3.6% African American, 0.5% Native American, 31.2% White, and 60.9% Hispanic. The district is a Title 1 district and 51.2% of students are considered economically disadvantaged; this number is steadily growing. The dropout rate is 0.4% and 5.8% are ELLs. Special education is provided to 11% of the students and 5.1% of the students are classified as gifted and talented. The district has a 14.5% mobility rate, a 95.5% attendance rate, 28% are considered at-risk, and suspended students average 1.6% of the student body each year (TEA, 2019b).

The new middle school has a population of 692 students. The demographic composition is Asian 0.6%, 5.1% African American, 0.7% Native American, 22.5% White, and 66.3% Hispanic. There is a 0% mobility rate, 48.6% are economically disadvantaged, 5.5% are ELLs, 10.7% are special education. The reason for the 0% mobility rate is because the campus is new. The original middle school has a student population of 609. The demographic composition is 0.2% Asian, 0.5% African American, 0.5% Native American, 35.3% White, and 60.8% Hispanic; 54.5% are economically disadvantaged, 4.9% are ELLs, 10% are special education, with a 13.3% mobility rate (TEA, 2019b).

The following data are specifically from the district's students with special needs population. On the 5th grade Math State of Texas Assessment of Academic Readiness (STAAR), 82% met the state standard, 38% required accelerated instruction, and 14% did not meet the standard. In the eighth-grade STAAR, 33% approached grade level, 67% required accelerated instruction, and 43% met the standards. Across the district, 56% approached grade level, 24% met grade level, and 8% mastered their grade level; 11.1% passed the Texas Success Initiative Assessment (TSIA), 33% received college credit, and 100% graduated. Of considerable importance for the context of this study is the issue of students with special needs success rate among their peers in mathematics.

The Problem

The new accountability system has been implemented in Texas, the A-F system. In this system, our district has received an 89 (B) for the 2017-2018 academic year, then an A for the 2018-2019 academic year, and then due to COVID no letter grade was given for the 2019-2020 school year. Even though the district has been successful, there are a multitude of areas needing improvement, specifically at the middle school campuses and special needs and ELL students across the district. Thus, the focus of this record of study was middle school students with special needs. The reason for choosing special needs over ELL was there is a larger population of students with special needs. An additional focus was in mathematics. The district's goal was to achieve a strong A on the accountability system, I believe study helped achieve this goal.

The district is currently addressing these issues in a few ways. Firstly, the district has hired a Mathematics and Science director in 2016. The position was meant to assist in making sure the elementary schools were aligned with the district so that when they came to the middle school, each student would have the same background knowledge. In 2017, the position was expanded to meet the needs for having two middle schools. The focus was on alignment, enrichment, and a small role in academic coaching. In the 2019-2020 academic year, the position became specialized to mathematics and creates small group sessions for students who need extra help to pass STAAR examinations. While this position has helped the district with alignment, one-person struggles meet the needs of the whole campus. In the 2020-2021 school year, the position was modified to be an academic coach for mathematics and science teachers. Moreover, the district math director does not necessarily help address student numeracy, but teacher competency.

Historical Context

The district has an A rating on the A-F accountability system, and it has taken just over a decade to transition from a nearly failing school district to where the district is today. Twelve years ago, the district was a very low-performing district and needed a change in administration, and a change of district leadership needed to happen. Once a change in superintendent and several principals occurred, the district has steadily improved over the last decade to become one of the top-performing districts when comparing to districts with similar demographics. The district received several distinctions: closing gaps, College, Career, and Military Readiness (CCMR), exceptional STAAR performance in English and Science. The high school specifically received the title as "One of the Best High Schools" (Medina Valley ISD, 2021) by *U.S. News and World Reports*. Now with an A rating, the most difficult task is to maintain the high quality of education and close the gaps where we can. One of the many areas that the district is focusing on is students with special needs and ELLs. In addition, there is an overarching goal for the math department to have a distinction in the content area, which has not happened in the last couple of years. To continue the path of success, the district's administration is working to obtain every distinction available on the A-F accountability system.

Before the middle school split into two different campuses, the scores based on the TEA Report Card were always high. In the 2015-2016 school year, the middle school's students achieved higher than state standards again with the distinction of post-secondary readiness. In 2016-2017, the middle school's students scored well above the state standards, although only achieved a distinction in post-secondary readiness. In the 2017-2018 school year, the overall score was in the top 20th percentile of middle schools, although there were no distinctions. While looking at the report cards is informative, it is important to note that the formulas for distinctions and performance index often change. Within the last five years, the middle school students and staff have performed better than the state student average in multiple categories.

Of the two middle schools, the newest one has the most distinctions. Those distinctions for the middle school are Academic Achievement in English Language Arts/Reading, Top 25%: comparative academic growth, post-secondary readiness and Top 25%: comparative closing the gaps. The new middle school did not receive the following distinctions: academic achievement in Science, Social Studies, and Mathematics. Because the school is in its first few years of existence, this is the only historical data on record. The overall score of the new middle school students on the A-F system was a B.

The older middle school tended to struggle a little more after the split, relative to the new middle school. The distinctions they have earned are academic achievement in Mathematics and post-secondary readiness. The distinctions that they did not receive were academic achievement in Science, English Language Arts/Reading, and Social Studies, top 25% comparative academic growth, and top 25%: comparative closing the gaps. The overall score of the older middle school students on the A-F accountability system was a B.

A more focused approach to increase both campus scores on the A-F system is to address the lack of numeracy. The district has implemented several measures in the last few years to help students progress. Since 1998, an elementary instructor has requested the district hire specialists for elementary mathematics. Through their persistence, the district as of the 2019-2020 school year, has a mathematics specialist at every elementary campus. In the 2020-2021 school year, the mathematics specialists for the elementary schools are moving into the academic coaching role. By far, administrators believe that this has the potential to improve numeracy for middle and high school students. To help the middle school campuses, district coordinators are filtered into each campus four days per week. The coordinators focus on students who are struggling and design targeted instruction for students who are struggling and students on the verge of meeting the master's level.

The content coordinators not only focus on students who are struggling, but they also focus on getting students to the master's level on STAAR assessments. As mentioned previously, the most challenging part of receiving an A is maintaining it over the next academic year. Since interventions are becoming less frequent, content coordinators can focus on enrichment. More specifically, the district is transitioning from having math academies that are designed as intervention for students who have not passed the STAAR, to having blocked classes for Mathematics and English Language Arts. The courses that are receiving enrichment are called Mathematics Advanced Placement courses and are the equivalent of honors courses in the middle schools. Content coordinators now can focus on curriculum and instruction that help students achieve the master's level on content specific exams.

Each middle school campus is also transitioning from math academies to other various courses. The math academy courses are slowly disappearing and transitioning to courses with a co-teaching model. In the co-teaching model, there would be the general education teacher and a special needs teacher, inclusion teacher, or content specialist. In addition, the core content classes are blocked. Each day the average middle school student spends two class periods per day to work on mathematics, English language arts, and science. At the campus level, principals and counselors are working together to better meet the needs of their unique student population.

The elementary campuses are also addressing the need for numeracy. Many basic numeracy skills are taught at the elementary campus, as stated by the TEKS. The districts are now required to address numeracy because the Texas Government has recently passed Texas House Bill 3 (2021). This requires districts to make a five-year plan for English Language Arts and a five-year plan for Mathematics Numeracy. The law requires districts to focus on pre-kinder through third grade and set goals for improvement. To address House Bill 3, the district is disseminating several programs outside of TEKS, such as UIL in multiple content areas, specifically number sense competitions and hiring math specialists for each elementary campus.

The district staff and elementary campuses are working together to help create a better foundation for student's numeracy in middle school and high school.

The problem of numeracy has existed for years. Innumeracy has not been addressed in the district until this last decade. In the last decade, strides have been made to improve students' numeracy and proficiency in mathematics. There is still a gap that needs to be closed for ELLs, students with special needs, and students who are on the verge of meeting master's level on the Mathematics STAAR End-of-Course exams. Over the next five years, the goal is to not only maintain high achievement, but also help the special population's scores become comparable to general education students' scores. To do this, the curriculum and instruction department worked on numeracy throughout all the grade levels.

Significance of the Problem

The lack of numeracy content in the middle school and primary levels of education produces students who struggle not only in mathematics but in areas of applied math or where interpretation of concepts is needed to be successful. First, teachers do not necessarily have the content knowledge or background knowledge to assist students in a mathematical context. Primary and middle school teachers are not required to possess a certification in mathematics to teach the content; a majority of them are alternatively certified for fourth through the eighth-grade generalist. A secondary problem is that there is a lack of content specific professional development available to assist teachers in learning the content and to eventually master it. Thirdly, students lack sufficient and relevant numeracy instruction. Often teachers are forced to teach cheap tricks to solve problems on a government-mandated exam, whether it is due to the pressure by the district, administration, or stakeholders. Finally, there is a lack of assessable curriculum for teachers and students to work through at the middle and secondary level.

Curriculum and instruction should be available for both student and staff alike so that numeracy can be taught equitably and used to supplement daily lessons in the classroom that focus on understanding and application alike.

Numeracy affects many areas of education; when school districts do not address numeracy, they risk losing its positive benefits. Numeracy can grow a student's level of confidence in not only mathematics but other STEM-related fields (Hackett & Betz, 1983). More importantly, innumeracy has social consequences for communities (Craig, 2018). If ignorance concerning numeracy continues, there will be a society that is ill-equipped to address the ever-changing culture and work environment that is the 21st century. Through this study, I attempted to address lack of curriculum and instruction that specifically focuses on building numeracy in the middle school classroom.

Research Questions

The research questions focusing this study are:

1. What effect does focused numeracy instruction, specifically rational number supplemental instruction, have on middle school students' learning and self-efficacy of rational numbers?
2. What are the lived experiences of students with special needs with instruction in middle school mathematics at Medina Valley ISD?

Important Terms

English Language Learners (ELLs): "A student who is in the process of acquiring English and has another language as the primary language. The terms English language learner and English learner are used interchangeably and are synonymous with limited English proficient (LEP) student, as used in TEC, Chapter 29, Subchapter B." (TEC, §89.1203)

Low Socioeconomic Status (SES): Describes a student "who is eligible for free or reduced-price meals under the National School Lunch and Child Nutrition Program." (U.S. Department of Agriculture, n.d.)

Mathematical Self Efficacy: "A situational or problem-specific assessment of an individual's confidence in her or his ability to successfully perform or accomplish a particular task or problem" (Hackett & Betz, 1989, p. 262)

Middle School: "A school facility that includes some or all grades from Grade 6 through Grade 8 or 9, or a school facility that includes only Grade 6" (TEC, §61.1036).

Numeracy: "The ability to understand and reason with numbers, to act wisely in daily living activities, and to participate in civic life. It also allows one to use mathematics in order to solve problems" (Wium & Louw, 2012, p. 8).

Self-efficacy: "As a person's judgment of his/her capabilities to complete a specific task with the skills he/she possesses and is usually described as being task and context specific" (Kim et al., 2015, p. 136).

Special Education Students: Or students who have special needs, "The determination of whether a student is eligible for special education and related services is made by the student's admission, review, and dismissal committee" (TEC, §89.1040). Also, must meet the "eligibility definitions" (TEC, §89.1040).

Texas Essentials of Knowledge and Skills (TEKS): "Are the state standards for what students should know and be able to do." (TEKS, n.d.)

Significant Stakeholders

The primary stakeholders were middle school mathematics teachers and middle school mathematics students. Those who received the greatest benefit were the teachers. Their collective experience and knowledge supported production and inform spiraled numeracy instruction that focuses on the ratio. Also, all middle school teachers and every student who passed through the middle school are key stakeholders because of the continual potential of spiraled numeracy instruction. All future instructors will hopefully benefit from current cohorts of supplemental numeracy instruction; this is inclusive of Algebra I through AP Calculus instructors. Because numeracy impacts more than the mathematics classroom, benefactors also include every instructor post seventh grade.

Other stakeholders included the curriculum and instruction staff members, campus administration, and parents. The curriculum and instruction department is under pressure to maintain a quality rating from the state. The pressure is felt from the campus administrator to the classroom teacher. A viable curriculum to supplement and address gaps for students, specifically special populations, is necessary and will help alleviate the pressure of the curriculum and instruction department in terms of mathematics.

Closing Thoughts

Introducing a numeracy-based curriculum, or even supplementary curriculum, has potential benefits. Changing curriculum or implementing a new one with the STAAR in forefront of stakeholders' minds can be difficult. This is even truer for instructors who are under pressure to improve instruction from previous years. When instruction has numeracy at its forefront, numeracy can empower students. It can potentially improve retention of content knowledge to beyond the daily lesson and help students become better members of society with abilities to work through a given problem with an intellectual and logical basis.

In this action research study, I investigated middle school grade students' academic achievement, and self-efficacy toward mathematics as they receive supplementary numeracy instruction. I also investigated four students with special needs perceptions and experiences of middle school grade students as they receive supplementary numeracy instruction. The observations occurred during the late spring semester after state assessments in the 2020-2021 school year. In Chapter II, I researched the origins of numeracy, how it is related to mathematical self-efficacy, potential implementation, and tools to measure both numeracy and mathematics self-efficacy. In Chapter III, I discussed the implementation of the tools, methods, and solutions. The results were discussed in Chapter IV, and the conclusions were discussed in Chapter V.

CHAPTER II

LITERATURE REVIEW

Over the last three decades, quantitative literacy has received more attention, and it can no longer be considered mutually exclusive to mathematics or other content areas. It is clear, the gap between general population students and special population students is widening (TEA, 2019a). Students on the special needs spectrum or are considered ELLs have some of the largest achievement gaps in the local district, according to the Texas Academic Progress Report (TAPR) (TEA, 2019b). Curriculum, instruction, and interventions need to be designed with the specific needs of the campus and district in mind because there is no one single solution to closing the multiple achievement gaps in education (McLafferty & Morrison, 2018). This review of the literature will explore the connections between numeracy, mathematics self-efficacy, and how each factor affects an ELL or special needs student's achievement in mathematics.

Through my Chapter II Literature Review, I discuss how numeracy and quantitative literacy have been previously defined. Next, I explore what the prior literature says about how numeracy and mathematics self-efficacy are related. After working with the connection of numeracy and mathematical self-efficacy, I start to connect how numeracy will affect both special needs and ELLs. Through further review of prior research, I look at how numeracy can be improved in the general education environment and the challenges that face progression. Lastly, I conclude my literature review by examining potential solutions to problems with measuring assessing numeracy and self-efficacy.

Numeracy and Quantitative Literacy

Quantitative Literacy, also known as numeracy, has multiple definitions throughout its existence and even today; there is still no clear and unified definition of numeracy. The word numeracy was devised in 1959 by Crowther to address the growing concern for his fellow citizens and the ability to understand the implication of data in Great Britain (Crowther, 1959; Craig, 2018). Numeracy is more than an association with or the ability to calculate complex equations because it includes how people use mathematical literacy given the social context (Craig & Guzman, 2018; Fagerlin et al., 2007). Certain researchers (Mcintosh et al., 1992) clarified numeracy by claiming number sense and numeracy synonyms. Number sense is the aptitude to comprehend numbers in multiple abstract situations, along with the ability to recognize that there are not only multiple correct paths to the solution but there exist efficient paths to the correct solution (Mcintosh et al., 1992). "Numeracy is the ability to understand and reason with numbers, to act wisely in daily living activities, and to participate in civic life. It also allows one to use mathematics to solve problems" (Wium & Louw, 2012, p. 8). Numeracy cannot be simplified into a series of discrete computations, but rather it refers to our daily interactions, thinking abstractly, and logically about any given situation.

Mathematics Self-Efficacy

Self-efficacy has implications for both the educator and student alike. With a lens of mathematics, self-efficacy has a positive correlation with academic achievement in mathematics (Celick, 2019; Hackett & Betz, 1989). Bandura (1997) in his *Theory of Self-Efficacy* stated that self-efficacy has a central part in analyzing changes in actions such as anxiety, avoidance of difficult tasks, self-confidence, and partaking in each objective. Self-efficacy is derived from diverse sources of information conveyed by both direct and mediated experiences (Bandura et al., 1996). Self-efficacy affects a student's decision-making process and the capacity to solve or work through specific tasks (Kim et al., 2015). In both students and instructors, self-efficacy is directly linked to a person's achievement. Although, students of overconfident educators, with a high awareness of self-efficacy, seemed to be less willing to participate when equated to students of teachers with an average perception of self-efficacy (Lih & Ismail, 2019). Increasing both an educator's and student's self-efficacy can help students become more successful academically and help instructors be more proficient in their careers.

The implementation of numeracy in the classroom setting has come to the forefront in research within the last decade and a half. The reason for this could be because the debate in defining numeracy has waned; research has now moved toward theory and application (Craig & Guzman, 2018). Preliminary work has already been done to construct a framework for assessing a student's numeracy (Mcintosh et al., 1992). The medical field has created specific tools to assess a student or adult learner's numeracy using *Objective Numeracy* and *Subjective Numeracy Scales* (Fagerlin et al., 2007; Lipkus et al., 2001; Wolf & Hoiland, 2017). The medical field needed to address the lack of numeracy in both their field of candidates and patients. Patients and candidates could not convert basic measurements for the delivery of medicine, and there is a growing concern that patients do not understand the severity of their condition based on given data (Gregory & Spitzer, 2018). Numeracy is important to research because it has implications that affect the social life of the everyday citizens both in and outside of the STEM fields.

Numeracy is important because it is critical for model citizenship. Promoting and communicating numeracy skills instills in students an ability of how to think intensely about a topic not just in a mathematics classroom but rather gives students a logical and reasonable outlook throughout life's daily events (Muir, 2002). Numeracy and literacy are equally important, and they are both becoming more and more necessary for students to become numerate (Sellars, 2017). With the rapid rise of technology and the need for 21st-century skills, the gap in numeracy is becoming more and more apparent (Capraro et al., 2014). "Failure to properly educate citizens in mathematics and statistics weakens cultural and social structures and promises to impose personal and social costs" (Craig, 2018, p. 65). It seems numeracy may need to be explored in contexts outside of mathematics. Much like literacy needs to be reinforced cross curricular, it is time for numeracy to be treated with the same level of importance and respect as literacy; otherwise, there will be social consequences.

As students get older, their level of self-efficacy in mathematics decreases as well as the belief that mathematics is truly applicable as compared to other content areas. This could be due to subject interest such as music, science, or journalism, but why do students believe that mathematics is less useful as they get older? While this is an interesting correlation, Wigfield et al. (1997) did note that the younger the student, the less reliable the data became. These data results were surprising because the data collected were only up to sixth grade. The literature suggested that the disinterest in mathematics could be due to the very disjointed nature in which mathematics courses are taught; integrating numeracy in other content areas should not be exclusive to STEM (Western Australian Project, 2004). Even still, another factor could be a potential cause of the lack of self-efficacy (Pajares, 2006). The reasons for lack of interest in mathematics is far-reaching, increasing self-efficacy may be a potential solution to helping students of all levels be more actively engaged, both in and outside the mathematics classroom.

Numeracy has implications that affect a student far beyond the ability to perform mathematical computations. Numeracy has three promises: (a) numeracy is a reflection and understanding of the modern society, (b) numeracy can empower, and (c) the lack of numeracy (innumeracy) has more than just social consequences culturally for the individual and society (Craig, 2018). Because numeracy can empower, it is important to explore what numeracy instruction can do for traditionally lower-performing and underrepresented populations. Critical numeracy helps students see the usefulness of mathematics and more so how to apply it to other contexts outside the mathematics classroom (Stoessiger, 2002). Failure to address numeracy in the educational environments could potentially develop a generation of citizens who are ill-equipped to deal with the fast-changing technology-driven environment of the 21st century.

Self-efficacy is the single best indicator for academic success in the mathematics classroom and needs to be defined because each content area has its own definition for self-efficacy. Therefore, it is important to define what mathematics self-efficacy is (Jones, 2015). The four criteria that are used to assess a student's mathematical self-efficacy are: (a) self-efficacy scales (Bandura, 2006), (b) mathematics course self-efficacy (Hackett & Betz, 1989), (c) mathematical skill based on the NCTM standards (NCTM, 2000), and (d) self-regulated learning (Usher & Pajares, 2009). NCTM's (2000) mathematics standards published in *Principles and Standards for Mathematics* were used to create a coherent list of mathematics standards and as a teacher, a resource to supplement local state and national standards. Self-regulated learning is a mental process that students undergo when transferring academic thought to the physical form of writing (Usher & Pajares, 2008), or in this case, from thought to the physical form of presenting a solve mathematical problem. The base for mathematics self-efficacy is the confidence in oneself to perform the mathematics required in a given problem, both inside and outside of the mathematics content area.

To generate mathematics self-efficacy, each of the measures needs to be explored and further developed curriculum, instruction, and/or intervention that is rooted in numeracy. For students, self-efficacy can be generated by working through problems successfully (Lih & Ismail, 2019). Interventions that are embedded in numeracy help a student's confidence and self-efficacy increase significantly (Gregory & Spitzer, 2018). NCTM has been very clear when writing their standards to not only make them universal but to develop standards that are grade-level and appropriate including suggestions for imbedded quality mathematics instruction (NCTM, n.d.). For the State of Texas, the standards are set and are clear, although this does not mean NCTM standards should be mutually exclusive to common core or state-mandated standards. Mathematics self-efficacy has the desire to be explored to better curriculum, instruction, and assessments.

There is a very strong positive correlation between a student's mathematics self-efficacy and academic achievement in mathematics. The disparity, or problem of practice, exists when comparing general education students to those in special populations. In a large body of research, females tended to have lower levels of self-efficacy than their male counterparts (Hackett & Betz, 1989; Lloyd et al., 2005; Pampaka et al., 2011). As a student's numeracy increases, especially a female student's numeracy, their self-efficacy in mathematics also increases (Hackett & Betz, 1989). This empowers traditionally underperforming students and increases their overall achievement in mathematics. This conjecture is not only true for female students, but also other special populations.

A decrease or lack of self-efficacy has multiple negative implications for students. Students who lack self-efficacy often perceive a simple task to be much more arduous then originally intended (Jones, 2015). Students who have low self-efficacy can be identified by procrastination or giving up quickly when a more difficult task is given to them (Kim et al., 2015). A student who has low mathematics self-efficacy rarely will enter or even attempt to enter a STEM field in their post-secondary careers due to the fear of failure (Hackett & Betz, 1983; 1989; Jones, 2015; Pampaka et al., 2011). It is important to note that while there is a strong correlation between self-efficacy and academic achievement, a student with low self-efficacy does not lack the ability to perform academically (Usher & Pajares, 2008). Low self-efficacy might be the source for low female STEM majors because there is a gap between male and female mathematics self-efficacy.

Research has shown there is a disparity between male and female self-efficacy in mathematics. Males tended to have higher self-efficacy than females (Bellini et al., 2019; Hackett & Betz, 1983; 1989; Lloyd et al., 2005; Pampaka et al., 2011). One researcher (Celik, 2019) found the opposite when investigating visual mathematics literacy self-efficacy; females attained significantly higher self-efficacy than their male counterparts in middle school. Visual mathematics literacy self-efficacy is the ability to express and analyze quantitative literacy visually and spatially (Celik, 2019). When observing the data with students who were in high school, Celick (2019) noted that the correlation switched at age 15, while research has shown that female achievement in mathematics was equal to or greater than that of male achievement (Lloyd et al., 2005). Another interesting aspect is that male students still had a greater level of self-efficacy in mathematics than females did, even though males performed lower academically.

Even though female students' self-efficacy has been consistently lower throughout the review of the literature, students' academic achievement cannot be correlated to their gender. In addition, neither gender nor socioeconomic status predicts academic achievement (Zuffiano et al., 2013). In several studies, it was found that female students outperformed male students, although it was not statistically significant (Jones, 2015; Wigfield et al., 1997). Repeated success during traditional skill drills also builds mathematics self-efficacy (Lloyd et al., 2005). It is interesting to note that even though there is a difference in self-efficacy, there is not a significant difference in academic achievement.

The gender gap with the lens of mathematics self-efficacy is a multifaceted issue, as well as closing the gap for special populations. Parents and teachers alike need to foster an environment in which female students are encouraged academically and socially in STEM. Encouragement needs to come from several sources: the home, school, and social environments in order for girls to feel comfortable in the STEM fields (Hong & Jun, 2012). Females' mathematics self-efficacy is derived from more than just environmental factors at home and/or school; success in STEM can be linked to a positive growth mindset (Degol et al., 2017). A growth mindset is a belief that through hard work and perseverance, you will be successful even though the student may not currently be as successful (Dweck, 2014). The student's belief in themselves is an important predictor of success (Zuffiano et al., 2013). The mindset of a student is important for the success of the female mathematics student; moreover, these conjectures can be associated with traditionally underperforming populations such as special needs, at-risk, ELLs, and low socioeconomic status students.

English Language Learners and Students with Special Needs

A large body of research has been conducted with females and their mathematics self-efficacy, ELLs and students with special needs have shown a similar relationship with mathematics self-efficacy and numeracy. Many researchers have noted that future research needs to focus on other populations outside the difference in gender connected to mathematics self-efficacy (Bellini et al., 2019; Lloyd et al., 2005; Melan et al., 2017). When working with ELLs, it was noted that increasing their self-efficacy helped increase academic proficiency (Kim et al., 2015). The trend remains to be consistent when observing students who are learning disabled and/or possess a mild intellectual ability who showed a positive correlation between self-efficacy and academic achievement (Buzza & Dowl, 2015). There is a positive correlation for students of all intelligences and second language learners between mathematics self-efficacy and academic achievement.

English Language Learners

The STAAR for Mathematics is based on story or word problems. One of the claims is that English Language Learners (ELLs) who are proficient in mathematics have trouble with the STAAR exam because they are based on stories and leads to a misunderstanding or misinterpretation of the problem (Martiniello, 2007). The ability to talk not only in a secondary language, but to have discourse in a mathematical way is paramount to the success of any student and even more so for ELLs (Campbell et al., 2007). The TEA has recently added measures to address students who immigrate to the United States with no prior schooling, have gaps in learning due to inconsistent transferring from their native country back to the United States again, come in mid-year at the secondary level, and are both ELL and special needs (Texas House Bill 3, 2019). Constructive argumentation in an academic setting can assist in increasing academic success because it promotes logical thinking and ultimately numeracy.

Numeracy has the potential to do more than simply teach mathematics to ELLs, it can empower them. Working through word problems are like negotiations and require a logical progression of thought. Negotiations are cross-culturally understood and could potentially be turned into a strategy to teach numeracy indirectly (Barwell, 2007). There is a significant increase in students' mathematics achievement when software was specially designed for low-income Spanish speaking ELLs who had numeracy embedded into the problem sets (Foster et al., 2018). This is important because ELL students from poor backgrounds often started school behind other ELLs who were from a more prestigious background (Foster et al., 2018). Small districts often cannot afford specialized programs for ELL intervention. Therefore, other sources of intervention need to be implemented such as tier two or three individualized intervention education plans.

Students who are classified as both ELL and special needs would need more individualized and specialized programs. For the Response to Intervention (RTI) process, this stage would be considered tier three (Powell & Fuchs, 2015). RTI is a process that provides teachers and administrators a route to help struggling students become successful (TEA, 2020). Intervention can come in many forms to help ELLs become successful. Each form of intervention has a unifying theme. Each of the interventions has numeracy rooted into the programs and interventions.

Students with Special Needs

Students with special needs are often expected to underperform; this could not be further from the truth. Identifying a student as special needs is not indicative of lower performance in numeracy or literacy (Lloyd et al., 2009). Students who are either special needs or just lagging behind the curve can improve and catch up to their classmates (Holmes & Dowker, 2013). When students need tier three interventions, individualized lesson plans are necessary to aid students with special needs (Powell & Fuchs, 2015). The success of individualized lesson plans has a strong correlation with increased academic success for elementary students (Dowker, 2001). The problem lies in the fact that individualized lesson plans are difficult to implement if a campus or district lacks the resources. Students with special needs can improve their numeracy skills when their teachers use targeted instruction.

Students who have been identified as special needs or as being significantly behind their developmental age group can benefit from supplemental numeracy instruction. Students who have learning disabilities generally improve when their self-efficacy is increased (Levi et al., 2013). Using tricks to teach mathematics hinders students with special needs especially because it removes numeracy from the instructional process (Fuchs et al., 2008). There exist several pedagogical strategies for instructors to use that are designed for students with special needs in mathematics; more importantly, these listed strategies can be used to carry content knowledge into long term memory (Fuchs et al., 2008). Using strategies that are rooted in numeracy and mathematics can help all students become more successful.

Instructors should avoid using simple tricks and shortcuts because it undermines true quantitative reasoning. When working with more complex equations and computations, the habit is to use a calculator or equivalent technology to solve the problem (Mcintosh et al., 1992). This tool becomes a crutch and undermines all the positive promises of numeracy (Brown, 2015; Craig, 2018). As mentioned before, tricks and shortcuts are especially harmful for special needs and ELLs because shortcuts remove the understanding and generalizability of solving an abstract problem (Fuchs et al., 2008). Instructors undermine numeracy by using tricks and shortcuts provide a temporary fix for a more complex problem, and in the long-term, shortcuts exacerbate the numeracy gap for ELL and students with special needs.

How to Increase Numeracy

Because numeracy is multifaceted, it can be improved by using various pedagogical strategies and professional development. Brown (2015) found teachers should have multiple 10 to 15-minute lessons on a bi-weekly basis. The results showed that while students' numeracy increased, there was no significant difference when comparing academic achievement on benchmarks. Martinie and Coates (2007) suggested that adding more estimation problems in middle school grades helped students think abstractly and logically. McLafferty and Morrison (2018) recommended academic coaching as the best route. The goal of the given professional development was to advance practitioners to become more skilled at teaching numeracy so they could close the achievement gap for special populations and general education students. Research recommends practitioners to be using an appropriate number sense framework and aligned standards (Mcintosh et al., 1992; NCTM, 2000). Collaborative learning amongst kindergarteners helped increase their numeracy (Melan et al., 2017), showing that early numeracy interventions helped students of special populations perform close to or one level with general education students. For special needs and ELL students, Holmes and Dowker (2013) proposed individualized sessions, or short lessons designed to target students' weaknesses in mathematics. Holmes and Dowker's (2013) intervention was conducted in addition to professional development for pre-kinder instructors. Multiple pedagogical strategies can be enacted to help close the achievement gap or increase students' numeracy.

While each strategy works for particular students in particular schools, districts and campuses need to design their own programs that are rooted in the culture of the local area. Educators on campuses need to be creative in constructing their own solutions that are analogous to campus/district/local culture (Marcus, 2016; McLafferty & Morrison, 2018). Programs, curriculum, intervention, and instruction need to be designed to allow the greatest amount of success as possible, no matter how broken down each subsequent topic needs to be taught (Usher & Pajares, 2009). While generalized programs can be useful, targeted instruction for a particular campus population offers the greatest potential for improving the numeracy skills and closing the achieving gap of special population students.

Numeracy needs to be explored in more than just the mathematics classroom. If non-STEM instructors embed numeracy into their curriculum and instruction, i.e., discuss essay prompts through a logical sequence of outcomes, students would gain greater levels of achievement in not just mathematics, but across multiple content areas (Erickson, 2019). Literacy's importance is clear and present though multiple content areas; thus, numeracy should also be held to such a standard (Western Australian Project, 2004). This argument supports that mathematics, much like numeracy, should be implemented in some form, in every content area (Steen, 2007). Since innumeracy has social implications, numeracy should be reinforced in multiple if not all content areas. This is not to say computation and algebra should be in every lesson and every classroom, but the logical progression of thoughts, evidence-based reasoning, and data analysis should be.

The challenges to increasing numeracy are just as numerous as potential solutions. Students will gain higher levels of self-efficacy if instructors address challenges students may face in upper-level mathematics courses at a younger age (Zuffiano et al., 2013). Students are likely to avoid academic objectives if they believe that such objectives are beyond their understanding due to fear of failure or fear of incompetence (Bandura, 1977). Supplemental instruction in mathematics helps students grow in confidence, which would be addressed in tier two of the RTI process (Gregory & Spitzer, 2018). If students are not as receptive, whether by choice or need, tier three intervention along with individualized lesson plans are necessary (Fuchs et al., 2008). Therefore, students need to have foundational concepts continually reinforced in mathematics; hence, the need for further research focusing on the benefits of continual and early numeracy.

Numeracy is the foundation of every mathematical process and can increase mathematics self-efficacy. Once students complete an academically rigorous task, they analyze their results, mastering the topic leads to an increase of mathematical self-efficacy (Usher & Pajares, 2009; Zientek et al., 2019). In a similar fashion, lack of success results in a decrease in mathematical self-efficacy. Martinie and Coates (2007) noted that students who have proficient numeracy skills felt more confident when working with mathematics problems. Confidence, as indicated earlier, is a factor in mathematics self-efficacy. Hence, the relationship between numeracy and self-efficacy needs further exploration.

Instructors need to be careful to not make numeracy monotonous. Repetition of similar content does not promote flexible thinking; repetition promotes rigidity for similar situations that require a different technique (Markovits & Sowder, 1994). One of the measures of numeracy in a mathematics class is knowing that there exist multiple strategies to solve a problem (Mcintosh et al., 1992). In social contexts, as citizens of the 21st century are bombarded by new information, technology, and information, instruction embedded with numeracy should help students and citizens quantify an ever-changing reality (Craig, 2018). When designing an intervention plan, instructors should consider showing the multiple paths that lead to the common answer.

The need for curriculum and instruction that is rooted in numeracy is necessary to further close the achieving gaps in mathematics for ELLs, special needs, and other special populations. There are viable paths to assist numeracy acquisition. Number talks is a curriculum that requires students to discuss mathematics in a meaningful and engaging way (Gresham & Shannon, 2017). Students need the chance to inquire, argue, and struggle because this brings meaning, grows flexibility, and actively engages the student in authentic mathematical content (Graham & Lessig, 2018). Structured academic arguing creates ownership of the learning, ultimately creating a student-led environment that allows students to openly struggle and gain tenacity when solving more difficult problems (Cho et al., 2019). Having students constructively argue and debate in a mathematics class builds both numeracy and mathematics self-efficacy that can be translated to other course work such as Science, Social Studies, English Language Arts, Career Technology Education courses, and many more. Numeracy is a language unto itself and has implications far beyond the scope of the mathematics classroom.

Assessing Numeracy and Self-Efficacy

Frameworks for designing and measuring numeracy have existed for some time. Creating a formalized instrument for a student's level of numeracy has just recently been explored (Bellini et al., 2019). The issues lie in the fact that numeracy is not the ability to calculate complex algorithms. However, in addition, numeracy is the ability to understand what calculations mean once they have come to fruition and what they stand for in a real and present way. Surprisingly, the medical field, not education, has created several tools to assess numeracy. The purpose of these assessments is to make sure that when patients receive their results, they can understand the potential risks of a procedure or gravity of a current condition or the lack thereof (Fagerlin et al., 2007). This confirms that numeracy or innumeracy has social implications (Craig, 2018). To measure a student's numeracy, two tools need to be used: *Objective Numeracy Scales* and *Subjective Numeracy Scales* like the medical field.

The measurement of numeracy needs to be done in a dual capacity. There exists both *Subjective Numeracy Scales* (Fagerlin et al., 2007) and *Objective Numeracy Scales*, also known as the Lipkus Scale (Lipkus et al., 2001). Both *Subjective* and *Objective Numeracy Scales* should be used to test the results. Fagerlin et al. (2007) have suggested using both tools to measure numeracy because of the limitations of their study. The focus of the current study was on students with special needs; therefore, *Subjective Numeracy Scales* were able to assist in measuring a student's numeracy. This was necessary because numeracy was not about the ability to compute complex equations but rather a quantitative reasoning.

Measuring mathematics self-efficacy is a qualitative process and is the single best predictor for academic success. Bandura (1977) used the *Unified Theory of Self-Efficacy* for the bases and construction of the tool (Hackett & Betz 1983). Bandura (2006) went on further to write a guide for constructing self-efficacy scales. Hackett and Betz (1989) suggested that Bandura's work can be applied to mathematics self-efficacy. Therefore, mathematics self-efficacy can predict student academic achievement in mathematics.

Mathematics self-efficacy is a qualitative process and is the single best predictor for academic success across multiple grade levels. Through this literature review, I have connected mathematics self-efficacy and numeracy. A multitude of studies have been conducted to shed light on how numeracy and academic achievement are related (Bellini et al., 2019; Celik 2019; Craig & Guzmán, 2018). Other studies have compared mathematics self-efficacy and academic achievement (Bandura 1977; 2006; Craig, 2018; Hackett & Betz, 1989). However, these variables have not been utilized and measured together into a unified study for analysis. Other factors that have shown promise with numeracy instruction are ELL (Foster et al., 2018), gender (Lloyd et al., 2005), and special needs (Levi et al., 2013). Numeracy, mathematical self-efficacy, and academic achievement are related and need to be considered when constructing quality lesson plans and interventions.

Closing Thoughts

Through my record of study, I explored how middle school students who have special needs experience supplemental numeracy instruction and measure their mathematical self-efficacy and academic achievement. However, the practical implementation of supplemental numeracy instruction remains unclear. During my internship, I utilized faculty and staff's experience to construct and derive meaningful intervention that fit into the daily workings of the classroom teacher. The first objective was to observe current interventions used for students with special needs in mathematics classrooms. This provided insight into the current procedures of tier two intervention and informed me when integrating intervention instruction into the general education program. The second objective was to field test supplementary numeracy instructional strategies with current middle school grade instructors and students.

CHAPTER III

METHODOLOGY

Research Questions

The research questions that will focus this study are:

1. What effect does focused numeracy instruction, specifically rational number supplemental instruction, have on middle school students' learning and self-efficacy of rational numbers?
2. What are the lived experiences of students with special needs with instruction in middle school mathematics at Medina Valley ISD?

Outline of Proposed Solution

I used numeracy instruction to remediate students' misconceptions on the application of ratio across the middle school mathematics curriculum. The purposed solution was a set of more engaging lessons on numeracy instruction focused on ratio. This was achieved during two to three review sessions after the state assessment. Each intervention targeted gaps and misconceptions in the student's understanding of ratio as it connected to but not limited to slope, rates of change, fractions, decimals, and percentages though numeracy.

After an initial assessment of student's numeracy using both *Subjective* and *Objective Numeracy Scales*, targeted engaged instruction was designed utilizing regular instruction times plus review lessons during set aside times for state testing review. The initial assessment of student's numeracy was both *Subjective* and *Objective Numeracy Scales*. Each intervention was conducted during the regular instructional times, and the review periods were designed to target gaps and misconceptions in a student's knowledge for core classes. In this case, data from previous years consistently showed areas of weakness around standards that contained or used ratio as a base. Example standards are the TEKS. The TEKS that was used for the intervention was:

6th grade:

(5) Proportionality. The student applies mathematical process standards to solve problems involving proportional relationships. The student is expected to: (A) represent mathematical and real-world problems involving ratios and rates using scale factors, tables, graphs, and proportions; (B) solve real-world problems to find the whole given a part and the percent, to find the part given the whole and the percent, and to find the percent given the part and the whole, including the use of concrete and pictorial models; and (C) use equivalent fractions, decimals, and percent's to show equal parts of the same whole.

7th Grade:

(12) Measurement and data. The student applies mathematical process standards to use statistical representations to analyze data. The student is expected to: (A) compare two groups of numeric data using comparative dot plots or box plots by comparing their shapes, centers, and spreads; (B) use data from a random sample to make inferences about a population; and (C) compare two populations based on data in random samples from these populations, including informal comparative inferences about differences between the two populations. (1) Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:

8th grade:

(11) Measurement and data. The student applies mathematical process standards to use statistical procedures to describe data. The student is expected to: (A) construct a scatterplot and describe the observed data to address questions of association such as linear, non-linear, and no association between bivariate data; (B) determine the mean absolute deviation and use this quantity as a measure of the average distance data are from the mean using a data set of no more than 10 data points; and (C) simulate generating random samples of the same size from a population with known characteristics to develop the notion of a random sample being representative of the population from which it was selected.

(12) Personal financial literacy. The student applies mathematical process standards to develop an economic way of thinking and problem solving useful in one's life as a knowledgeable consumer and investor. The student is expected to: (A) solve real-world problems comparing how interest rate and loan length affect the cost of credit; (B) calculate the total cost of repaying a loan, including credit cards and easy access loans, under various rates of interest and over different periods using an online calculator; (C) explain how small amounts of money invested regularly, including money saved for college and retirement, grow over time; (D) calculate and compare simple interest and compound interest earnings; (E) identify and explain the advantages and disadvantages of different payment methods; (F) analyze situations to determine if they represent financially responsible decisions and identify the benefits of financial responsibility and the costs of financial irresponsibility; (§111.28, 2012).

The course meeting times were on a block schedule.

Review times were called panther tracks; students were assigned to a specific teacher, and every mathematics lesson was the same for every classroom across that grade level. The panther tracks intervention occurred on a weekly basis every year beginning in early March. Each regular instruction allowed for 45 minutes of instruction on a topic based on benchmarks and previous state testing data. During this time, review lessons were spiraled back to the original two lessons designed during the regular school year. Each of these interventions were designed in collaboration with other middle school mathematics teachers.

Intervention Design

Multiple strategies were implemented for the intervention. The *Fundamental 5* (Laird & Cain, 2011) and *Five E* models were used as a base for the lessons. The *Fundamental 5* is a lesson design method that the district has requested all teachers follow so that there is consistency across all district campuses. The intervention had engagements utilizing the *Think-Pair-Share* strategy. In addition to using the TEKS, numeracy standards were also considered (Mcintosh et al., 1992; NCTM, 2000). Shortcuts and tricks were not used because it did not promote the student's ability to make the process of solving a problem generalizable; this was especially true for students with special needs and ELLs (Fuchs et al. 2008). Instead, the focus was on the development of the process. The use of calculators was restricted. The more complex the problems are, the habit is to use a calculator to solve the problem (Mcintosh et al., 1992) and often becomes a crutch (Brown, 2015). Students were also asked to estimate their answers before computing their responses (Martinie & Coates, 2007). Collaborative learning was interwoven throughout the intervention; the literature has shown success for students with special needs (Melan et al., 2017). This has been shown to help students with special needs perform on par with their peers. These strategies are in addition to district-required classroom strategies as recommended in *The Fundamental 5* (Laird & Cain, 2011). With the stated strategies, the intervention was research-based and showed great success.

Justification of the Use of Instruments

Several instruments were used to collect data to answer the first research question. There exist both *Subjective Numeracy Scales* (Fagerlin et al., 2007) and O*bjective Numeracy Scales*, also known as the Lipkus Scale (Lipkus et al., 2001). The *Subjective Numeracy Scales* revealed three factors of experience, interest, and ability (Fagerlin et al., 2007). The *Objective Numeracy Scales* revealed itself to have one factor (Fagerlin et al., 2007). Participants took each of the scales via Google Forms before and after the intervention. Both *Subjective* and *Objective Numeracy Scales* were used to interpret the findings by comparing both pre- and post-scores (Fagerlin et al., 2007; Creswell, 2014). Fagerlin et al. (2007) suggested using both tools to measure numeracy because of the limitations of their study. Bandura (1977) used the *Unified Theory of Self-Efficacy* for the basis and construction of the tool (Hackett & Betz, 1983). Bandura (2006) went on further to write a guide for constructing self-efficacy scales. Hackett and Betz (1989) suggested that Bandura's work can be applied to mathematics self-efficacy.

To answer the second research question, a phenomenological approach was employed. To study students with special needs experiences as they undergo focused numeracy instruction, specifically rational number supplemental instruction, a descriptive phenomenological methodology was used. Descriptive phenomenology allowed the researcher to explore the "what" and "how" of the instruction as experienced by students with special needs (Sloan & Bowe, 2014). Data were derived from student interviews. The first interviews were the day after the intervention. The goal was to understand the common experiences of students with special needs; thus, a phenomenological paradigm was best suited.

Study Context and Participants

I conducted the study at a middle school campus with middle school students being the subjects of the study. Student participants were derived from two middle school mathematics teachers. The first teacher was a sixth-grade instructor, and the other was an eighth-grade instructor. Both classes were general education classes. Some eighth graders are considered in courses with the additional title of inclusion. At the district, this is defined as a course that has an inclusion teacher or co-teacher. Due to COVID restrictions and protocols, several sample sizes may not be large therefore for Hedge's g was used for calculating effect size. This gave a total same size of 53 students.

A subgroup of four randomly selected students with special needs who had all experienced focused numeracy instruction, specifically rational number supplemental instruction, was the focus of the interviews that represented the qualitative portion of the study. Students with mild intellectual disabilities were assigned with a student identification number. These numbers were put into a random number generator and then selected. Since multiple grade levels were used, the groups were first stratified into sixth- and eighth-grade groups; three were chosen by the random number generator.

Research Paradigm

In this study, I employed both quantitative and qualitative research paradigms. In other words, in the first part of the study, I analyzed the data quantitatively and in the second part, I analyzed the data qualitatively. The rationale for using a quantitative paradigm was to potentially generalize the findings to other cases. To demonstrate the effectiveness of the pedagogical strategies, the growth change of the intervention group for the general education students was compared to the rate of growth change for the students with special needs. Data were collected from common assessments: Appendix B contains Fagerlin et al.'s (2007) *Subjective Numeracy Scales* (Wolf & Hoiland, 2017) and Appendix C contains *Objective Numeracy Scales*, also known as the Lipkus Scale (Lipkus et al., 2001) and analyzed quantitatively, specifically using Hedges' g method of effect size. The results from this quantitative strand demonstrated whether the rate of academic growth for students with special needs was like that of the general education students.

In the second portion of the study, I collected phenomenological data (Creswell, 2014; Peoples, 2021). The purpose of the phenomenological approach was to understand the lived experiences of these four students with special needs during the focused numeracy instruction (Hope et al., 1997), specifically rational number supplemental instruction (Appendix D). Using a phenomenological approach for this portion of the study allowed me to study the experiences of the students with special needs. The research occurred in the "natural setting" of the classroom setting and focused on students' perception of engaging intervention on numeracy instruction focused on the ratio (Creswell, 2014). The findings provided a context to further understand the experiences, thought processes, and potential growth or point of further inquiry for students with special needs. There were a set of semi-formal interview questions (Appendix E) after the intervention. Each student with special needs was assigned to a number and then using a random number generator, four participants were selected. Each interview was recorded and transcribed verbatim using Trint® and a second party checked the transcription for accuracy (Worthen & McNiell, 1996). Member checking methods are specific for adolescent interviews. These were accomplished by using the process of I-poems and word trees (Simpson & Quigley, 2016).

Data Collection Methods

I used two instruments to collect data. The instruments that were used were the *Objective* and *Subjective Numeracy Scales* (Lipkus et al., 2001). Previous research suggested that using the *Subjective Numeracy Scales* sufficed to measure a person's numeracy; for a more complete dataset and as a point of inquiry, it was recommended that students complete both scales (Fagerlin et al., 2007). Researchers have developed 13 questions for the *Subjective Numeracy Scales* (Fagerlin et al., 2007). Each question had a Likert scale response: 1 being not at all and 6 being extremely proficient that measures the student's numeracy. There were 11 questions for the *Objective Numeracy Scales*. Each question was designed to assess a student's level of numeracy, but the difference being that the responses were problems based on ratios. Together each scale developed a more complete picture of a student's numeracy.

Students with special needs were able to provide their own individual perspective on the intervention process. Data were collected from one-on-one semi-formal interviews and document analysis. The interviews were recorded using the speech to text software Trint®. Seven participants were interviewed. One-on-one interviews were used to generate in depth data on the experiences of the students with special needs during the intervention process. The interviews were bracketed to the individual's experience. Several open-ended questions were asked during the interviews. There were five or more questions in each interview. The questions were at minimum the following questions:

- When you see these kinds of questions, how do they make you feel?
    - If I asked you to solve some of them, how would that make you feel?
    - Would feel confident or concerned? Why do you feel that way?
- Describe a typical math class, what is it like?

- Could you tell me about the classroom at the time yesterday's lesson was discussed?
- What did you like about the lesson? What did you not like about the lesson? Why did you feel this way?
- If you were to change one thing about the lesson, what would it be? Why?
- How do you feel about your math class?
- "I learned that ____________." Is there anything else you want to say about your experience before we finish?
- How have these lesson(s) affected you? (Creswell, 2014)

Additional questions were either unstructured or designed to ease into the interview process. The document analysis came from the students' work. The students' work was the most authentic form of understanding, and in the one-to-one semi-formal interview, the participants were allowed to describe their work.

Data Analysis Strategy

To analyze the quantitative data, Hedge's g measure of effective size was used because these calculations allow for a potentially small sample size. Each instrument had the effect size compared using pre- and post-intervention scores of all students in the study. The participants were comprised of sixth and eighth-grade middle school students from the older middle school campus. The effect size was considered small when the analysis was around 0.2, 0.5 for medium, and 0.8 for large (Durlak, 2009).

Qualitative analysis came from a phenomenological approach. Interview questions began with scripted questions about the participants' personal background. Following the scripted questions, participants continued to discuss their lived experiences as they underwent the lesson intervention. Each participant took part in the supplementary instruction and subsequent interviews after both sets of instruction. Each interview was recorded using Google Meets® and then transcribed using Trint®. The codes were interpreted using meaning-making methods (Kvale, 1996). Then commonalities between codes was used to construct themes. After the themes had been identified, the themes were reviewed to make sure they accurately represented the data.

In addition to interviews, students' work was collected to observe how they solved questions dealing with the ratio. Observations were done in second hand, in that observations came from the teacher of record. Interviews, student work, and observations were then compared together for emergent themes and were noted (Willig, 2008). All data were reviewed repeatedly until no more themes arose from the analysis. After collecting emergent themes, the construction of a summary table of the themes was generated (Willig, 2008). A narrative was then constructed from the Top 50% most occurring table of themes (Willig, 2008). The interviews, observation, and student work ensured the validity of the qualitative analysis (Creswell, 2014).

Timeline

A proposed timeline

- Spring 2021:
    1. Collaborate with practitioners to design first lesson.
    2. Pre-test for subjective and *Objective Numeracy Scales*.
    3. The lesson will occur during the regularly scheduled timeframe with whole class instruction. Followed by interview questions.
    4. Interview questions will be transcribed.
- Summer 2021:
    1. Analyze data and writing results for the record of study.

2. Write the discussion for the record of study.

3. End of Summer: Submit record of study to chairs.

- Fall 2021:

1. September: Committee reading of the record of study.

2. October 2021: Defense of the record of study.

- Winter 2021:

December 2021: Graduation with Ed.D.

Reliability and Validity Concerns or Equivalents

I addressed reliability and validity for all instruments being used. The validity for scores on the *Lipkus Scales and Objective Numeracy Scales* were conducted by Fagerlin et al (2007). For their first study, they reported a reliability with a Cronbach's alpha coefficient of .84 and .66, respectively, for a heterogeneous group of adults (*n* = 364) in a hospital with a diverse range of education levels. Additionally, they reported a reliability Cronbach's alpha coefficient of .82 and .75, respectively, for a heterogeneous group of adults in a Veteran Affairs hospital waiting rooms with a diverse range of education levels (*n* = 287) in their second study. The reliability scores for *Mathematics Self-Efficacy Scales* conducted by Usher and Pajares (2009) was a Cronbach's alpha of .95, for a heterogeneous group of (*n* = 803) middle school students.

For my study, I reported my reliability in the form of Cronbach's alpha for my data on all surveys and all subconstructs and all sub-samples for which I reported results. I reported any validity estimates that I computed or obtained as part of my research including reviews of the items as suitable by supervisors, field, or subject experts, or building level experts who I consulted.

The quantitative and qualitative action research met the criteria for validity. The action that proved the success of the program was a comparison of the post-test scores in both general education and special education students. The process that was used was grounded in research, and the study was modeled in the same fashion because the processes had already been validated (Process). Stakeholders such as eighth-grade instructors and assistant superintendents had their opinions noted, and instruction was modified based on their opinions. The participants in the study grew in mathematics self-efficacy, which was a greatest indicator for success in academics with the end goal of closing the achievement gap for students with special needs (Hackett & Betz, 1989). All findings were presented to the school board and curriculum and instruction department for review.

Closing Thoughts

Deriving results for student's numeracy and proficiency is straightforward although the understanding how students experience this intervention provided greater meaning to the study. The focus was on students with special needs to help district scores, knowing where students can help develop targeted instruction to help students with gaps or special needs (Fuchs et al., 2008). The hope is that this artifact derived from the study will help future lessons and intervention development for students of similar demographics.

CHAPTER IV

RESULTS

Through my Chapter IV results, I discuss how data were collected to answer my research questions using both quantitative and qualitative analyses. Next, I briefly describe the demographics of my participants along with the research questions I answer using quantitative methods. Then I will describe the results from the *Subjective Numeracy Scales* pre- and post-tests. Subsequently, I explain the results from the pre- and post-tests of the *Objective Numeracy Scales*. Following these quantitative results, I further explore the results from the interviews that were analyzed qualitatively by displaying and describing the emerging themes in a table followed by a narrative and a summary of these themes.

Data Collection

To assess the effect of student numeracy, an intervention was designed focused on ratio. Data were disaggregated and aggregated and then analyzed. The groups were then checked for growth or improvement from pre- to post-tests. Participants were chosen based on teachers who volunteered their time and classes. A total of two teachers who taught five class periods volunteered, four class periods were eighth-grade mathematics teachers, and the remaining class was a sixth-grade mathematics course. The eighth-grade classes were considered inclusion courses. Inclusion courses have a special education co-teacher as a resource. Altogether from these teachers, we generated $N = 53$ student participants ($n = 22$ sixth graders; $n = 31$ eighth graders). In part of the study that was analyzed quantitatively, 53 took the pre-test, and 50 took the post-test; three eighth-grade students with special needs were absent for the post-test. Thus, $n = 22$ sixth graders and 28 eighth graders took the post-assessment.

After the intervention lesson was enacted over a three-day period, interviews were conducted and analyzed qualitatively. Seven semi-formal interviews were conducted with students who were special needs. These seven students were randomly selected from the classes that were engaged in the lesson to examine their perceptions, feelings, and thoughts during the intervention. The only exception to the randomness was that the sixth-grade classes only had one student with special needs; therefore, that student was chosen to be part of the study. The other six students with special needs were in the eighth-grade math class. All students who participated in the interview took both the pre- and post-test.

Quantitative Results

To answer the following question, quantitative methods were used: What effect does focused numeracy instruction, specifically rational number supplemental instruction, have on middle school students' learning and self-efficacy with rational numbers? There were 53 students who participated in this portion of the study. Data collected from the pre-test came from one middle school campus using two separate mathematics classes with five class periods. The two classes consisted of sixth- and eighth-grade students. The sixth-grade group from one period contained a total of 22 students; only one of these was considered to be a student with special needs (Table 1). The eighth-grade group contained 31 students, of which 15 were considered to be students with special needs. The pre-test was *Subjective and Objective Numeracy Scales* was administered to the students at the beginning before the intervention.

Table 1

Sample Description by Grade Level for Pre- and Post-Test

Grade Level	Pre-Test	Post-Test
6th grade	*n* = 22	*n* = 22
8th grade	*n* = 31	*n* = 28
Total	*n* = 53	*n* = 50

The data collected from the post-test used the same population with a sample size of 50 (22 sixth graders; 28 eighth graders). The discrepancy from pre-test to post-test was due to pull-outs for STAAR testing. The post-test was administered to students at the end of the lesson for sixth graders. Due to scheduling and state assessment testing multitude, the eighth-grade class took the post-assessment five school days after the intervention was completed.

The *t*-test Results for the *Subjective Numeracy Scales*

The *Subjective Numeracy Scales* (SNS) revealed that the students did increase in self-efficacy but not at a statistically significant level. The SNS is a self-assessment of the students' perceptions of numeric abilities (Fagerlin et al., 2007). A two-sample *t*-test test was employed to compare the student population holistically with the H_0: $\mu_1 = \mu_2$ and H_a: $\mu_1 < \mu_2$ with an α of 0.05, where μ_1 and μ_2 represented the pre-test scores and the post-test scores respectively. Because a *p*-value of .196 was greater than an alpha of .05, I failed to reject the null hypothesis. There was not sufficient statistical evidence to suggest that students' scores on the subjective numeracy test were higher on the post-test than on the pre-test (Table 2). Although there was not a statistically significant increase, there were increases across the SNS. Each question and category were disaggregated and analyzed with identical null and alternative hypotheses as above. In addition, Hedge's g was used to measure effect size, due to having a smaller sample size (Enzmann, 2015). Hedge's g (0.170) revealed a small effect size for the SNS (Enzmann, 2015; Durlak, 2009). There was no difference in means of the SNS pre-test 30.113 (6.618) and the SNS post-test 31.300 (7.329). The test statistic for the difference of means was .8608 with a *p*-value of .196.

Table 2

Subjective Numeracy Scales t-test Statistics

	Aggregated	6^{th} grade	8^{th} grade
	Mean (SD)	Mean (SD)	Mean (SD)
Pre-Test	30.113 (6.618)	31.909 (6.015)	28.839 (6.882)
n =	53	22	31
Post-Test	31.300 (7.329)	33.455 (6.449)	29.607 (1.219)
n =	50	22	28
Difference of Means	1.187	1.546	0.768
t-value (*df*)	1.861 (101)	1.256 (42)	0.543 (57)
p-value	0.196	0.106	0.294

There were two groups that demonstrated measured increases, although the increases were not statistically significant (see Table 2). Moreover, it is clear that there was an increase in each grade level. Once again, these increases were not statistically significant. Sixth graders did have a more significant difference than their eighth-grade counterparts with a *p*-value of .106 and

.294, respectively (Table 2). Another interesting trend is that the sixth-grade class scored significantly higher than the eighth-grade class when comparing their SNS pre-test using a *t*-test with the same hypotheses as above ($t = 1.684$ (101); $p = .049$). In addition, when comparing the SNS post-test sixth graders to the eighth graders, sixth graders scored significantly greater than that of the eighth graders on the SNS post-test using the same test as mentioned previously ($t = 3.254$ (101); $p = .00101$). It is very clear that sixth graders showed a greater mathematics self-efficacy than that of eighth graders both before and after the intervention.

Two Sample *t*-test Results for the *Objective Numeracy Scales* Results

The *Objective Numeracy Scales* (ONS) or Lipkus Scales revealed that the students increased in percent accuracy at a statistically significant level. The ONS are a series of questions that test students' numeric abilities (Fagerlin et al., 2007). Students' scores were calculated by totaling the number correct and then dividing it by the total number of questions (see Appendix C). A two-sample *t*-test was used to compare the student population holistically with the $H_0: \mu_1 = \mu_2$ and $H_a: \mu_1 < \mu_2$, where $\mu_1 = 0.352$ (0.246) and $\mu_2 = 0.457$ (0.285) represented the pre-test scores and the post-test scores, respectively. Because I obtained a $t = -2.005$ (101) and a *p*-value of 0.024 that was less than an alpha of .05, I rejected the null hypothesis. These data results indicated that students scored higher on objective numeracy from pre-test to post-test (see Table 3). Even though there were no statistically significant results for the SNS, the students' scores for ONS increased significantly. Each category was measured and disaggregated with identical null and alternative hypotheses as stated above.

Table 3

Objective Numeracy Scales t-test Statistics

	Aggregated	6^{th} grade	8^{th} grade
	Mean (SD)	Mean (SD)	Mean (SD)
Pre-Test	0.352 (0.246)	0.402 (0.246)	0.317 (0.224)
n	53	22	31
Post-Test	0.457 (0.285)	0.576 (0.246)	0.363 (0.245)
n	50	22	28
Difference of Means	0.105	.174	0.046
t-value (*df*)	-2.005 (101)	-2.346 (42)	-.075 (57)
p-value	0.024	0.012	0.227

There were two groups that demonstrated measured increases. Sixth-grade students showed a statistically significant increase using an alpha of .05 ($t = -2.346\ (42); p = .012$). Once again, eighth graders showed an increase in their scores although they were not statistically significant ($t = -.075(57); p = 0.227$). Sixth graders did have a higher score than their eighth-grade counterparts on the ONS pre-test with a *p*-value of .106 and .294, respectively (Table 3). Dissimilarly to the SNS pre-test, the sixth-grade class did not score significantly higher than the eighth-grade class when comparing them using a *t*-test ($t = 1.307\ (51); p - \text{value} = .096$). Although when comparing the grade levels ONS post-test, sixth graders scored significantly higher than that of the eighth graders using the same test above ($t = 3.046(49); p - \text{value} =$

.002). Sixth graders showed a greater mathematics self-efficacy than that of eighth graders, but also demonstrated greater competence on the ONS post-test.

Qualitative Results

I conducted a phenomenological study (Peoples, 2021) and employed qualitative methodologies to answer the second research question: *What are the lived experiences of students with special needs with instruction in middle school mathematics at Medina Valley ISD?* A total of $N = 7$ students with special needs were interviewed during this study ($n = 6$ – eighth graders; $n = 1$ – sixth grader). Each of the students were classified as mild intellectual ability (Buzza & Dowl, 2015). After interviewing the initial four students with special needs, the sample size increased from an initial $N = 4$ to $N = 7$ as described in Chapter III. This change was introduced because the four interviews did not initially convey enough data to construct a complete narrative. Three of the eighth-grade students were not in a mathematics inclusion course, and the other three of which had an inclusion teacher. The sixth-grade student was in a general education mathematics class with no inclusion teacher (see Table 4). All students were on grade level and in the least restrictive environment.

The interviews were semi-structured and occurred in a classroom adjacent to the class in which they attended for their mathematics classes. Students were informed that they may be selected for an interview a day after the intervention lessons were completed. The students were asked to leave the classroom by their teacher to join me for the interview. Each student was asked a series of questions along with further probing questions to seek further understanding of the students' experiences (see Appendix C). Interviews were recorded using Google Meets® and were then transcribed using speech-to-text software Trint®. Each document produced was reviewed against the recording to ensure accuracy and notated for other important remarks, experiences, or emotions. All lesson materials were available for the interviewees' review during the interviews. This included the PowerPoint presentations on a laptop and the assignment that was turned in for a grade. Each of the interviews ranged between 10 and 15 minutes.

Table 4

Qualitative Sample Description

Participants	Grade Level	Gender	With Inclusion Instructor
Jonathan	8th grade	Male	With
Erikson	8th grade	Male	With
Maximus	8th grade	Male	Without
Jillian	8th grade	Female	Without
Kenneth	8th grade	Male	Without
Joseph	6th grade	Male	Without
Theresa	8th grade	Female	With

Note. All student names are pseudonyms.

The following is a brief description of the qualitative analysis process (Peoples, 2021). Once the interviews were transcribed by Trint®, the audio recording was listened in conjunction with the transcription to ensure accuracy. Irrelevant information was deleted, for example use of the word "umm." Then, preliminary meaning units were constructed with a focus on the research question (Giorgi, 1985). Then, themes were generated after reading and obtaining deeper understanding of the interviews. Then, a situated narrative was constructed using direct quotes from the student interviews to derive meaning from the students with special needs lived experiences. Finally, I constructed a general narrative unifying the students' experiences into a general description.

A few confounding factors occurred during the interview process. First, the recording for Maximus's interview was started after the ice breaker questions. Therefore, researcher notes were used for coding during the missing audio time. In addition, several precautionary measures were taken for the in-person interviews because the data collection was done during the COVID-19 pandemic. Interviews were conducted in such a way that they met the Center for Disease Control's (CDC's) and TEA's guidelines for safe practices during the interview process during the COVID-19 pandemic. The student and I wore masks and sat socially distanced. In addition, the computer, table, and seat were cleaned before each new participant came in and after they left room. In addition, a new blank assignment was replaced in between each interviewee. To ensure that the interview were properly recorded for transcription, there were additional microphones next to the student and me.

Themes

Themes are discussed in order of greatest to least commonality amongst students with special needs (Peoples, 2021). Codes for this record of study were derived primarily from the interview process because student work did not reveal any pertinent codes. Initially, the codes were focused on the commonality of all, most, or some of the students with special needs experiences. These developed into a list of themes (see Table 5). Each theme was justified, followed by the interpretation of the themes in Chapter V.

Table 5

Themes of Student Experiences

Student Number	1	2	3	4	5	6	7
Initially Overwhelmed	X	X	X	X	X	X	X
Math is Not Student's Favorite Class	X	X	X	X	X	X	X
Confident After the Lesson	X	X	X	X	X	X	X
An Average day	X	X	X	X	X	X	
Real World Application		X	X	X		X	X
Without Prompting to Solve	X	X			X	X	
Large Numbers Were Difficult	X		X		X	X	
Did Not Like Math	X				X		X
Unknown Topic	X	X				X	
Adding an Activity		X	X				X
Misunderstood Words		X		X		X	

Note. 1: Jonathan, 2: Erikson, 3: Maximus, 4: Jillian, 5: Kenneth, 6: Joseph, 7: Theresa (all pseudonyms).

Theme 1: Initially Overwhelmed

Students with special needs described their reaction after the pre-test and before the lesson as initially overwhelming and confusing especially because of the wording. After showing Jonathan, he felt that just looking at the assignment confused him because he did not know what to do. After discussing his initial feeling on the assignment, he said, "I just didn't know." Jonathan further went on to say he had never been taught how to solve these kinds of problems before: "[I] have never seen these kind of problems." Erikson found some of the lesson easy but other parts difficult due to the wording. Interestingly, Erikson did say they have seen some of the problems before. Maximus also mentioned they were initially overwhelmed claiming that “it was overwhelming and frustrating.” Jillian said, “I first looked at it. I did not know how to do this.” Kenneth said he felt that if he had a calculator, he could do it and gave himself a 50-50 percent accuracy before the lesson: “I know am not going to get everyone right.” Joseph said that it was his first time ever seeing these kinds of problems in this context and “it’s just stuff I did not know before” and claimed that “it was just a little complex.” He went further to say that “I really didn't know what that [solving percentages over 100%] meant until the end of the lesson.” Theresa said, “Oh my god! That was a lot!” She went on to further say that, “When I looked at it . . . there is a lot of numbers” and she just did know what to do.

Theme 2: Math is Not Student’s Favorite Class

During the ice breaker questions, students with special needs did not express that they chose mathematics as their favorite course. Jonathan claimed to not like any class inside the classroom setting. He further elaborated and said that he preferred being an office aid because he did not feel “cooped up.” Erikson said his favorite courses were science and English classes. Maximus listed his favorite class as athletics because he enjoyed playing football. Jillian discussed social studies as being her favorite due to her learning about past cultures, facts, and experiences of people. Kenneth, similarly to Maximus, expressed an interest in athletics and playing football. He further went on to say the only reason he liked his math class was because he liked his teacher for that subject. Joseph also expressed an interest in social studies because he likes learning all things about history. Theresa said she really likes her art class, after first saying she did not like any subject at school. In addition, several students mentioned that they did not like their mathematics course.

Theme 3: Confident After the Lesson

After the intervention lesson was enacted in the classrooms, all students with special needs felt more confident about finding the percentages of a given value. Jonathan claimed that after the lesson, he understood it and could repeat the process again in a new future context. Jonathan substantiated this claim by solving one of the problems from the section he did not complete during the lesson. Erikson felt very confident after the lesson and said that while he was doing the problems, he then recalled "after the lesson I remember doing these in the 4th grade; it was like déjà vu." Erikson also explained a problem without being prompted to do so. Maximus said that after the lesson, it became "like mental math," and he could even do some of the problems by just looking at them, "I feel more prepared to figure out the tip of a bill." Like Maximus, Jillian also felt that as the lesson progressed, some problems became simple enough: "I can solve most of these in my head." She went on to add that the more examples her teacher gave, the more confident she became in her own ability to answer questions. Kenneth said the lesson helped, but if he had the choice, he would still use a calculator to help him solve the problems: "The lesson helped, but I would still rather use a calculator." Joseph said that he understood how to calculate percentages over 100% after the lesson and that finding 200% of something was much easier than he previously thought. Theresa found that as the lesson progressed so too did her understanding of how to calculate similar problems: "I started to understand it more."

Theme 4: An Average Day

Students with special needs felt like the lesson delivered was a normal lesson and followed the routine of their regular mathematics class. Jonathan felt that "nothing felt different" from the day-to-day lessons in his math class. Erikson thought "it felt the same as [usual] just people were talking a lot," starting with a warmup, lesson, and then the assignment. Maximus thought "the lesson did not feel different. It felt like a review, but he did divide us up." Jillian believed that the lesson was on par with a regular day, although the content that was taught was unique. Kenneth claimed that the lesson felt like "it went the same as every other day."

Theme 5: Real World Application

Most of the students with special needs expressed an interest in learning topics that they could use in their everyday lives. During the interviews, they talked about learning how to solve real world application problems during the lesson. Erikson liked that "I learned that I could use it to ...figure out taxes." Maximus liked learning how to figure out taxes as well as working with "money… taxes, … and tip." Maximus was proud that he could now calculate some percentages mentally in applied situations, such as sales, tips, and taxes. Joseph was pleased to know that he could now figure out "know how to tip" his waiter. Theresa not only liked but enjoyed assigning probabilities to a given context and ordering them from most likely to least likely. Specifically, she "liked this one [referring to ordering probability]."

Theme 6: Without Prompting to Solve

During the interview, most students with special needs demonstrated their competency by solving a problem with a visitor due to their increase in self-efficacy. Jonathan showed that he could find 20% of 75 with the use of a calculator. Erikson realized that finding 25% of something was the equivalent to taking half of a number and repeating the process again. Kenneth claimed that the easiest problem was finding 100% of something because it was just itself. Joseph demonstrated how to multiply by a percentage greater than 100% such as 200% and 250%. He further went on to explain how to find 200% of 68.

Theme 7: Large Numbers Were Difficult

Most students with special needs felt that some of the problems were difficult due to them containing numbers with a large magnitude. Jonathan felt the larger than dollar amount numbers were more difficult; for example, 32,000 was more difficult than 320. Maximus felt that when the percentages were over 100%, the problems became more difficult. Kenneth, similar to Jonathan, thought if the dollar amounts were smaller, the problems would be less difficult, for example, 200% and 250%. Joseph said that he would have preferred the questions to be in multiples of 10s, for the percentages of the problems would have been a lot less difficult.

Theme 8: Do Not Like Math

A few students with special needs did not like their mathematics classes. Jonathan said he did not like math or did he like being cooped up in a classroom. Kenneth said, “I do not like math” and that he was “not good at math.” Kenneth went on to further say that he was only comfortable with his current class because of the teacher. Theresa repeatedly said that she did not like math class and preferred art to anything else.

Theme 9: Unknown Topic

A few students with special needs claimed to not connect the content to their lived experiences and have never seen problems like the ones in the assignments before. Jonathan and Erikson both said that they had “never seen these kinds of problems.” Joseph claimed it was not yet taught to him and that he learned it for the first time during that lesson. He went on further to specify that it was the percentages over 100 that had not been discussed previously in his math classes.

Theme 10: Adding an Activity

A few students suggested that to make the lesson more interesting, there should be an activity embedded into the assignments. Erikson "would have liked the back side to have a puzzle or maze where you could check your answer. That would be fun or interesting." Maximus claimed that if the assignment had more of a "game out of it. Right now, it [the assignment] seems more overwhelming. Put more fun in it." Theresa explained that she learns more from lessons that are fun "like doing a game . . . a matching game" that went along with the problems. Making the activity interesting to the students well help them be more engaged in what they do in class. Their interests will be attracted to games or activities.

Theme 11: Misunderstood Words

During the assignment, students with special needs expressed confusion toward the end of the assignment when the word in the problem changed from "of" to "loss," "gain," or "profit." Erikson claimed to be successful and confident when working through the problems, although he struggled when the verbiage changed. He said, "I think I would be able to avoid the problem if it had words like loss or profit." When Jillian read the problems containing profit, she felt confused because "the loss and profit threw me off because I didn't know whether it was the same thing or not." Joseph said he did not understand the last problem because "number 20 saying" 'loss," I didn't know what that meant." Interestingly, every student did ask their respective teacher for assistance to better understand.

General Narrative

General narrative is an overall explanation of the themes (Peoples, 2021). All students with special needs felt the lesson was initially overwhelming. All the students did not choose mathematics as their favorite class; moreover, they said that they did not like math class. Some students claimed this was the first time they saw this topic. Each of the students felt increasingly more confidence as the lesson progressed. Students viewed the progression of the lesson as not any different from a lesson during the regular school year.

When working on the assignments, a few problems gave most of the students some difficulty. Students with special needs fell into two different categories when it came to the perception of difficult types of problems, either the verbiage was confusing or unknown, or the larger numbers created the perception of difficulty. When the students began the assignment, they felt it was very easy. Then, when the verbiage changed from using the word "of" to "loss," "gain" and "profit," students became confused and did know if the mathematical process was identical to the earlier problems. The other category of difficulty came when students saw a percentage over 100 or the magnitude of a number was very large. Students were under the perception that the larger the number, the more difficult the problem was to figure out. Students were appreciative that the lesson did provide some real-world application, such as how much to tip a waiter or how to order the likeliness of a given set of events. Overall, students felt more confident to repeat the tasks and processes after the lesson. Therefore, their self-efficacy increased for this topic.

General Description

The analysis revealed unique discoveries regarding the experiences of students with special needs as they were engaged in an intervention lesson on the ratio. After the set of analysis, it was clear that students developed and improved their own mathematics self-efficacy. Students began being overwhelmed as was gathered from the interviews. These students felt confused and expressed a lack self-confidence during the pre-interviews. Transitioning to after the intervention, students found themselves juxtaposed from their original thoughts and feelings.

Students with special needs after the intervention no longer felt overwhelmed. The problems on the post-test appeared so simple that they could work them mentally without paper and pencil. The students regained their self-efficacy allowing them to figure out the amount for a sale, tip for a waiter, or how to figure out the discount rate at a store using their newly acquired numerical sense.

Trustworthiness/Creditability

To archive the trustworthiness of the data collected and the analyses I used, two of the eight methods were used as proposed by Creswell and Poth (2016). The two methods used were peer review and member checking (Creswell & Poth, 2016). These were in addition to multiple reviews of the interview transcription and audio from the interviews of students with special needs on their lived experiences.

Peer Review

After constructing the initial meaning units and themes, I had peers review my results. In addition, I asked questions about the methods to confirm that the methods were sound and properly represented in this study. Modifications were made off their recommendations. The study was reviewed by peers through the analysis process to ensure trustworthiness.

Member Checking

For member checking, I-poems were used, for they are best suited for adolescence (Simpson & Quigley, 2016). Insights gained from the lived experiences of students with special needs may be like insights about other student populations with similar interventions. Future researchers should consider the students' experiences and setting before generalizing findings. The general summary and themes derived from this phenomenon may offer insights for middle school mathematics instructors and mathematics education researchers.

Validity and Reliability

As mentioned in Chapter III, validity, and reliability for the ONS and SNS were used by researchers in previous studies. Lipkus et al. (2001) reported a Cronbach's alpha coefficient of .84 and .66, respectively for the SNS and ONS. In a secondary study (Lipkus et al., 2001), they reported a reliability Cronbach's alpha coefficient of .82 and .75, respectively for the SNS and ONS. For this record of study for the data in hand, the scores on the pre-test and post-test had a Cronbach's alpha of .70 and .80, respectively.

Summary

This study contained two research questions. The research question that was answered using quantitative methods had a total of 53 students taking a pre- and post-assessment on the ONS and SNS to measure the differences. The analysis revealed significant growth in students' competency on the ONS and growth, although not significant, in their mathematical self-efficacy. The second research question that was answered using qualitative methods had a total of seven students answering questions on their lived experiences during an intervention lesson. Through the interviews, these students showed a growth in their perceptions of the content covered during the lesson. The students with special needs experience began with feelings of being overwhelmed and confusion. After the intervention, students with special needs shifted their perceptions to ones of increased self-efficacy, desire to be engaged in the lesson, and wanting to check their answers for accuracy. Using the lens of numeracy while designing a lesson creates an avenue for student success academically and an increase in self-efficacy.

CHAPTER V

DISCUSSION

The purpose of this study was to answer the following research questions:

1. What effect does focused numeracy instruction, specifically rational number supplemental instruction, have on middle school students' learning and self-efficacy of rational numbers?
2. What are the lived experiences of students with special needs with instruction in middle school mathematics at Medina Valley ISD?

The means to answering these questions were to remediate students' misconceptions on the application of the ratio across the middle school mathematics curriculum. This was achieved by constructing a researched-based engaging intervention on numeracy instruction focused on the ratio. More specifically, the instruction focused on decimals and percentages based on the standards guided by TEKS. To answer the first research question, each student participant was administered an assessment before and after the intervention to measure student growth. To answer the second research question, seven students with special needs were randomly selected, using a random number generator, from those who participated in the intervention. Each of the seven students with special needs were interviewed on their lived experiences within the instruction.

In this Chapter V, I discuss my study results presented in Chapter IV. First, I summarize the findings for each of the research questions. Second, I discuss how the results relate to the relevant literature. Third, I discuss personal revelations from the study. Fourth, I discuss implications for future pedagogy for similar populations of students. Fifth, I discuss future research recommendations and the limitations of this record of study. Finally, I discuss my closing thoughts.

Summary of Findings and Discussion

Quantitative

Data collected from the quantitative portion of the study showed an increase in student numeracy, the *Objective Numeracy Scales* (ONS), when comparing the pre- and post-assessments. The students who participated in the study derived from of sixth- and eighth-grade students who took the pre-test (*n* = 22 sixth graders; *n* = 31 eighth graders) and the same students from the initial sample took the post-test (*n* = 22 sixth graders; *n* = 28 eighth graders). All students were in a general education mathematics class appropriate for their grade level. This portion of the study showed a statistically significant increase in performance using the *Objective Numeracy Scales* ($ONS_{pre} = \bar{x}\,(SD) = 0.352\ (0.246), ONS_{post} = \bar{x}\,(SD) = 0.457\ (0.285),$ $t - statistic\ (degree\ of\ freedom) = -2.005\ (101), p - value < 0.05$).

Analyzing the data from the quantitative portion of this study, the students increased in their competence of the ratio ($ONS_{pre} = \bar{x}\,(SD) = 0.352\ (0.246), ONS_{post} = \bar{x}\,(SD) =$ $0.457\ (0.285)$). Interestingly, students' scores did not significantly increase on the *Subjective Numeracy Scales* (SNS), since the *p*-value was not below 0.05 ($SNS_{pre} = \bar{x}\,(SD) =$ $30.113\ (6.618), SNS_{post} = \bar{x}\,(SD) = 31.300\ (7.329), t - statistics\ (degree\ of\ freedom) =$ $1.861\ (101), p - \text{value} = 0.196$). This is a surprising revelation because the *p*-value was less than 0.05 for the ONS and did increase significantly overall when comparing both aggregated and disaggregated groups. From statistics tests from the difference in SNS pre- and post-test was $\alpha = 0.197$ and from the difference in ONS pre- and post-test was $\alpha = 0.024$. Therefore, there was statistically significant growth for students on the ONS (p-value < 0.05). Growth was also seen on the SNS, although it was not statistically significant growth.

Several unique and unexpected trends occurred when observing the disaggregated data. Sixth-grade students showed significant increases on the ONS from the pre-test to the post-test as opposed to their eighth-grade counterparts. Eighth-grade students did not display increases on the ONS. Moreover, the data show they regressed significantly on question 7 (see Appendix C). Although, the possible reasoning for the differences between the sixth- and eighth-grade results being the time difference in which each grade level took their post-test. Sixth graders took their post-test the day after the lesson was completed and the eighth-grade students took their post-test five days after the completion of the lesson (see Table 3).

A secondary conjecture for the difference in growth could be the difference in experience of the students. Sixth graders did not have as complete prerequisite knowledge as eighth-grade students. Eighth graders have their seventh and virtually all their eighth-grade year completed and creates a greater knowledge base. Thus, there was a smaller increase in learning, whilst the sixth graders had greater learning experience because the lesson was a relatively new topic. This could have created the potentiality for greater student growth.

While not the focus of this research question, another interesting trend that occurred when analyzing the disaggregated data were students with special needs received a score lower than students in general education on the ONS. This pattern was similar for the SNS. Students with special needs scored lower than the students in general education on all but question 4 on the SNS. Students with special needs showed greater self-efficacy on this question on both pre- and post-test. Statistical significance could not be determined for this due to the small sample size of students with special needs. It can be determined the students with special needs had a smaller p-value, when comparing pre- and post-test SNS results, than their general education counter parts ($p - \text{value} = .006$ – Students with special needs; $p - \text{value} = .034$ – Students in general education). This is important because it implies that students with special needs and in general education have a greater self-efficacy on the post-test as compared to the pre-test when calculating tip. As mentioned previously, this may be due to the focus of the lesson, which was on percentages of given values and understanding what they represent.

Qualitative

For the qualitative portion of the study, seven students with special needs were invited to participate in interviews, from those who underwent the intervention lesson to understand their lived experiences. From these seven interviews, I observed clear improvements from the initial perceptions of students with special needs thoughts on the ratio as it deals with percentages. All students with special needs who participated in the interview process felt that if they were to see the assignment before the lesson began, they would have felt very overwhelmed. Before the lesson began, students with special needs perceived the assignment as overwhelming and difficult; then, after the lesson, the students' perceptions shifted to one of simplicity and ease when looking at similar problems. Some of the students with special needs were so confident, they demonstrated their competence during the interview process by solving a problem from the assignment without provocation; thus, further solidifying the results of the quantitative portion of the study that students' mathematical self-efficacy increased.

Interpretation of Themes

Theme 1: Initially Overwhelmed. The comments and responses of students with special needs when asked about their feelings and initial reactions to the assignments were met with confusion, self-doubt, and a sense of being overwhelmed by the tasks at hand. Student responses had a negative connotation to the problems before the intervention began. Several felt overwhelmed specifically about the wording, large magnitudes of the numbers, and the length. Because most of the students have an aversion to mathematics, this may have exacerbated the situation. Students' self-confidence played a large role when initially engaging into the lesson.

Theme 2: Confident After the Lesson. The comments and responses of students with special needs when asked about how they felt after the intervention was enacted led to an increase in mathematics self-efficacy. Some students even seemed to be enjoying their work with problems. Because the intervention focused on understanding why percentages are solved using a specific method, their confidence extended to beyond the intervention. This is substantiated by students spontaneously solving a problem the day after the lesson from the available assignment. While their self-confidence increased, some still seemed to hold reservations of their ability to solve future mathematics problems, using a calculator as opposed to using the methods taught during the lesson.

Theme 3: Math is Not Student's Favorite Class. The comments and responses of students with special needs, when asked what was their favorite course among the ones they were currently taking, none of the students chose mathematics as their favorite course. This may have resulted from another factor concerned with students' mathematics self-efficacy. Students are not likely to choose mathematics as their favorite subject if they are not confident in the course (Hackett & Betz, 1995). Building lessons that target students' mathematics self-efficacy could be a useful tool for more effectively engaging students with special needs.

Theme 4: An Average Day. When asked if the intervention felt different than a regular day, students with special needs felt that the intervention followed the same routine as an average day in mathematics class. This question was asked during the interview to make sure that the confounding factor was considered. The only difference noted was that students were split up for the assignment, which felt unique to at least one student. It was important to note that students did not feel like the intervention was out of the ordinary; therefore, this confounding factor was not an issue for this study.

Theme 5: Real World Application. Intermittently during the interview, students with special needs were appreciative that they were able to use their classroom mathematics in a real-world application. Students liked that they could take what they learned in the lesson and apply to contexts outside their mathematics classroom. The results from these interviews confirmed the effectiveness of this pedagogical strategy and confirmed that it should be used by educators as frequently as possible and should continue to be used to increase interest and engagement of all students but especially those students with special needs.

Theme 6: Without Prompting to Solve. When discussing post-lesson confidence, several students responded by solving a problem without prompting. This further demonstrated an increase in students' mathematics self-efficacy. Not only did students believe they were better at working with the applications of percentages, but they were able to demonstrate their confidence by proving it during the interview. These students' actions were one of the strongest indicators for proficiency and an increase in self-efficacy.

Theme 7: Large Numbers Were Difficult. The comments and responses of students with special needs when asked what were the most difficult activities or problems during the lessons, students chose one of two areas. The most common area was the magnitude of numbers. The larger numbers were perceived as most difficult. This was despite the fact the actual difficulty in mathematics remained the same, such as 50% of 3000 was perceived to be more difficult than 50% of 300.

Theme 8: Do Not Like Math. During the interview, students with special needs expressed that they did not like mathematics classes. To further clarify, some students with special needs repeatedly expressed throughout the interviews that, "I really do not like math." As mentioned previously, students who are not traditionally successful in their mathematics class would not choose that course as a favorite. For students to say that they do not like math class showed their lack of mathematics self-efficacy and even the potential fear of failure. When asked why she did not like math, Theresa was not sure why she did not like it.

Theme 9: Unknown Topic. During the interviews, students with special needs claimed to have never encountered these kinds of problems before. Contrary to the student's statements, this topic was initially discussed in fourth-grade classes when covering the topics of percentages, then again in the sixth grade when introduced during the concept of rational numbers. In seventh grade, teachers further work on the topic when discussing ratios or percent increase and decrease of similar figures in geometry. In eighth-grade mathematics, the TEKS again requires teachers to discuss proportionality as slope and a direct variation. This demonstrates that while students were previously taught and introduced to the basic underlying concepts of the topic, the students did internalize the concept of ratio and proportion completely and deeply enough to be able store it in their long-term memory and be able to apply it using a problem-solving situation. This phenomenon needs to be further researched by future educators.

Theme 10: Adding an Activity. The comments and responses of students with special needs, when asked what about how the lesson could be improved, choose to add an additional activity. This indicates that students with special needs strive to stay engaged. They do not want to be left behind and want to understand. Either to help students stay engaged or to check the answers for correctness, students intrinsically wanted to be successful in mathematics. Students with special needs suggested a matching game, puzzle, or even a maze. Future lessons could be better designed than to have mundane problems and have more engaging activities like the ones mentioned by the students.

Theme 11: Misunderstood Words. The comments and responses of students with special needs, when asked what was the most difficult activity or problems during the lesson, fell in one of two areas. As mentioned above, one was large numbers and another common area of difficulty was also the change in verbiage from what the earlier problems contained. The word "of" that most students learned through other lessons was indicative of multiplication to them. When the verbiage shifted to "loss" and "profit," students became confused. Therefore, instructors need to make connections between the use of words in word problems and how it is represented in mathematics. Students did not let the problem stand in the way of completion or understanding of the assignments. They asked their respective instructors for assistance. This goes to show the trust the students have in their instructors to help them out as opposed to cloistering themselves due to lack of understanding.

Discussion of Results Related to the Literature

The results from this study provided similar results to the relevant literature on the topic. The impact of a lesson using numeracy as lens focused on ratio developed into greater competency and increased self-efficacy. The following discusses the different topics and how this record of study relates to relevant literature.

Numeracy

In Chapter II, I defined numeracy as more than an association with or the ability to calculate complex equations because it includes how people use mathematical literacy given the social context (Craig & Guzmán, 2018; Fagerlin et al., 2007). Students with special needs encountered numeracy within the intervention lesson. Before the lesson, students with special needs lacked mathematical self-efficacy. This was revealed in the quantitative data showing the lowest scores on average on the SNS, and further in the qualitative data as Student 3 expressed "[the lessons were initially] over whelming and frustrating." Self-efficacy affects many aspects of students' performance; for this record of study, mathematics self-efficacy affects the capacity to solve problems (Kim et al., 2015). To help improve a student with special needs academic achievement, Fuchs et al. (2008) suggested constructing a focused intervention.

The lens of numeracy must continue to be at the forefront of the lesson design to build mathematics self-efficacy. If numeracy is not in the thought process of lesson design and development, the risks will weaken cultural structure, social structure (Craig, 2018), and a growing gap in 21st century skills (Capraro et al., 2014). Wigfield et al. (1997) showed a negative correlation between students' grade level and the usefulness of mathematics courses. This could be due to the lack of mathematics self-efficacy (Pajares, 2006). Therefore, when lesson design uses a lens of numeracy, it could potentially increase mathematics self-efficacy and thus the importance of numeracy.

Numeracy and Mathematical Self-Efficacy

Self-efficacy is the best indicator for academic achievement in mathematics. Numeracy can empower students (Craig, 2018). This helps students see the usefulness of mathematics and more and how to apply it to other contexts outside the mathematics classroom (Stoessiger, 2002). Interventions that are embedded in numeracy help a student's confidence and self-efficacy increases significantly (Gregory & Spitzer, 2018). There was an empowerment observed during the interviews. Students showed such confidence as to demonstrate the learned or relearned ability without provocation.

Increasing mathematics self-efficacy can be generated in multiple ways. Lih and Ismail (2019) suggested that when students work through multiple problems successfully, it generates an increase in mathematics self-efficacy. Interventions that are data driven and embedded with numeracy also significantly increase in mathematics' self-efficacy (Gregory & Spitzer, 2018). This study confirmed the research that shows such a strong correlation between students' mathematics self-efficacy and academic achievement (Hackett & Betz, 1981; Lloyd et al., 2005; Pampaka et al., 2011). Intervention development should focus on developing mathematics self-efficacy imbedded with numeracy.

Intervention Development

When constructing a focused intervention lesson, there are items to consider that derived from this study, considering the framework for numeracy and students' self-efficacy as some of the basis (Macintosh et al., 1992). Research shows that an increase in students' self-efficacy will also show an increase in their academic achievement (Bandura, 2000; Hackett & Betz 1989). From students with special needs, adding an activity to make the lesson more engaging would be helpful. In addition to activities, as suggested by students with special needs, adding problems that demonstrate the application to realistic out-of-class scenarios would help as well. Considering these aspects in lesson development could potentially empower students to have more mathematics self-efficacy.

Using the developed intervention, there was a clear increase in outcomes with students with special needs. Powell and Fuchs (2015) argued that the third level of the RTI process was successful for students with special needs (TEA, 2020). It is important to remember that students who are special needs or simply behind the curve can improve their academic status and have the potential to be on par with their student peers (Holmes & Dowker, 2013). A greater emphasis has been shown to be successful for students with special needs.

To ensure success, several strategies were used. In addition to using the TEKS, numeracy standards were also considered (Mcintosh et al., 1992; NCTM, 2000). Shortcuts and tricks were not used because it does not promote the student's ability to make the process of solving a problem generalizable, this is especially true for students with especial needs and ELLs (Fuchs et al., 2008). Instead, the focus was on the development of the process. The use of calculators was restricted. The more complex the problems are, the more the habit is to use a calculator to solve the problem (Mcintosh et al., 1992) and often becomes a crutch (Brown, 2015). Students were also asked to estimate their answers before computing their responses (Martinie & Coates, 2007). Collaborative learning was interwoven throughout the lesson; the literature has shown success for students with special needs (Melan et al., 2017). This has been shown to help students with special needs perform on par with their peers. These strategies are in addition to district-required classroom strategies as recommended in *The Fundamental 5* (Laird & Cain, 2011). With the stated strategies the intervention was research based and showed great success.

Implications for Practice

Future practice should be modified with similar populations of students based on the research from this study. Educators should continue to use data to determine areas of student difficulty. Educators should now consider, if not already, using numeracy as a foundation at the middle school level when deriving their next lesson and allowing a student voice in creation of the lesson.

The district is currently undergoing a large project to construct a unified curriculum amongst all the campuses. This study could be used as a model to construct future lessons for the mathematics courses at the middle school campuses. It also goes to show that using numeracy as a foundation for lesson design has a propensity to increase a student's mathematical self-efficacy. This increases the viability for strong growth and potential for future STEM fields (Hackett & Betz, 1989). Literacy has been a focus and should remain as such although quantitative literacy should also become an area of focus for professional development and be embedded into lesson design. More specifically, the emphasis on students with special needs is an area of focus for improvement.

Students with special needs need to continue to have a more focused targeted instruction by using the strategies suggested by the current literature with focused instruction on areas of needs. More specifically, the use of multiple strategies should be implemented in a single lesson grounded in numeracy. This study shows that when implementing a focused intervention process, students generate an increase in student mathematical self-efficacy and academic achievement. An unexpected side effect is that the intervention focused on numeracy, mathematical self-efficacy, and academic achievement further generates a student's drive to grow academically and not just be academically proficient.

This study suggests that students want to be engaged in the lesson and want to grow academically. From the interviews, a few students suggested that assignments should have some from activity to check their answers. This shows that students want to remain engaged and have accurate answers. Moreover, students strive to grow academically. Therefore, when constructing assignments, designing activities, or deriving lessons, educators should add in games or other means of checking answers and active engagement.

Connections to Context

There were two major goals of this study. As mentioned in Chapter I, a major goal of this study was to develop an intervention that would target students with special needs gaps in understanding. This is because the district data suggests that students with special needs struggle in our mathematics classes at the middle school. District students with special needs tend to perform on average with other comparable districts in the State of Texas according to TAPR. Thus, the focus on numeracy develops conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (NRC, 2001). As an A rated district, the goal is to continue to improve and maintain the score. The focus on numeracy within lesson and intervention development can be reiterated for middle school grade levels.

When developing an intervention embedded with numeracy, there are standards that must be upheld. Local and state governments have implemented standards that are imbedded with numeracy as put forth by the NRC (2001). These standards can be observed in the TEKS, ACT standard, and Common Core. For Texas educators, the TEKS provide the guide needed to develop high quality lessons. The focus needs to remain on teaching both the readiness and supporting standards. As it has been said time and time again in professional developments across districts, if we teach the standards, the ACT, STAAR, and End-of-Course exams will take care of themselves. We need to remain vigilant to teach numeracy-based standards and not focus on passing exams because the standards are of quality.

Connections to the Field of Study

Lesson and intervention designed with numeracy embedded within itself can be a difficult shift. To better facilitate the needs of students with special needs or those students who have a gap in knowledge, it can be tempting to resort to tricks to get by. This can further hinder students with special needs and those who have gaps in knowledge. When interviewing students with special needs, students spoke to understanding the mathematics at hand and were able to apply the concepts outside the context of the mathematics classroom. More specifically, they were more confident to progress forward into future mathematics classes. The depth of the confidence was displayed when students without provocation solved problems to demonstrate their content knowledge. While the development of the lesson or intervention may be time consuming, the results of doing so cannot be denied.

To make this development into consistent common practice, teacher and district support collaboration is key. As mentioned previously, the organic development of collaboration for this study was a major factor in the success in this study. I believe that this will continue to be the case in addition to other professional development and collaboration. The district heavily promotes the lesson study as point of emphasis, and it has been successful thus far. If quantitative literacy becomes a topic of focus during that collaboration and development to the lesson study, I perceive that students' gaps will become negligible. Moreover, the district will maintain a strong A rating as a testament to the educators.

Discussion of numeracy amongst educators is of clear importance. As mentioned previously, the current focus on literacy is understandable. The focus should be inclusive of quantitative literacy. With the support of the curriculum and instruction department, campus and district level administration, we can better develop and plan lessons that are in line with standards that are imbedded with numeracy.

Discussion of Personal Lessons Learned

There were a multitude of lessons learned during this record of study and through the research process. There were lessons learned for my own personal growth, growth as an educator, and the knowledge gained as a future researcher. Personal growth was derived from the ability to continue forward despite consistent setbacks and adjusting to face the consent modifications to pandemic protocols. As an educator, I found growth occurred most during the interviews with students. While listening to the experiences of students with special needs, I learned about practices that will now be added to my own curriculum. As a future researcher, the collaboration and motivation of my committee, writing coach, and fellow peers have provided the greatest form of growth as a future researcher. Moreover, the more I learn, the more I learn what I do not know.

Patience and perseverance are the greatest lessons I learned for my own personal growth. My patience grew through dealing with the effects of the pandemic consistently looming overhead, becoming a father, hybrid learning, and working with a faculty different from my own. As many who are working on research during this time know, designing a study during the pandemic created a unique series of roadblocks. With the perseverance of my peers and district level administration, we designed the intervention and obtained volunteers who met the CDCs and TEAs guidelines. If I kept persevering and had patience, the study moved forward and was a success for my personal growth.

An increase in collaboration was another lesson learned and developed organically as the study was being developed. As I was studying and learning what should be the focus, many conversations were held with district level administration and with the committee members. This initial relationship to develop ideas has created greater opportunity for growth in the district as well as a more developed professional relationship with the curriculum and instruction department and instructors from other campuses. Without the organic development of collaboration amongst peers, my growth would not have developed into the network of professionals. This leads into the seamless shift from peer inquiry into lesson development for the study.

The analysis of the qualitative portion of this study has developed some personal changes in pedagogical practices. I used to think that students should see complex examples to develop a future curiosity in STEM fields. While these examples are important, students want real world examples applicable to them and within their own context. I need to make sure to include examples and problems that students can relate to and use within all my teaching strategies. In addition, students want to be engaged in the lesson. My assignments can at times be a list of problems from a textbook. My assignments will now contain some form of activity or way of checking their own work. Such was discussed during the intervention. Real world examples need to be applicable to the population of students who are being taught and have a way for students to check their own answers. This would be a quality change in place because it would place increased emphasis on student responsibility and frankly, less grading responsibilities on the teachers because the students will have already checked their own work for correctness.

Collaboration amongst peers and campus administration was a great lesson learned. When beginning the study, there was an apprehension to discuss or acquire volunteers from other campuses. These fears were caused from a perceived lack of willingness from middle school teachers to participate in the study. That fear was alleviated after working with our district level administration. After asking for help, administration immediately helped with a solution. Within the next weeks, not only did I have volunteers, but the volunteers were enthusiastic to assist in the development of the invention for the study. Moreover, educators across grade levels were willing to work and develop the intervention as well. One of the greatest lessons learned is to lean on peers of all levels, campus and district administration.

Recommendations for Future Research

This record of study was developed successfully by me; although when analyzing the results of the study, several questions arose from the analysis. What would happen if the sample was more diverse in age? What are the longitudinal effects of an intervention on numeracy and mathematics self-efficacy? How would students' perceptions change if the study was developed outside the mathematics classroom? Does student perception of a mathematics class change with an increase in mathematics self-efficacy?

The sample size was limited to one campus due to the COVID-19 pandemic and volunteer teachers. As with any study, a greater sample size would have been more beneficial. Specifically, the qualitative interviews were derived from six eighth-grade students and only one sixth grader. It suffices to say, a greater variety in age groups may have provided a more rounded outlook on the students with special needs lived experiences as they participated in the intervention process. This was also true for the quantitative research portion of the study as well. Most of the classes were that of eighth-grade students with only one period of sixth-grade students. An increase in the diversity of age groups would have helped further substantiate the claims made in this study.

Recommendations for research would include a longitudinal study of the effect of the interventions and student self-efficacy over time over an academic year. This study was implemented within a single month. Thus, it would be prudent to further explore the longevity of students' mathematics self-efficacy over time. Moreover, it would be important to study the effects of numeracy over time in relationship to student mathematical self-efficacy. A longitudinal study would be beneficial with this type of research to determine if students could maintain the increased self-efficacy and numeracy levels as more time passes.

As mentioned previously, intervention design that is imbedded with numeracy can potentially increase mathematics self-efficacy and thus the importance of numeracy. Future research should be conducted to explore this correlation. When students show an increase in mathematical self-efficacy, what effect does it have on students' perceptions of the importance of mathematics or their productive dispositions (NRC, 2001). Hackett and Betz (1983) claimed that the higher mathematical self-efficacy students have, the more students perceive mathematics as important. If a students' mathematics self-efficacy is correlated with numeracy, therefore, could it be concluded that students' numeracy is associated with their productive disposition?

Research into quantitative literacy outside the mathematics classroom may prove fruitful. Literacy and numeracy, quantitative literacy, should be taught together (Beaudine, 2018; Marston et al., 2013). It would be a point of interest to repeat this study and next time include numeracy horizontally across the disciplines, as opposed to the isolation in just a mathematics class. Numeracy is correlated with literacy and is fundamental to the development of a quality mathematics student. When students increase in one area, the others may also increase. A study that focuses on promoting both quantitative literacy and literacy may prove to be interesting.

Closing Thoughts

Students with special needs or students with gaps can grow in their own mathematical self-efficacy and numeracy. Lessons and interventions that are imbedded in numeracy can help develop students' mathematical self-efficacy. This has several positive side effects beyond just the context of a mathematics classroom. Each student during interviews, and quantitatively, displayed an increase in their competency as well as their mathematics self-efficacy.

The district is currently highly successful and one of the many tasks is to maintain a successful environment. A greater focus on numeracy instruction could be one of the many modalities to maintain that success. It is important to show the success of implementing this curriculum and instruction to demonstrate that students of all backgrounds are capable because this district is successful despite an ever-increasing low socioeconomic student population. Success in this district can further help others do the same by example.

It is my goal that by reading the results and discussion in this record of study plus implementing similar interventions, that we as educators can help improve students' numeracy and overall mathematical self-efficacy. The focus of the study was on students with special needs, although my hope is that these suggestions could be put into practice for students of all backgrounds in the district whether they be gifted and talented, in AP courses, special needs, Section 504, in remediation courses, or regular or general education classes.

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APPENDIX A

IRB EXEMPTION LETTER

DIVISION OF RESEARCH

TEXAS A&M UNIVERSITY

NOT HUMAN RESEARCH DETERMINATION

January 29, 2020

Type of Review:	Initial Review Submission Form
Title:	SUPPLEMENTAL NUMERACY INSTRUCTION FOR SEVENTH GRADE SPECIAL NEEDS STUDENTS
Investigator:	Mary Margaret Capraro
IRB ID:	IRB2020-0106
Reference Number:	105247
Funding:	
Documents Received:	IRB Application (Human Research) - (Version 1.0)

Dear Mary Margaret Capraro:

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

Further IRB review and approval by this organization is not required because this is not human research. This determination applies only to the activities described in this IRB submission and does not apply should any changes be made. If changes are made you must immediately contact the IRB about whether these activities are research involving humans in which the organization is engaged. You will also be required to submit a new request to the IRB for a determination.

Please be aware that receiving a 'Not Human Research Determination' is not the same as IRB review and approval of the activity. IRB consent forms or templates for the activities described in the determination are not to be used and references to TAMU IRB approval must be removed from study documents.

If you have any questions, please contact the IRB Administrative Office at 1-979-458-4067, toll free at 1-855-795-8636.

Sincerely,
IRB Administration

750 Agronomy Road, Suite 2701

1186 TAMU
College Station, TX 77843-1186

Tel. 979.458.1467 Fax. 979.862.3176
http://rcb.tamu.edu

APPENDIX B

SUBJECTIVE NUMERACY SCALES (Adapted from Fagerlin et al., 2007)

1. How good are you at working with fractions?

❑1	❑2	❑3	❑4	❑5	❑6
Not at all good					**Extremely good**

2. How good are you at working with percentages? (Not at all good 0 – Extremely good 10)

❑1	❑2	❑3	❑4	❑5	❑6
Not at all good					**Extremely good**

3. How good are you at calculating a 15% tip?

❑1	❑2	❑3	❑4	❑5	❑6
Not at all good					**Extremely good**

4. How good are you at figuring out how much a shirt will cost if it is 25% off?

❑1	❑2	❑3	❑4	❑5	❑6
Not at all good					**Extremely good**

5. When reading the newspaper, how helpful do you find tables and graphs that are parts of a story?

❑1	❑2	❑3	❑4	❑5	❑6
Not at all helpful					**Extremely helpful**

6. When people tell you the chance of something happening, do you prefer that they use words (“it rarely happens”) or numbers (“there's a 1% chance”)?

❑1 ❑2 ❑3 ❑4 ❑5 ❑6

Always Prefer Words … **Always Prefer Numbers**

7. When you hear a weather forecast, do you prefer predictions using percentages (e.g., "there will be a 20% chance of rain today") or predictions using only words (e.g., "there is a small chance of rain today")?

❑1 ❑2 ❑3 ❑4 ❑5 ❑6

Always Prefer Words … **Always Prefer Numbers**

8. How often do you find numerical information to be useful? (Never – Very often)

How **often** do you find numerical information to be useful?

❑1 ❑2 ❑3 ❑4 ❑5 ❑6

Never … **Very Often**

APPENDIX C

OBJECTIVE NUMERACY SCALES (Adapted from Lipkus et al., 2001)

1. Imagine that we have a fair, 6-sided die, (For example, from a board game). Imagine we now roll it 1000 times. Out of 1000 rolls, how many times do you think the die would come up even (numbers 2, 4, or 6)?
2. In the big bucks lottery, the chances of winning a $10 prize is 1%. What is your best guess about how many people would win a $10 prize if 1000 people each buy a single ticket to Big Bucks?
3. In the Acme Publishing Sweepstakes, the chance of winning a car is 1 in 1000. What percentage of tickets to Acme Publishing Sweepstakes win a car?
4. Which of the following numbers represent the biggest risk of getting a disease?
   a. _________ 1 in 100
   b. _________ 1 in 1000
   c. _________ 1 in 10
5. Which of the following numbers represent the biggest risk of getting a disease?
   a. 1%
   b. 10%
   c. 5%
6. If a person A's risk of getting a disease is 1% in 10 years, and person B's risk is double that of A's, what is B's risk?
7. If person A's chance of getting a disease is 1 in 100 in 10 years, and person B's risk is double that of A's, what is B's risk?

APPENDIX D

STUDENT ACTIVITY (Adapted from Hope et al., 1997)

Activity A - Calculate the amount of each:

1. 100% of $60 = ________________
2. 100% of $1800 = ______________
3. 10% of $60= __________________
4. 10% of $1800= ________________
5. 50% of $60 = __________________
6. 50% of $1800 = ________________
7. 25% of $120 = _________________
8. 25% of $80 = __________________
9. 200% of $250 = ________________
10. 200% of $75 = _________________
11. 5% tip on $60 = ________________
12. 15% tip on $30 = _______________
13. 20% tip on $5000 = _____________
14. 20% tip on $45 = _______________
15. 10% tax on $60 = ______________
16. 15% tax on $80 = ______________
17. 50% of $2500 = _______________
18. 150% profit on $200 = _________
19. 250% profit pm $3200 = ________
20. 20% loss of $200 = ____________

Activity B - Calculate the amount of each:

1. 200% of $30 = ________________
2. 200% of $1900 = ______________
3. 50% of $120 = ________________
4. 50% of $ 3600 = ______________
5. 25% of $240 = ________________
6. 25% of $3600 = _______________
7. 100% of $30 = ________________
8. 100% of $20 = ________________
9. 50% of $1000 = _______________
10. 50% of $300 = ________________
11. 15% tip on $20 = ______________
12. 10% tip on $45= ______________
13. 25% tip on $4000 = ____________
14. 40% tip on $22.50 = ___________
15. 20% tip on $30 = ______________
16. 10% tip on $120 = _____________
17. 200% of $625 = _______________
18. 300% profit on $100 = __________
19. 125% profit on $6400 = _________
20. 80% loss on $800 = ____________

APPENDIX E

SEMI-STRUCTURED INTERVIEW QUESTIONS

Introduction:

- What is your name and what grade are you in?
- What is your favorite class? Why?
- Who is your math teacher? Do you like them?
- *compliment them on something. *
- Do you have plans for the summer?
- Discuss the purpose of the interview. “Thank you for letting me talk to you today. Today’s goal is to understand your experiences, feelings, and thoughts are on the lesson from today’s and yesterdays in math class.”

Interview Questions:

1. When you see these kinds of questions how did they make you feel? *show student the questions that they saw in the lesson*
2. If I asked you to solve this problem, what would you feel?
3. Would you feel confident?
4. Would you be concerned? Or anything you believe that the student my feel — if this is what you meant to ask)
5. Tell me what does your math class like? (Describe a typical math class, what does it like?). Why?
6. Could you tell me about the classroom at time the lesson was discussed?
7. What did you like about the lesson?
8. What did you not like about the lesson?

9. If you were to change one thing about the lesson, what would you change? Why?
10. How do you feel at your math class?
11. Tell me what did you feel at the last lesson?
12. “I learned that_____________.” Is there anything else you wan to say about your experiences before we finish?

Questions for follow up or continual probing:

- Can you say something more about _______________?
- Can you give more detail about ___________________?
- You mentioned that you had ______; could you tell me more about that. You mentioned when you were doing ____, _____ happened. Could you give me a specific example of that?
- Think of a time when you experienced ______ and can you tell me more about that as much as possible?
- You mentioned earlier that you _____. Can you tell me more about that?
- You mentioned ______ tell me what that was like for you?
- You mentioned you were worried (or felt uncomfortable) about ________, can you tell me about that?
- You mentioned ______ describe that in more detail for me?
- Think of a time when you had an _________ experience. I would like you to tell me about that in as much detail as possible.