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The Relationship Between The Development Of Math Operation Proficiency And Student Confidence

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THE RELATIONSHIP BETWEEN THE DEVELOPMENT OF MATH OPERATION PROFICIENCY AND STUDENT CONFIDENCE

by

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"Each of us has a spark of life inside us, and our highest endeavor ought to be to set off that spark in one another."

- Kenny Ausubel

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CHAPTER ONE

INTRODUCTION

What is the difference between someone who loves and appreciates mathematics, and one who does all they can to avoid math at all costs? Why is it that there are some students that pick up new math concepts readily and quickly, and others require remediation, practice, re-teaching, more practice, and still do not understand? What stands in the way of students gaining math knowledge and confidence along the way? These questions have spun around my head too many times to count over the first eight years of my teaching career.

As a 1st grade teacher, then elementary math support teacher, and now a 5th and 6th grade special education teacher, I have observed that many of my students over the years hit a roadblock in terms of developing efficiency and a strong understanding of basic math facts. Traditional strategies of memorization, timed tests, and even catchy jingles just do not seem to be enough for these students. More than that, struggling math students are not always able to even explain what addition, subtraction, multiplication, or division are in concrete terms. Despite the many learning experiences students have had with these concepts over one or more years of formal education, basic ideas of computation seem to lack staying power. As a consequence, I have observed these struggling math students put up a wall when it comes to taking out the math textbook. They lack confidence, understanding, and problem solving skills to empower themselves as math students. They do not find connections or meaning behind the math activities, worksheets, and assessments they complete in school. They are not able to make quick and easy estimates to realize if an answer is reasonable or not. They must be asking themselves, “What is the point?” And, “Why doesn’t this make sense to me?”

I would like to explore questions of the struggling math student in greater detail, specifically: "*What is the relationship between math operation proficiency and a student's confidence and perception of math in general?"*

Personal Experience as a Math Student

When I reflect back on my own journey as a math student, I am fortunate to say that I do not remember having to learn basic facts, or even having to practice memorizing them. In 4th or 5th grade, I remember competing with other students in my class to get faster scores on the timed tests. There may have been a few difficult facts that I could not recall automatically, but it may have taken me a few days of practice memorizing these facts before I had them down. In the classrooms I grew up in, there were winners and losers. Because I was able to learn quickly and perform well in the classroom, along with this came a sense of confidence and entitlement. I do remember the quiet joy of realizing how something works in math, such as using the multiplication fact as the inverse for a division basic fact. I can only imagine what friends of mine felt about themselves when timed tests did not come as easily, and when these patterns and realizations about numbers were not discussed and shared in the classroom.

To me, as a child, there always seemed to be a connection between the kids that did well on timed tests, and those that seemed to understand math lessons in class as well. I was put in the higher ability "advanced" classes in middle school, and continued on the advanced track in high school. It was not until Advanced Placement Calculus my senior year of high school that my confidence in math began to break down. I no longer just "got it," but had to work extra hard to memorize terms and procedures to do well on the test. Luckily, these were things I was good at doing, so by the end of the year my grade was still strong enough. This experience during my senior year of high school, however, stuck with me. Is math worth learning if we do not understand it at a deeper level?

I did not pursue math classes in college, as I pursued general education classes, and thought I might want to major in Art. I spent a year at a local junior college, before transferring to a small liberal arts college in the Midwest. My journey in college eventually led me to becoming an Elementary Education major by my junior year, including a certificate in Special Education and a minor in Art. It was not until my junior year in college that I touched math at all after high school. Perhaps my confidence was shaken from a difficult year in A.P. Calculus. Reflecting back, I believe I realized as well that my foundation in mathematics was not as strong as I always believed it to be. Sure, I could regurgitate procedures and achieve high scores on tests. But even as an “A” student, my math experiences left me less than confident in my own mathematics abilities. If this was how I felt about math courses at that stage in my life, I can only imagine what lower-achieving peers of mine felt about math and math-related careers in early adulthood.

Through my coursework with a particular teacher in the education department, I was given the task of analyzing math concepts to be taught, and determining how I would structure a lesson in math. This teacher challenged me to dig deeper and think about all of those math procedures that I memorized over the years in school. I enjoyed exploring how math procedures and algorithms actually worked. “What is long division, really? How does the distance formula work?” I thought. It felt like the first time I wondered “why” in a math class. Throughout my elementary education and secondary education, I recalled very few times a teacher opened the door to more than one way to solve a problem, or more than one answer. The traditional way of teaching math, in my experience as a student, and also observing other teachers throughout my teaching career, has first been modeling for the students how they solve a particular problem before asking the students to replicate the procedure with various practice problems. In my experience, replication of skills does not always develop deep understanding in part of the students. For me growing up, it certainly did not, even though I was pretty good at replicating skills. Merely having the option of delving into the "why" behind math skills in particular lit a spark in myself as a mathematical thinker, even at twenty-plus years old. As a teacher today, I have come to believe that the "why" is essential for learning and teaching math, in order to support others in constructing their own understanding and knowledge of the math universe.

The teacher from my college methods course saw my ability to unpack math skills, meaning determining the specific composite skills that come together for more complex math skills, which empowered me in more ways than one. I think of this as finding the basic skills one needs to thoroughly understand in order to advance to higher level math with understanding and confidence. Not only did I find my passion and excitement for math again, but I also realized my potential for becoming a teacher that could help students find this in themselves as well. This leads me to my burning question of: "*What is the relationship between math operation proficiency and a student's confidence and perception of math in general?"* I saw firsthand, even as a college student, that math was much more intriguing and fascinating to myself once I developed a deeper and more personal understanding of foundational numeracy, math operations, and algebraic thinking.

As an undergraduate student, I had many classmates that dreaded even a Math Methods course. I was shocked at how many very intelligent, capable, high achieving undergraduate students would actually wince at the thought of 5th grade math. I can only assume that these peers of mine had similar educational experiences growing up as I did, but perhaps they were not as good at replicating skills, which possibly left them feeling very uncertain in their mathematical abilities. In my perception, many children and adults today are intimidated by mathematics, at least in part because of how math was introduced and taught to them, beginning at an early age. It warrants further exploration to determine what experiences led them to either end of this dichotomy.

Personal Experiences Teaching Math

As I began my career as a Special Education teacher and then following as a first grade teacher, I was in survival mode. I had a difficult class, therefore early on in the year I was more concerned with keeping things in line management-wise than developing powerful math and literacy lessons. I did have confidence in my ability to break skills down to teach to understanding, but more times than not, I was asking my students to complete the same old tasks that my peers and our parents went through over the past decades of math classrooms. Some students excelled, others rebelled at the thought of math. Thankfully I had the support of a great teaching partner while teaching first grade, who took the time to help me determine what specific skills my students were in need of extra support with, and how to differentiate instruction through math centers. Analyzing student performance and designing a classroom environment that allowed for differentiation gave me the opportunity to start with student needs' first, rather than a page in a textbook.

After relocating to a new state, I found a job as a math support teacher at an elementary school. I worked with students one on one, in small groups, or co-teaching full classrooms for grades one through five. The opportunity to work with students in a format that allowed for deep differentiation of instruction excited me. I thought this was a chance to figure out how to connect with students and make real progress in their learning as math students. Over the following three years, I found great personal joy and satisfaction with the light-bulb moments from students, and especially when a student began achieving so well in math that I no longer saw him or her in my groups anymore. This was the bitter sweet epitome of success as a math support teacher.

One third grade student, who I will call "Eddy," remains in my memory. Eddy was identified by his teacher and intervention team as a student who qualified for extra help in math. I worked closely with the grade level team to determine what types of strategies to work on with Eddy for this intervention. As the result of our findings, I focused on addition fact strategies with Eddy and his small group. I met with him three times per week, for fifteen minutes each session.

At recent professional development staff meetings, I learned about the use of inclusive language in teaching, which is the practice of using language that includes all people openly; in example, prompting students with a question such as "how could we solve this problem," instead of prompting "how did you solve this problem?" The use of inclusive language is a simple yet profound way to open learners up to wonder and participation in exploring a topic or math strategy.

When teaching Eddy an "adding 9" strategy, I applied what I learned about inclusive language. After guided practice with Eddy, I followed with an open-ended question such as: "I wonder if the 9 Rule would work for other facts as well?" Eddy's face lit up with excitement. He said, "Mr. E, next time, let's find an 8 Rule!" And of course, we did. He was beginning to see the relationships with numbers, finding the power of "making 10" with concrete materials, and was developing powerful numeracy based on his own math curiosity. It worked for Eddy. I was pleasantly surprised to find out several weeks later that he would be grouped in a grade-level ability class. I do not take complete credit for this move based on the few hours total I spent with him, likely it was the combination of many factors coming together, including the masterful teaching of his classroom teacher. Eddy showed me that even struggling students, when presented with experiences that develop fact strategies, can feel empowered to become a mathematical thinkers.

I wish I could say I had several other stories like Eddy. Unfortunately, over my three years as a math support teacher, I spent hours, weeks, months, and in some cases years with many of the same students. Even with strong evidenced-based strategies, concrete materials and scaffolded instruction, many of these students never found the light-bulb moment like Eddy did. At that time, the question of "*What is the relationship between math operation proficiency and a student's confidence and perception of math in general"* was beginning to develop in my mind. I saw many students that struggled in math, and it seemed that a lack of proficiency and understanding of the most basic building blocks of mathematics made it very difficult for these students to take risks and put forth the necessary effort to develop as a learner. I often wondered, was it possible for these students to "fake" confidence in order to develop those skills? At the same time, was it possible to deliver instruction for these students that was appropriate for their development levels, but also developing themselves in terms of confidence?

After my most recent move back to the region where I grew up, I accepted a teaching position in a rural middle school as a special education teacher and case manager for grades 5 and 6. My caseload is comprised of students qualifying for special education under the criteria of Specific Learning Disability, Other Health Impairment for conditions such as Attention Deficit Hyperactivity Disorder, Autism, and Asperger's Syndrome, as described by Bender (2004). Bender explains Specific Learning Disability as a disorder that may impact a person's ability to process information in a variety of ways, including verbal and written language, reading, writing, and mathematics. Students who have qualified for Special Education services under the label of

Specific Learning Disability on my caseload are all at least one year behind in one or more content areas including reading, writing, and math, based on standardized assessments administered by a school psychologist. Bender (2004) describes Attention Deficit Hyperactivity Disorder as a disorder affecting an individual's ability to maintain attention. According to Bender, this may manifest itself physically in the person, resulting in fidgeting and very active behavior, but also can dramatically affect a person's ability to focus and concentrate on a task. He also explained that Autism Spectrum Disorders, including Asperger's Syndrome, affect an individual's social and communicative domains, as well as a detrimental impact on adaptive behavior, which allow a student without a disorder to adapt flexibly to change and their environment.

My students have a wide range of abilities, challenges, and needs in terms of support in and outside of the classroom. Some of my students participate in the general education classroom for the entire day, and some are removed from those classrooms for reading, writing, or math into a smaller classroom known as the Resource room, where I develop more specific instruction more appropriate to the students' ability levels and academic needs. I believe in and closely abide by the "least restrictive" philosophy of special education, meaning that students with disabilities must be placed with their peers in the regular education classroom to the highest extent possible. With that said, I have found it difficult to close the gap for students with identified disabilities in math both in and outside of general education, with respect to learning and performance on classroom, district, and state assessments at the level of their same aged peers. By 5th and 6th grade, many of my students have already developed a low self-concept about math, and do not have a positive outlook on their math abilities. My goals are both to build student self-confidence in my classroom, through a highly engaging and inquisitive environment, while also developing the building blocks of students' math minds, including fluency with operations and basic facts.

I have discovered many challenges associated with raising achievement for students in special education. One dilemma that many teachers face is the question of how much time to spend on any particular concept. I am aware of the negative effects of covering content, meaning the teaching mindset of covering as much material as possible, as opposed to teaching towards mastery of concepts for specific student needs. However, as I have observed over many years of teaching, students with slow processing times and inconsistent retention of learned content require far more time and exposure to mathematical ideas and skills than is possible in one school year. It is very important to prioritize learning standards, which are academic skills or content that is expected for all students per a given grade level, while also attempting to build bridges to learning standards from students' current ability levels.

With respect to math facts, I have struggled to achieve lasting results with my students. The majority of my students made strong progress in fact strategies in my first year of this teaching position, but I observed them to fall back in their speed, efficiency, and strategy use when not focusing the majority of class time to fact instruction and practice. I also believe in developing engaging and thought provoking math units and lessons for students in Special Education, as all students have a right to interesting, thought-provoking curriculum in school. In order to develop a love of learning, these students also deserve interesting math activities that build their confidence, self-concepts, and connections to their own lives and math. In Special Education, some may be surprised at how drastically different the students on a caseload can be. They may all have an identified disability, but vary to great length on strengths and weaknesses, in not only academics, but also socially and emotionally. My question, "*What is the relationship* *between math operation proficiency and a student's confidence and perception of math in general,"* becomes even more interesting in my current position because of the wide range of abilities and characteristics of my students.

Conclusion

Students need to feel empowerment over their own learning, and in my opinion, students are most engaged in learning when they are exploring their own understanding of the world around them. I would like to learn more about the impact that developmentally appropriate math fact instruction makes on a student's confidence and perception of math. Memorization and rote learning does not work for everyone; on the contrary, I have found during my years teaching that many students are left behind academically when they are not able to achieve the memorization that a teacher expects of them.

Another related question to explore is to what extent do evidenced-based practices in math have on students' motivation to learn intrinsically? Specifically for students that have struggled in math, or have been identified with a disability that impacts their achievement in math, is it helpful? Can low-achieving math students reliably and consistently be developed into motivated math thinkers? At what point should students be taught to rely on counting or computation devices? In my opinion, the math itself is an end to the means of becoming a mathematical thinker. I do believe that if given the right tools, more people can find this passion and confidence for math, which will have a positive impact on their lives in many other ways. Teaching with developmentally appropriate fact strategies is a starting point for the development of mathematical thinking in my students.

In Chapter 2, I will explore what other scholars have discovered about the question *"What is the relationship between math operation proficiency and a student's confidence and* *perception of math in general,"* including best practices for math fact instruction and assessment. I hope to find strategies that inspire and empower all learners, as I was lucky enough to find in a 3rd grade student named Eddy. The research in Chapter 2 will provide a foundation for the action research in response to the question, "*What is the relationship between the development of math fact operation fluency and a student's confidence and perception of math in general?"*

CHAPTER 2

REVIEW OF LITERATURE

Throughout my years teaching in a 1st grade classroom, as an elementary math support teacher, and now as a middle school Special Education teacher, I have had students of all ages that struggle significantly with recalling basic math facts. Poncy, McCallum, and Schmitt (2010) reported that over half of our nation's students are underachieving in math, and the rate for struggling math students also increases the higher the grade level. McTiernan et al. (2016) reported that successful math students require a strong foundation in prerequisite skills, which rely heavily on fluency in basic facts. Skinner, Pappas, and Davis (2005) found that students who struggle with basic facts have also been found less likely to even attempt more complex math skills. I found throughout my research that the need for evidenced-based fact instruction is crucial to provide the math foundation students need to be successful. In my experience, inefficient recall and conceptual understanding of basic facts impedes students' progress in math lessons, activities, and practices in the classroom, but also has a detrimental effect on their self-concept as a learning and thinker in mathematics. I have noticed students by 5th and 6th grade can lose their enthusiasm for math when they do not have sufficient fact fluency to compute or estimate quickly, efficiently, and with confidence.

In this chapter, I will review the literature relating to math anxiety, student self-confidence in math, and the development of math fact proficiency in learners, in order to determine *"What is the relationship between math operation proficiency on student confidence and perception of math in general."* A holistic approach to basic fact proficiency for students with learning challenges is unique in that in my experience, the majority of school districts and classroom teachers rely on one theory or instructional method for math fact development, such as a timed test or fact practice games. Any individual strategy may work for many or most students in a given classroom, yet students with learning challenges often fail to reach proficiency with a one-strategy instructional approach. For this reason, it warrants further investigation through a review of research literature to develop an understanding of math anxiety, as well as what leads to confidence and fact proficiency in math students.

First, I will review research on the state of math students in the United States, including the prevalence of math anxiety, theories of how math anxiety develops and spreads in society, and conversely the factors that lead to confident math students. Following, I will discuss research pertaining to the development of math fact proficiency in students. I will share best practices on assessment techniques for measuring student growth and proficiency. I will also discuss specific instructional techniques for students, in particular students with learning disabilities or other challenges.

Math Anxiety and Confidence

Prevalence of anxiety in math students. According to Philips (2007), a majority of Americans have difficulty with basic math functions. He described challenges of everyday adult math skills many adults report experiencing, such as calculating a tip at a restaurant or determining how many miles per gallon for gasoline. Ramirez et al. (2013), found math anxiety to become a struggle for children as early as first or second grade. They also described how the continuation of anxiety with math can lead to students avoiding math practice, asking for extra help, or challenging themselves to take more challenging math classes at the secondary level. Andrews and Brown (2015) described instructional practices by teachers in the elementary grades, as well as assessment procedures, that have been found to elevate the levels of anxiety in math students. Their research reminded me of my experiences as an elementary and secondary student, with regards to the type of instruction I was accustomed to, and a lack of intrinsic motivation due to the type of instruction presented by my teachers. This section will describe the long-term effect math anxiety has on students and adults, but also the effect anxiety has on immediate learning outcomes with students.

According to Geist (2015), students that have higher levels of anxiety in relation to mathematics have been found to achieve less; this has been found to have an effect as early as 1st grade. Geist also reported a correlation between math anxiety of the teacher as well and decreasing levels of achievement in math classrooms. Geist concluded that math anxiety in children and adults, if not corrected, leads to avoidance of math altogether. Geist found this avoidance manifested itself even for teachers in planning and teaching math, leading to less effective instruction in their classrooms. Students, when presenting with anxiety, tended to avoid mathematics work as well.

Jameson (2014) also had concerns about anxiety, as he explained that the earlier the onset of math anxiety begins, individuals avoid math more, which leads to a self-fulfilling prophecy of being poor at math. As well, Andrews and Brown (2015), reported that the majority of Americans have a fear or dislike of mathematics. They explained that this may contribute to students in the United States taking fewer high level math classes in high school and college, and avoidance of math and technology related fields. Andrews and Brown also reported that employers in the United States have been affected by a lack of highly trained young adults in math and technology, and have seen gradual increases in the amounts of hiring from abroad in these fields to compensate. They demonstrated through their report that this is not just a classroom problem, but a problem that has filtered throughout society as well. According to the above research, my question, *"What is the relationship between math operation proficiency and* *a student's confidence and perception of math in general?"* shows implications not only for children's primary education, but for their future careers as well.

Development of math anxiety. As described by Erikson's stage of industry versus inferiority (as cited in Andrews and Brown, 2015), children between the ages of six and twelve either develop competence and proficiency or feelings of incompetence and failure in particular areas. Andrews and Brown reported that between grades 6 and 9, higher levels of math anxiety are reported in 9th grade. They theorized that due to increased levels of evaluation of skills, students develop a greater sense of inferiority of their math abilities. Andrews and Brown explained that it is also more common for students after 6th grade to be grouped into classrooms based on their perceived ability levels, which also increases or decreases student confidence in math. Andrews and Brown reported several studies of an inverse relationship between math performance and math anxiety, beginning in early elementary school, and increasing throughout middle school and into high school.

Jameson (2014), described the early onset of math anxiety in children, and possible root causes. Jameson noted that despite the stereotype that boys achieve more in math than girls, there was almost no significant difference in achievement between male and female math students. She did report that the rates of anxiety in female students however is notably greater, which supports possible causation of less young women pursuing careers in math related fields. Jameson found that math anxiety has an indirect negative effect for boys, in that it lowers their value of the importance of math. Additionally, Jameson found that environmental factors such as parent involvement, encouragement, and personal attitudes about math and learning have an impact on students' self-efficacy in math as well. Through my research and experience teaching, the reality of several factors being involved in determining what causes math anxiety in children, and alternatively what develops confidence in math, makes it a complex question to analyze and assess. Jameson unveiled, however, that recognizing these indicators of a confident math student contributes to the idea of where a student's confidence is at.

Development of math confidence. Kyriacou (2005), discussed the importance of developing not only math competence at an early age, but also math confidence. Kyriacou highlighted that math confidence and competence cannot be thought of as separate entities, but must coincide with one another. He rationalized that if one does not have the ability to perform mathematics tasks, eventually they will give up to avoid failure. Kyriacou conducted a study involving a mathematics classroom and lessons meant to increase student math confidence. Based on the results of his research, he concluded that a lack of success in raising student confidence through the duration of this study was attributed to failure of the teachers to fully understand the implementation of these lessons, and also the teachers inability and lack of opportunity to follow-up and intervene when lessons were not successful. Kyriacou found that the classroom teachers involved in his study failed to reach the appropriate level of engagement and higher-level thinking in students. In analyzing what encourages or inhibits the growth of math confidence in students, Kyriacou theorized that a truly interactive classroom gives all learners the ability to reflect and develop strategic mathematical thinking.

In my experience, traditional classrooms that have a quick pace and low-level thinking questions do not provide the environment for students to develop confidence in their own strategic thinking, in particular low-achieving students. Kyricou said that an interactive classroom should include "rich dialogue, wait time, discussion, and opportunities for strategic thinking for all learners" (2005, p. 178). He explained that the quick pace of traditional classrooms limits children's ability to think and respond at their own pace, and also has the unintended consequence of increasing students' math anxiety.

Kyriacou (2005) described the consequence of math anxiety as the negative effect of treating all students the same, and not considering the differences in learning styles, processing times, and ability levels. In my experience as well teaching math at the elementary and middle school level, I have observed that when students are not able to think, reflect, share, and investigate, they are not given the room and time to develop confidence as mathematical thinkers. I see this (albeit unintended) negative climate in the classroom tells students that they are not quick enough or smart enough to "get" the math, and end up with feelings of helplessness. Kyricou concluded as well that for students' confidence to increase, they require a rich, supportive environment that gives opportunities for all students to think critically about mathematics.

Kyricou's (2005) work described the type of environment that develops confidence in math students. In my experience, higher confidence in students also leads to higher motivation. When students are confident and motivated, I see them as more likely to fully experience the rich learning environment that is necessary for them to thrive. Linder and Cribbs (2015), described the importance of high motivation for math, beginning at an early age for students. They explained that children develop either positive or negative attitudes about math early in life; once established one way or the other, it is difficult to change. This shows how crucial early intervention is for struggling students, and also underscores the great value of a strong early-childhood education program. Jameson (2014), also found problems with anxiety beginning very early for students. He reported that the strongest indicator of the level of math anxiety in 2nd graders was the students' math self-concepts. Jameson explained that similarly to other forms of anxiety, math anxiety tends to stem from negative experiences that are left un-remediated. Jameson made the claim that one's beliefs about abilities in a particular area can at times be a stronger predictor of success than past performance of the actual task. In response to Linder and Cribbs ((2014), and also Jameson (2014), this makes me wonder what we can do as educators to reverse the trend of low motivation and confidence in a student.

Alternatively, Linder and Cribbs (2014) listed many predictors that high motivation brings to a math student, including student performance, self-regulation, and effective goal setting. They explained that motivation increases the attention of the student, which consequently has a positive impact on the student's opportunity for learning to occur. Bandura (1997) suggested that student self-efficacy may be an even stronger indicator for achievement than objective assessments. As a teacher, information about my students' self-efficacy and motivation is extremely important for me when planning for success. Based on Bandura's findings on self-efficacy, if a student lacks belief that they can grow and achieve through hard work, then I believe my job as a teacher is many times more difficult. To bridge the gap between low and highly motivated students, I also need to know specific traits of highly motivated students.

Linder and Cribbs (2015) summarized findings of a qualitative research project on the traits of highly motivated math students. They found that students are highly motivated in classrooms with a positive learning environment that supports all learners to participate and share, and one in which students are not afraid to make a mistake. Linder and Cribbs' research showed that when students respect one another and differing perspectives, all students become more motivated to learn and take risks. They also found that high levels of discussion in the classroom were a major factor in motivation, including having the opportunity to share throughout the class. Lastly, Linder and Cribs found that a teacher with a positive disposition in teaching math and interacting with students and other adults greatly benefits student motivation. Their findings make it evident to me that the classroom environment, including opportunity for discussion, as well as the teacher's disposition, have significant contributions to the level of a child's motivation. I believe it is possible to change a child's motivation, even a child with very low self-efficacy, if the teacher can implement the type of supportive and inclusive classroom environment that Linder and Cribbs described.

I am also concerned however with the implications of poor classroom environments and what effect that can have on student learning. Earlier in this section, I included Philip's (2007) description of the wide prevalence of math anxiety in the United States with children and adults. If the parents and teachers of our children have negative connotations with math, I wondered what impact this has on children's learning as well. Geist (2015), reported that teachers and parents can indeed pass on negative feelings of math to the children. He connected negative math attitudes from adults leading to less positive interaction and experiences with math on part of the children, and furthermore the children avoided math because of those negative feelings. Geist observed this in his research with students as young as 1st grade. With several students I have worked with over the years, I recall many of their parents also commenting to me that they also do not like math, or do not understand it, in some instances almost saying that they are not surprised that their child struggles with math as they did. This is frustrating to hear as a teacher, but I also feel empathy for those parents who did not receive a motivating math education as a child, and that they perhaps are re-living the same negative experiences now as a parent. Based on the research of Geist, as well as my experiences, it is clear that the math dispositions of teachers and adults do make a positive or negative impact on a child's own disposition. However if teachers and parents are aware of their impact and reflect on how they can positively impact their child or student, it is something we can control and change for the better.

Linders and Cribbs (2015) concluded that there is a need for analysis for other external factors as well that play a significant role in student motivation, confidence, and math achievement. They determined that students that are less motivated have increased anxiety about math, which directly impacts and lowers achievement as well. The above researchers have analyzed the factors that support motivation and confidence in math, which lay the groundwork for establishing classrooms that support the growth of confidence in math students.

Throughout the literature, I found that the authors suggested that students' experiences have a direct impact on their ability or lack of ability to develop confidence in themselves as math students. Previously, I may have believed that people are confident or not because of their ability in a particular area. Through the research I have read on mathematics, the authors attribute much of students' self-efficacy to the environment and external factors of a child's early life and education. It is not clear to me however what impact instructional practices have on the math self-efficacy of students with learning challenges specifically. I understand through my experience teaching the many challenges of assessing students with a variety of disorders and disabilities, including communicative and language disorders that make it difficult to acquire a valid assessment of these students.

In order to develop a plan to explore my question of "*What is the relationship between math operation proficiency and a student's confidence and perception of math in general,"* it will also be very important to determine reliable strategies to assess student learning, as well as a way to measure student confidence as math students. The following section will describe methods reviewed in the literature for assessing math students with learning disabilities, including the development of math fact fluency.

Math Proficiency & Assessment

Math students in the U.S. Poncey et al. (2010) reported on findings from the National Center for Educational Statistics regarding the low achievement of math students in the United States, including only 39% of 4th grade students and 32% of 8th grade students performing at or above grade level in math. Based on this data, Poncey et al. concluded that students are not mastering "basic math foundations and skills necessary to acquire more advanced skills" (2010, p. 917). They describe the acquisition of basic math facts as central to the progression of foundational math skills to more advanced ideas. The researchers included considerable debate, however, on what methods meet objectives best for students to succeed, including minimally guided approaches known as constructivist techniques, as opposed to directly guided approach, sometimes referred to as behaviorists techniques, to teaching and learning. Poncy et al. cited the National Council of Teachers of Mathematics (2009) on the importance of students' fluency when responding to basic math facts. Kirschner et al. (2006) also explained how the debate throughout past decades has revolved around issues of how much guidance is appropriate for math instruction in general. Poncy et al. (2010) reported no clear consensus in the research on what methods work best in develop student understanding and proficiency in math, but did say that pure constructivist models of teaching "may even have negative consequences for students, leading to frustration, confusion, and misconceptions of knowledge" (p. 918). They also noted that in particular for students with learning disabilities, student-led instruction lacks appropriate structure for these students to build on prior knowledge independently.

Skinner, Pappas, and Davis (2005), indicated that the implications of students falling behind in math fact proficiency may extend far greater than the confines of their immediate classroom, often having a negative impact on their future math experiences and opportunities. Skinner, Pappas, and Davis (2005) explained that when students are not able to develop immediate recall of math facts, all tasks related to math in the classroom become difficult, tedious work. They found that students are also less likely to attempt math tasks in the future because of negative feelings associated with mathematical thinking, many of which are fundamental to living an adult life. Poncy et al. (2010) also said that these students will likely struggle with career or vocational opportunities that involve math, and may be inept with basic living skills as well, such as balancing a checkbook or making change. Poncy et al. found that students with learning challenges struggle with basic foundational learning skills more than typical students, therefore they are at greater risk of the negative consequences later in life. It is clear to me that the stakes are higher for these students to develop strong foundational math skills in the early grades, due to the risk factors associated with falling behind in school and not accessing higher level math skills and curriculum.

Assessment for math fact instruction. I often wonder and worry about the types of assessments that myself and other teachers give my students with special needs. Some of these assessments are mandated by the school district or State of Illinois, and others are assessments based on a unit of study developed by the teacher. The students on my caseload all have accommodations written into their Individualized Education Plan (IEP), which is a document developed annually by the school team, parents, and often the student as well. Accommodations are meant to allow the child to access the curriculum on a leveling playing field with their peers, after accounting for the effect of the child’s disability. Even doing so, I find that many assessments set up struggling students to fail more often than not, or do not fairly measure growth. That being said, my school district is in the process of developing standards-based grading for all students in our middle school. This is a fantastic step forward for all student learning, including students with special needs. In my opinion, assessments should measure fairly what a child has learned, in a reasonable amount of time with adequate instruction and experiences. I believe the environment, including teacher, parent, and student dispositions about their learning, are shifting because of this shift in assessing and grading practices. I will describe in this section what researchers have found on assessing students accurately, and in a way that contributes a positive effect on their self-efficacy as students.

Ford & Usnick (2011) stated that traditional timed tests have dominated classrooms in the United States for the assessment of math facts. In my experience, timed tests in many classrooms replace the instruction for the development of math fact proficiency as well, meaning that students do not receive specific instruction or direct practice with the strategies they are applying and being assessed on. Ford & Usnick also described alternative forms of assessment that encouraged students to show their thinking and development of strategies. In my opinion, the way students are assessed offers implications for our priorities for math students; is simply knowing the answer enough, or is it also important to have strong conceptual knowledge of strategies? I believe the types of strategies students are using offer great insight into how they will be able to perform mathematically. For example, if a student is finger-counting to add "7 + 5," I know there will be limitations for that student on how quick and efficient they will be with fact recall. There is no need to put them through a time-test if that is their current strategy; they will only ever by minimally efficient if using a less efficient strategy.

Poncy, McCallum, & Schmitt (2010) explained that the ability to deconstruct numbers with single and multi-digit numbers correlates with student success on more complex math tasks as well. The authors described deconstructing numbers as the ability to flexibly regroup, add, and subtract numbers in a variety of different ways. In my observations, this is a strategy that will lead math students to much more efficient recall of basic facts. I also think back to my former student “Eddy” from Chapter 1, who was able to build his math confidence quickly in my observation through the development of new fact strategies. I wonder when students like Eddy are able to unlock the ability to group numbers flexibility and efficiently, if this provides them inspiration and confidence in applying those math skills to more complex tasks. Also, if we assess a child using a time-test that does not yet have efficient, quick strategies, are we not setting them up to fail? I can only imagine what some students must think when faced with the notion that they must count on their fingers even faster than they already are! If new strategies are not introduced, practiced, and repeated by students regularly, timed-tests in my opinion seem to set struggling math students up for both failure an increase in math related anxiety.

Kling and Bay-Williams (2014) found that with respect to math related anxiety, traditional timed tests have led to an increase of anxiety in math students, even for high-achieving math students. I have had students that wince at the word “fact fluency” or “timed test;” to many students, parents, and teacher, it seems to me that the intent and ultimate goals of timed tests are not consistent amongst all stakeholders. I question the purpose of timed tests and the intended effect. It is important to me to be very clear to all on the purpose and goal of any given assessment. Boaler (2015), also found that the term fact fluency is confusing for students, parents, teachers, and politicians that dictate educational policy. He emphasized that it is important to have a clear idea first of what is meant by fact fluency before one can accurately assess a student's proficiency.

I also found it necessary to consider how to determine how and when a student is fluent with math facts. Some of my students may be able to figure a fact out with deliberation, but may not be automatic. Others may develop a quick response to a point, but simply do not move and express themselves as quickly as others. Kling and Bay-Williams (2014) wrote that the Common Core State Standards Initiative (2010) define the procedural fluency of math facts as "skill in carrying out procedures flexibly, accurately, efficiently, and appropriately" (p. 490). Kling and Bay-Williams also explained that the traditional use of timed tests offers a very narrow view of a student's proficiency, including no information on what type of strategy development the child is using. This revealed to me that there is more to fact fluency that a number of correct facts in a given amount of time. As Kling and Bay-Williams described, the type of strategy, accuracy, and use of an appropriate strategy in a problem solving situations need to all be considered when assessing students' proficiency with math facts. Kling and Bay-Williams reported that timed tests have even had a negative influence on the efficiency of strategies used, accuracy, and number sense in general. I wonder if a timed test offers a message to our students that strategies do not matter, it is just an end result we are interested in. This closed mindset to the use of strategies would discourage myself from attempting to think mathematically, and no doubt would make me anxious if the sole purpose of the assessment was to respond more quickly and correctly. This information about negative effects of timed tests is crucial when moving forward with my question, *"What is the relationship between math operation proficiency and a student's confidence and perception of math in general?"* Given Kling and Bay-Williams' evidence that timed tests may even harm a student's ability to develop efficient strategies, it seems quite urgent to explore alternative assessment techniques further. In my opinion, assessment of any skill is a major component of teaching and learning; the two cannot thrive without multiple assessment opportunities throughout an instructional period. I am unclear to why timed-tests have become the dominant method for assessing students math fact abilities in recent years, but would like to explore new approaches that offer the teacher information on not only a student's fact retrieval ability, but also what conceptual strategies are being utilized by the students.

Ford & Usnick (2011) reported that alternative assessments have been used in particular with literacy and the fine arts for decades, but have not transferred to a large degree to mathematics. They explained that ultimately teachers tend to return to the practices they were brought up with through the years; teachers reported that other forms of assessment are overly time-consuming and can be subjective. The authors found that the end result has been the continued use of timed tests that do not meet the needs of all learners. Kling and Bay-Williams (2014) supported the idea that alternative assessments can become an invaluable tool for teachers as information to help shape instruction, alongside research-based instruction techniques, to develop fact fluency. They described a variety of assessments that offer specific and efficient information to the teacher, including observations, student interviews, performance tasks, and journaling. As the authors demonstrated, these are not overly time consuming, and can be readily worked into the flow of a typical school day or math instructional block. Kling and Bay-Williams described the goal of assessments is to give the teacher information on a child's math fact strategies, including flexible use of strategies, accuracy, and efficiency. They explain that one assessment should not be prioritized more than another, as in the case of timed tests. I also believe in the use of multiple assessments, which gives students with varying strengths and preferences more than one way to express their knowledge and learning.

Ford and Usnick (2011), described a specific method of assessment that provides the teacher with a more thorough report of information. They reported on the development of an alternative assessment for multiplication facts, designed similarly to an addition assessment known as the “hiding assessment”. Ford and Usnick followed guidelines from the National Council of Teachers of Mathematics (2009) that dictates for students to be able to “understand various meanings of multiplication, identify and use relationships between operations, develop fluency with basic number combinations, and use visual models” (2011, p. 54). It appears to me that this type of guideline goes well beyond what a timed test can offer in terms of assessment. Ford and Usnick described how students were asked to respond to a verbal and visual prompt of a missing factor type of multiplication fact. The authors explained that not only can the teacher determine if the student was able to produce the correct answer efficiently, but they can also record observations of the type of strategy the student used to arrive at an answer. I understand that when opportunities are given to a student to explain their thinking, the teacher is given invaluable information on what the students knows and understands, and where to go next in terms of instruction. Ford and Usnick also faced challenges however in initial attempts with this alternative assessments. They explained that pre-service teachers that were conducting the assessments did not always record observations of student strategies as intended. The authors explained that the teachers viewed the assessment as a different form of a timed test that simply showed if the students “knew their facts” or not. Through trial, error, and reflection, the researchers investigated other methods to facilitate the type of inclusive assessment they were trying to achieve.

Ford and Usnick (2011) developed a different formative assessment to record data directly of students’ strategies of multiplication facts. Their assessment included facts from “times 1” through “times 9.” They developed a simple chart that a teacher can use to record and tabulate data in an efficient way. Ford and Usnick explained that the first column of the chart includes numbers 1-9 going down, with each row including a randomized set of products for the initial factor, for example, all possible products for the number five, from 0 to 45. They wrote that each child is presented a number card with a dot-picture as well for the initial factor. They explained how a child is prompted to respond to a question asking how many groups of a number to make a particular product, such as groups of 5 to make 30. Ford and Usnick explained that follow-up questions were also asked to probe deeper into the child’s fact strategy. Ford and Usnick’s assessment described to what degree a child can recall multiplication facts, but also gives great insight into what strategies a child is utilizing.

Many comments and concerns I have heard from fellow teachers in the past in regards to any type of alternative assessment is how much time it will take. Kling & Bay-Williams (2014) explain that when designed thoughtfully, an educator can develop a system for the classroom that combines math fact instruction, assessment, and practice into a cohesive plan. They described the use of fact practice through games and activities, discussion and writing about strategies, use of visual supports, and quick fact quizzes that can all be apart of a fact curriculum that provides the teacher with formative data to drive instruction. In my experiences, timed tests offer a very limited view of what a math student can do and understand in terms of math facts, and in some instances may even hinder progress and confidence due to the time restrictions and anxiety this brings some students. Similarly to a complete classroom model described by Kling & Bay-Williams, Boaler (2014) wrote that a comprehensive approach to fact assessment involves giving students the opportunities to share and explore strategies, something that children generally are motivated to do when provided an environment where they are comfortable and supported in taking risks with their learning.

While developing assessments that drives instruction based on student needs, I also ask what type of instruction is the best fit for students with learning disabilities. As described by Kling and Bay-Williams, the assessment and instructional techniques established in a classroom also work to develop the learning environment of the classroom, for good or bad. Boaler (2014) agreed that the classroom environment is critical in allowing and supporting students to express themselves in order to share and build upon their mathematical strategies in a social context. I believe that the relationship between open-dialogue assessment and the need for a supportive environment become a two-way street. After reading Boaler, I understood that the collaborative, social nature of some alternative assessments rely on a supportive, nurturing environment, but also works to develop that atmosphere and culture in the classroom as well.

In my experience working with students with learning disabilities, these students have specific challenges and needs to accommodate for their disabilities, which always need to be considered first when implementing instruction and assessment. When I develop an IEP with a student, parents, and colleagues, we always begin by considering the unique circumstances, strengths, and weaknesses of the student. This helps to develop what accommodations the student requires in the classroom, what educational setting is most appropriate for the student, and what goals we focus and progress monitor throughout the academic school year. In my opinion, when planning instruction and assessment for students with disabilities, it must begin with the needs of the student first. There may not be a solution that fits for all students, however the following section will discuss the debate and nuances over instructional techniques that work best in this environment.

Math fact instruction for students with learning disabilities. Poncy, McCallum, and Schmitt (2010) described the constructivist and behaviorist approaches to teaching and learning, and how they apply to students with special needs. Poncy et al. described the constructivist approach first, which aims to develops students' own understanding of math concepts through personal experiences with concepts or materials. They explained that a constructivist approach does not include direct teaching in whole or small group, as a traditional classroom setting would include. Instead, Poncy et al. described a constructivist classroom as less structured learning, which puts more responsibility on the students to guide their own learning processes. I have always been skeptical and careful with this approach when teaching students with special needs, due to the wide range of needs of my students. I have seen the value of constructivist approaches with all students, but also understand that many of my students prefer and achieve at a higher rate after receiving forms of direct instruction, where the teacher is first explaining, showing, and modeling the skills and procedures of the lesson. Poncy et al. also analyzed other more direct instructional techniques meant to improve retrieval and fact fluency, known as a behaviorist approach.

Cover, Copy, and Compare. Poncy et al. (2010) used two interventions as examples to explore the effects of a constructivist based approach to a behavior based approach. The first intervention they describe is *Cover, Copy, and Compare (CCC)*, which is a procedure based on the principles of behaviorism. The authors describe Behaviorism as teaching practices that give students strong guidance, clear direct instruction, and immediate feedback. They explain that CCC is a targeted intervention for math students with learning challenges, which aims to "increase math-fact accuracy and speed, or fluency, as evidenced by performance on written math-fact probes" (p. 919). In the study of Poncey et al., they compared student growth of the

CCC methods to *Facts that Last (FTL)*, which is a constructivist approach, which is a learning philosophy that students learn best by exploring new concepts themselves. The researchers found that CCC led to immediate and sustainable increases in student fact-fluency, whereas FTL resulted in no increases in math-fact fluency. The authors found through qualitative data collection, such as open-ended questions asking for feedback, that teachers reported that students were excited from their quick progress through CCC, and that the constructivist FTL methods were not preferred by students. In my experience, when students are confused and faced with a task that is above their conceptual abilities, confusion and frustration can lead to giving up on the task altogether.

Singer-Dudek and Greer (2005) also supported the idea that a guided, direct instructional approach with students learning math facts leads to lasting results. This approach could include the teacher in front of a group of students, introducing and explaining the key concepts and skills, and guiding students through several examples. They based research on theories of quick yet accurate performance of skills practiced at a high rate. They found that many benefits were derived from this approach, including greater maintenance of skills, a longer duration of on-task practice, and quick and accurate results as well. Singer-Dudek and Greer researched the implications for transfer of skills to composite math skills, which they did not find to be present in their study. They theorized however that students may need more time in developing math fluency than was available to see a stronger transfer to composite skills.

Constructivist theory. Goldin and Schteingold (2001) describe Constructivism as a teaching and learning theory based on the premise that people learn best when constructing their own understanding and meaning through experiences and performing a task themselves, and that the teacher's role is to guide students through exploration. They explained that through

Constructivism, learning is constructed or developed through an individual's subjective and direct experiences. Kroesenbergen and Van Luit (2002), reported evidence that instruction with use of constructivist principles has been more successful for student learning than a direct instruction model, and also that Constructivism leads to more highly motivated students that are engaged and empowered in their learning. They also detailed concerns of special education teachers that find constructivist methods to be overly discovery-oriented, and that it does not meet the specific needs of students with learning disabilities. In my teaching position, it is very important that in policy and in practice, stakeholders must always advocate for what is best for in particular the most challenged students. I have observed classroom environments built on constructivists principles, and noticed that struggling students were not on-task and engaged in the learning task as other students were. I believe that students with special needs, including a learning disability, benefit most when directly taught new skills.

Kroesenbergen and Van Luit (2002) agreed that students with disabilities, given deficits in working memory, retrieval processes, and transfer of skills, require specific and direct instruction to meet their academic needs. "Students with math learning difficulties, whether severe or mild, clearly need structured and detailed instruction, explicit task analysis, and explicit instruction for generalization and automatization. This can be realized with direct instruction" (p. 364). They wrote that asking students with deficits to create and test their own strategies in mathematics may be pushing them well beyond their cognitive abilities. This crossover approach described by Kroesenbergen and Van Luit is familiar to me; that is the balance that I attempt to strike with my students with special needs. I have found that ideally, all students become more motivated when they are able to discover ideas as independently as possible. However, I have observed students with special needs often need much more instruction up-front in order to prepare them for interacting with learning materials and instructional content.

Another instructional approach described by Kroesenbergen and Van Luit (2002), was the Realistic Mathematics Intervention (RME), which they explained is a constructivist approach that has attracted attention world-wide. They suggested that RME can be “adjusted in such a manner that is is also very effective for students with math learning difficulties” (p. 364). After a controlled experiment, Kroesenbergen and Van Luit found that students of general education were found to have most success with guided instruction, meaning direct teaching from a teacher, yet based on constructivist principles or exploration and discover on part of the students. Kroesenberen and Van Luit found that those in special education benefited most from structured teaching methods.

Other researchers found middle-ground between instructional practices as well. Mercer and Jordan (1994) offered an analysis of constructivist approach as well with students with disabilities. Given the positives of a student engagement and immersion in learning of the constructivist approach, the authors discussed opposing viewpoints with the constructivist school of thought. They found that pure Constructivism, meaning a learning environment without regular direct teaching instruction, offers little up-front teacher direction over student learning. They explained that the materials and environment are designed to encourage discovery and strategy invention. Mercer and Jordan agreed that purely constructivist instruction does not do enough for students with disabilities. They did however find that some aspects of constructivism can be beneficial to these students. For instance, Mercer and Jordan explained that teachers can lead discussion of student cognitive processes and thinking strategies, and pair this with behaviorist direct instruction approaches. They concluded that this type of instruction and classroom environment will benefit all learners.

Mercer and Jordan (1994) also explained the “zone of proximal development,” which is the idea that all learners have a “just right” level of instruction that challenges them to the appropriate degree, depending on where they are as a learning in the learning process. They described scaffolding and supports from the teacher, that allows students to engage in guided discovery activities of new strategies. In my opinion, educators must always consider the student first when planning curriculum, instruction, and assessment methods. A difference in the type of instruction likely will change a student’s perspective of how they perceive their own math abilities and worth as a student.

Conclusion

To summarize, this chapter has reviewed the literature in areas of math fact instruction and theories in general pertaining to students with disabilities, the effects of math anxiety, and best practices for math fact assessment. Researchers have described best practice to increase proficiency in math facts. However, past research also shows that confidence plays a significant role in student achievement. Combining educational interventions to increase student confidence alongside interventions to increase fact proficiency is a holistic approach. Each of my students have their own unique strengths, weaknesses, and preferences as people and learners. Their emotions and past experiences also play a prominent role in their achievement in school. Therefore, this research study will look at the impact of a holistic math education intervention on student achievement, measured by both student confidence and math fact proficiency. A blended approach of direct instruction, student practice with the Cover, Copy, Compare intervention, combined teacher guided opportunities for students to share and discuss strategies, may offer a special education classroom the greatest benefits. To determine *"What is the relationship between math operation proficiency and a student's confidence and perception of math in general,"* I will utilize a blended approach as described by the above researchers. Chapter 3 will describe in greater detail the design and direction of my research for this question.

CHAPTER 3

METHODS

The literature review in Chapter 2 provided a summary and analysis of research on math fact instruction, including instruction for students with learning challenges, math anxiety, and best practices for the assessment of students in math. The researchers explained the prevalence and possible factors associated with math anxiety, and instruction techniques and environmental factors that build student math fact proficiency while also increasing student confidence. Kroesenbergen and Van Luit (2002) revealed that while behaviorist techniques may increase student achievement in math facts, a constructivist approach offers opportunities for students to grow in terms of self-empowerment of their learning which leads to increased confidence. For students to develop proficiency in math facts while also growing to love and understand math, a blended approach of instruction can be implemented along with assessments that record information on math fact proficiency, as well as students' attitude and perspective of math in general.

In this chapter I will outline my research methodology to explore further my research question, "*What is the relationship between math operation proficiency and a student's confidence and perception of math in general?"* I will discuss my use of a quantitative research approach to approach this study. Following, I will describe the participants and setting of this study. The procedures and tools will also be described, including the types of assessments to be used to collect data on student growth. To conclude, I will discuss how data was collected and analyzed to reach a conclusion to this research project.

Research Methods

Design. I implemented a mixed methods approach for this study, which included a variety of types of data to analyze the effects of the math fact intervention. Pre and post assessments were administered to the student participants to determine the impact of the interventions on both math fact proficiency and student confidence. Student achievement was captured by two measures: math proficiency and student confidence. A numerical score was calculated from both the Math Fact Strips (see Appendix A on p. 80) on math proficiency, and the index to capture confidence with use of the Math Self Concept Survey (see Appendix B on p. 85). The relationship between confidence and proficiency was determined by the pre assessment and post assessments given. Lastly, students were asked to answer four qualitative, open-ended questions to determine what aspects of the intervention they felt assisted them the most in the previous four weeks. Institutional Review Board (IRB) approval, which is a group from Hamline University that oversees any work conducted with human subjects, was obtained for the following methods prior to execution of recruitment and data collection.

Setting. The setting of this project was a rural Illinois middle school, which included grades 5th through 8th, and approximately 300 students. The demographics of the school district were 87% white, with 0.3% considered low income, as determined by free and reduced lunch counts. The school district has performed well above state averages on the statewide achievement tests. The school has a reputation of being academically high-achieving, and includes many affluent families from the greater area.

Participants. The participants in this study included students with an Individual Education Plan (IEP) in Special Education. All students included in this research study were students with an identified disability, including Specific Learning Disability (SLD), Autism, or Other Health Impairment (OHI) for conditions such as Attention-Deficit Hyper-Activity

Disorder (ADHD). Five students included in the study are mainstreamed in the general education classroom with educational accommodations; whereas six students included in the study have their math class in my Resource class for a small group setting. Specific student challenges, strengths, and interests were considered when developing ideas for individual math talks. Student needs relating to their disabilities were also taken into account, including the need for sensory integration, visual supports, concrete materials, and other learning preferences.

Procedures

Recruitment. To initiate this study, I first communicated with students and student families on the methods, confidentiality, and purpose of this study, and acquired permissions for student participation in data collection. I explained to families and participants that their names would not be used in any form for the research, but that I would have personal knowledge of the participants identities as the study relates directly to classroom curriculum. Students had the right to choose not to participate in the study, which would mean that data from the student would not be included in the research. However, the instruction for each student in the classroom remained the same.

Baseline Survey. Before math fact instruction or fact assessments, I assessed students' math perceptions with the use of the Math Self Concept Survey to acquire baseline data (see Appendix B). Participants responded to questions based on a 1-5 scale, which provided an overall numerical value of the students' levels of math confidence. Following, I acquired baseline data for student fact proficiency through the Multiplication Fact Strips. of nine facts per strip (see Appendix A). Fact strips were grouped by multiplication families, for example, all "times two" facts. Student proficiency data in multiplication facts "times 1" through "times 10" was collected. Students were timed during the fact strip assessments, but instead of a set amount of time to finish, they simply wrote down their time in seconds when done. When students were able to complete nine of nine facts correct in 27 seconds or less (3 seconds per fact), they were considered proficient with that fact family. All students were administered at least the foundational facts of x1, x2, x5, and x10. Students that passed all of the Multiplication Fact Strips on the pretest continued testing until they did not achieve the benchmark I had set to be deemed proficient.

Intervention. The intervention aimed to address math proficiency and student confidence. To impact math proficiency, students reassessed only the fact families they have practiced with through their intervention work with Cover, Copy, Compare (CCC). Students participated in the math fact intervention multiple times per week, for approximately five to ten minutes per practice session. To impact student confidence, “Math Talks,” which included open discussion of strategies for math facts, and individual journaling were introduced. Math talks were conducted as a whole group as well to discuss what students think about to solve difficult math facts. Strategies and connections were shared and discussed with the group. Visual diagrams were also used in particular for students who were having difficulty understanding basic ideas about multiplication, which was evident by difficulty retaining knowledge of math facts through practice with CCC. For example, visuals were provided for two students working with x2 facts, to review before practicing CCC. Students were asked to journal about fact strategies individually, which gave them an opportunity to reflect on learned strategies and express what they know and understand.

After each week of intervention, students were assessed with the Math Fact Strips on any fact family practiced with CCC that week. If a student passed a fact family, as recorded beginning on p. 50, they assessed with the next fact family to practice to acquire baseline data (if they had not already tested with the fact family when acquiring baseline data).

For the final observation after week 4 of intervention, students completed two quantitative measures (Math Fact Strips and the Math Self-Perception Survey), which includes a numeral score of both fact fluency and math self-perception. Students completed Math Fact Strips assessments on fact families they were focusing on through the CCC intervention. The Math Self-Perception Survey was compared to the baseline level, to be discussed in Chapter 4. Lastly, participants completed an Exit Survey (see Appendix C on p. 88) that included four qualitative, open-ended questions. There are two reasons why the use of open-ended questions are helpful in analyzing this results of this study. First, this was a multifaceted intervention. Therefore, the impact on the desired outcome measures, math proficiency and student confidence, cannot be directly linked to one of the three components of the intervention (fact strips, math talks, journaling). One cannot say for certain which factor benefitted students the most. Student success or lack thereof could be a combination of all three components that led to a change in student achievement. Asking students their opinions of each activity helped determine what helped them the most. Secondly, the Exit Survey provided an opportunity to ask additional questions to identify potential confounders. The major assumption of this study was that it is solely the holistic educational intervention that has impacted student achievement. However, students' social environment is extremely complex. There may be other events going on in their lives that could impact their success or failure. The Exit Survey provides a way to explore those potential confounders.

Research Tools

The math intervention implemented is known as Cover, Copy, Compare (CCC). Poncey et al. (2010) explained that this research-based approach is often used with students with learning challenges, as it has been found to increase math fact fluency for students with and without learning disabilities. Poncy et al. stated that CCC is considered a behaviorist approach because of intent of changing a specific, observable behavior. The instruction itself can become an independent routine with and without adult support. Depending on needs of the student, the teacher may offer varying levels of support through prompting and modeling. The student first looks at an accurate model of a math fact. Then, the student covers the model with a notecard, while writing the problem and correct answer. To compare for immediate feedback, the student checks what they have written with the original model. To complement this intervention, activities rooted in constructivist thought were implemented, including the use of “math talks” to describe and share students’ thinking when learning and practicing a fact group, and journal writing about specific fact strategies CCC gives students quick and efficient practice, build speed and accuracy, while alternative instruction and assessment techniques will provide students opportunities to reflect on and share their mathematical thinking. Teacher observations were recorded as well in a qualitative measure, such as notes on student strategies such as direct use of memory or skip counting. However, these activities were intended for instructional purposes first and foremost to develop student confidence and engagement in their learning.

Conclusion

This was a quantitative methods study designed to find the relationship between the development of math fact fluency for students in Special Education and their confidence in math. The purposes of the assessment tools were described, including how they related to the intervention of Copy, Cover, and Compare. In the following chapter, I will present and analyze the findings of the study, including individual results of fact assessments and correlations to the "Math Perceptions Survey." I will also discuss intermediary factors in student development of fact proficiency.

CHAPTER 4

RESULTS

Introduction

The goal of this study was to investigate the relationship between given math interventions and student self-confidence in math. My research question, "*What is the relationship between math operation proficiency and a student's confidence and perception of math in general,"* was investigated further using a number of assessments and interventions with students in the middle school in which I teach. Students assessed with use of Math Fact Strips (Appendix A) to determine which multiplication facts they were already proficient with, and to determine a starting point for the Cover, Copy, Compare (CCC) math fact intervention. Students also completed a pre and post Math Self-Concept Survey (Appendix B) to provide information on the student's level of confidence before and after the intervention. To conclude the action research, participants also responded in writing to four open-ended question on the Exit Survey (Appendix C), which sought to provide more insight into what the students preferred during this math intervention, and what confounding factors may have influenced the results of their fact fluency assessments. Other intervention techniques were used with students throughout the duration of the study as well, including Math Talks, use of visual supports, and student journaling. This chapter will share the data and results of my action research study pertaining to student math fact proficiency and student self-concepts as math students.

Results

Math self-concept survey results. To begin my action research, my student participants completed the Math Self-Concept Survey to provide baseline information. The purpose of this survey was to collect quantitative data on the students relating to their perceptions and confidence of themselves in regards to math. Student data for the pre and post assessment from this assessment are presented in Table A. Participants with a higher value on this survey indicate a higher level of confidence as a math student. I consider a value of 32 or higher on this survey to indicate a high level of confidence, 24 to 31 an average range of confidence, and 23 or below to be a low level of confidence. I determined these ranges of student confidence based solely on classroom judgment, and also considering that most students surveyed fell within the 24 to 31 range.

To maintain confidentiality, students are referred to as Student A, B, or C, and so on. A total of 11 students participated in the survey. Six of these students (Student A - Student F) have shown significant discrepancies on state and district testing, as well as standardized testing performed by a school psychologist, to the extent that they have been placed in a small group setting in my Special Education classroom for math instruction. These students are two or more years behind on standardized tests in math in relation to their peers. Five of the eleven students (Student G - Student K) have an identified disability that qualified them for Special Education, but are in the general education classroom for math. These students have a variety of supports in their general education classrooms, including a teacher's aide, and other accommodations to ensure challenges related to their identified disabilities do not prevent them from accessing and being successful with the general education curriculum. I found connections between student ability and their instructional placement in our school, and their perceived levels of math confidence per this survey. It appears that Students A - F, the group of students in Resource math, generally had a negative change in math confidence. Student G - K, the group of students in a General education math, overall had higher levels of confidence as found on this survey.

As seen below in Chart A, I first included the student label and the Math Self-Concept scores from pre to post assessment. The last column represents the change from pre to post assessment in students' Math Self-Concept Survey. Prior to conducting this intervention, I hoped students would increase in Math Self-Concept in response to developing fact fluency and other holistic strategies, such as math talks in journaling. The change in student self-concept showed many students decreased based on this data. Because the questions of this survey could be taken differently by the students after several weeks passed, I consider a change of -2 to +2 to be fairly insignificant, yet based on these results it does show that few students had notable increase in Math Self-Concept. I will further develop connections between fact proficiency and change of math self-concept in this chapter.

Chart A: Math Self-Concept Survey Pre and Post Data

Student	**Math Self-Concept Survey (Pre)**	**Math Self-Concept Survey (Post)**	**Change**
Student A	34/ 40	31/40	-3
Student B	29/40	27/40	-2
Student C	23/40	21/40	-2
Student D	21/40	20/40	-1
Student E	28/40	31/40	+3
Student F	28/40	19/40	-11

Student G	28/40	27/40	-1
Student H	27/40	30/40	+3
Student I	18/40	21/40	+3
Student J	37/40	33/40	-4
Student K	24/40	25/40	+1

After reviewing the data, I noticed that 7 out of 11 students decreased their Math Self Concept Score, whereas 4 out of 11 increased their score on this survey. Five out of the six Resource math students showed a decrease in their Math Self Concept score. With respect to the five student participants in general education math (Student G through Student K), three increased their Math Self-Concept score. The following table shows average pre and post Math Self-Concept scores for Resource math students, compared to the General education math students.

Chart B: Resource Math Students vs. General Education Math Students

	Math Self-Concept Average (Pre-test)	Math Self-Concept Average (Post-test)	Average Change from Pre-Post
Resource math students (Student A - Student F)	27	25	-2
General education math students (Student G - Student K)	27	27	0

With respect to Chart B, student participants in the Resource math classroom setting showed the same pre-test score for the Math Self-Concept Survey (27) than General education math students (27). Per the posttest, Resource math classroom students dropped an average of -2 to an overall average of 25, whereas the General education math students overall remained at a score of approximately 25. Overall this shows that the group of students in a General education classroom for math showed an insignificant change in the Math Self-Concept Survey, in relation to the math fact intervention time period. The group of students in the Resource math classroom setting saw more consistent declines in this survey.

With a small sample size of students, I also consider that some students may have simply thought of the questions differently on the posttest. One student in particular, Student J, changed from 37 out of a possible 40 points on the Math Self-Concept survey, down to a 33. Both of these scores represented the highest of all student participants. Although this student dropped 4 points, I do not believe this indicates this student had a negative experience. This student, per the Fact strip data below, showed proficiency for all 10 math fact families on the pretest. I also followed up with him with Division fact strips, and he was proficient in those as well. Following, he did not participate in the CCC intervention or any other instructional strategies, since he showed no areas of weakness to target with practice and instruction. He is clearly very confident in his abilities, so his lower Post-test score could be seen as an outlier.

When considering why 7 of 11 students had a decrease in the Math Self-Concept Survey, I have reflected on other factors and possibilities as well. As a teacher, I always consider how my instruction and interaction may impact my students in a positive or negative way. Jameson (2014) explained that the interactions and dispositions of teachers, parents, and other adults is a factor in the development of the student's math self-perception. I observed that the Resource math classroom students early in the intervention were excited to practice with Cover, Copy and Compare, but lost enthusiasm after the first couple weeks. No students indicated through their journals or Exit Survey that they felt uncomfortable, bored, or unmotivated, so it is difficult to say if there were any negative effects from classroom environment. I always take that into consideration however in my reflective process as a teacher.

Generally speaking, this group of students in the Resource math setting has difficulty sustaining attention to a task independently, in comparison to my students that participate in General education math, as well as non-Special education students in their grade level. Cover, Copy, Compare is a technique that transfers the control to the student, and makes them more independent in working on a task. The students I service in my Resource classroom can be dependent on adult support for much of the day. The fact that CCC is an independent task for them may have been something that tested their ability to perform independently. The independent nature of CCC may have caused these students anxiety based on the independent nature of the practice routine. I will explore this further when discussing student feedback from the Questionnaire given at the end of the intervention.

Another possible rationale to explain the decrease in Math Self-Concept scores could stem for students self-monitoring their progress throughout this intervention. I gave each student a Multiplication chart to keep in their personal folder, along with other supplies and directions for the CCC intervention. When a student passed a fact family, they were able to color in on the Multiplication chart the entire row left and right, as well as the column for that fact family up and down. Students that made slow progress, or had not passed additional fact families, had many rows and columns still open on their progress monitoring chart. Before this action research study, students with lower ability in this group often use a multiplication chart to help themselves with basic facts. They may not have been aware how challenging it would be for them to reach what I considered proficient for a fact family. Through self-monitoring, their confidence may have been impacted negatively in the sense that they were able to see how many fact families they had yet to master, and also how they were not making quick progress. I found this self-monitoring however to be motivating for students that were making progress and passing the fact strip assessments.

Finally, when reflecting on the decrease in my Resource students Math Self-Perception scores, I also consider their level success with the intervention. The Resource math classroom group all have significant delays in math ability, and struggle with all basic computation, including addition and subtraction. These six students also all struggle to retain basic information, in all many areas, and have difficulty focusing. Progress was slow with this group. Following, I will shared the Fact strip assessment data for each student, and briefly describe the student's progress throughout the four weeks of intervention. I then made a comparison between fact families mastered and the degree of change from the Math Self-Assessment Survey.

Math fact strip results. The following tables display student fact data collected from the Math Fact Strips (Appendix B). The pre-intervention fact strips were given at the beginning of the study. The purpose of this was to find a starting point for students to begin practicing with CCC. With students A - F in particular, I was already fairly aware of their abilities with multiplication facts through our work in the Resource classroom. I consider the foundational multiplication facts to be x1, x2, x5, and x10. These fact families tend to be the first that children learn, likely because they can be determined by skip counting with numbers students are familiar with. Students can use these facts to build knowledge of other more difficult facts. If a student did not pass at least one of those foundational fact strips, I did not give that student any more fact strips for the pre-test. If they passed all the foundational fact strips, we continued going through fact families until a starting point was found.

On the following tables, the letter "P" indicates that the student passed that fact family. The criteria to pass was 9/9 correct, in 27 seconds or less. For some students, that may have 9/9 correct, but continued working on that fact family if it was not achieved in 27 seconds or less. An arrow "^" on the table indicates the student decreased time spent on the fact strip from the previous week. A slash "/" indicates the student spent more time than the previous week. Following the row for the pre-test, only facts assessed that week are shown on the table. Students were not reassessed with fact families they had already passed.

Student A results: The following student had a Math Self-Concept change of -3. She had 1/10 fact families initially mastered, and did not pass any additional fact families throughout this intervention. As seen below in her chart, this student worked on x2 facts for the entire duration of the 4 week intervention. She grew from 5 facts correct out of 9, to 7 correct out of 9. She did see an increase in speed as well as indicated by the arrow in both weeks 3 and 4. This student did not practice times 5 or times 10 facts throughout this 4 week intervention, so those fact families were not reassessed. I spent extra time with Student A after observing her practice. She understood how to use CCC, but had difficulty retaining correct answers. Often, her answer was not close, in example, for 4 x 2, she may have finished with an answer of 18. CCC is a practice technique to help students memorize basic information, but through my observation students must be ready for this developmental step by understanding the concept of multiplication. Student A completed various pictures with me in order for her to visual the "double" facts, for example seeing a picture of 2 groups of 4 eggs. She appreciated these examples, but continued to lack confidence with the fact strip assessments. I consider for the future that she may not have been ready for the fact strips, as her time is better spent working with visuals and concrete materials to develop number sense and basic understanding of multiplication.

Student A	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	5			6					8
Week 1		7								
Week 2		6								
Week 3		7 ^								
Week 4		7 ^								

Student B results: This student had a Math Self-Concept change of -2 from pre to post test. Initially this student had 2/10 fact families mastered, and passed 0 additionally throughout the intervention. This student passed fact families for x1 and x10 on the pretest. He worked on x2 facts for the duration of this intervention. This student showed an immediate increase in accuracy after 1 week, from 4 of 9 facts correct on the pretest, to 9 of 9 facts correct. He did not yet reach the standard I set for proficiency of 3 seconds per fact, or 27 seconds per fact strip. This student spent 91 seconds on the pretest, however completed the fact strip below 40 seconds on the Week 3 and Week 4 fact strips. Although this student did not pass a fact family during the 4 weeks of intervention, given my experience with him, he did make significant gains for himself on x2 facts. In comparison to methods used in the past with this student, such as flashcards or computer games, CCC made a much more substantial difference in his accuracy and efficiency for recalling the facts.

Student B	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	4			8					9 - P
Week 1		9								
Week 2		9 ^								
Week 3		9 ^								
Week 4		8								

Student C results: This student's Math Self-Concept changed -2 from pre to post assessment. She initially had 3/10 fact families mastered, and passed 1 additional. This student passed fact families for x1, x2, and x10 on the initial pretest. She completed 9 of 9 facts correctly for x5 facts, but initially was not completing under the standard I set of 27 seconds per fact strip. After Week 4, she completed the x5 facts all correctly, in under 27 seconds. This student is very accustomed to skip counting on her fingers for multiplication facts, or using a multiplication chart. She was successful with CCC practice when focused, but was not able to consistently break the habit of skip counting when assessing with a Math Fact strip. For this reason, she took a longer period of time than I expected to make growth and master her x5 facts.

Student C	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	9 – P			9					9 - P
Week 1					8					
Week 2					9 ^					
Week 3					9 ^					
Week 4					9 - P					

Student D results: This student's Math Self-Concept decreased by 1 throughout this intervention. Initially this student had 2/10 fact families mastered, and passed 2 more fact families during the intervention period. She passed the pretest fact strips for x1 and x10 facts. She began working with x2 facts the first week. This student was very excited about working on her x2 facts, and asked to retest with her 2's earlier in the week. I allowed her to do so, and she passed in under 27 seconds! She then moved on to using the CCC intervention with x5 facts. After Week 1 she also showed improvement with x5 facts, but worked on getting faster during Week 2 of the intervention. She did pass her x5 facts at that time. During Week 3, this student began work on x3 facts. With an initial fact strip for x3 facts, she scored 9 out of 9 correct, but did not do so in under 27 seconds. This student has significant trouble with focusing on a task, and with basic skills in all academic areas. With two fact families passed, and close to a third, I considered this intervention to be successful for her.

Student D	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	8			8					9 - P
Week 1		9 – P			9 ^					
Week 2					9 - P					
Week 3			9							
Week 4			9 ^							

Student E results: This student had an increase in 3 points on the Math Self-Concept Survey. She initially had mastery of 3/10 fact families, and passed 2 more throughout the intervention period. This student initially passed fact families of x1, x2, and x10 on the pretest fact strips. After Week 1, she showed mastery of x5 facts as well, and scored a 5 out of 9 on a pretest for x3 facts. She showed steady progress after each week of practice with x3 facts, passing after Week 4. This student was the only Resource classroom student who had a gain on the Math Self-Concept Survey (+3). She was motivated throughout, and focused very well during practice sessions.

Student E	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	9 – P			8					9 - P
Week 1			5		9 -P					

Week 2			7							
Week 3			9 ^							
Week 4			9 - P							

Student F results: This student had the largest change in the Math Self-Concept Survey, with a decrease of 11 points. She initially had 3/10 fact families mastered, but passed 0 additionally. This student passed pretest fact strips for fact families of x1, x5, and x10. She scored 8/9 on her pretest for x2 facts. Her practice time for CCC was devoted to x2 facts. She showed some success throughout the intervention, completing 9 out of 9 correctly after Week 2, but was not able to achieve a faster time, and could not consistently complete all facts correctly. I observed this student relying on counting by 2's on her fingers for the fact strip assessment, which made it difficult for her to increase her speed to under 27 seconds. She expressed disappointed on the Exit Survey, saying that "I can't count on my fingers." It was difficult for her to rely on her memory and break the habit of skip counting. The Fact strips in general made her appear nervous from my observation, and she needed regular redirection during CCC fact sessions as well to keep going and remain focused.

Student F	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	8			9 - P					9 - P
Week 1		7								

Week 2		9 /								
Week 3		8								
Week 4		8								

Student G results: This student's Math Self-Concept Survey score changed by a decrease of 1, which I would consider an insignificant change overall based on her success with the intervention. She initially had 6/10 fact families mastered, and by the end of Week 3 passed the last 4 fact families as well. This student passed facts for x1, x2, x3, x4, x5, and x10 on the pretest fact strips. She also scored 9/9 on the pretest for x9 facts, but did not finish in 27 seconds or less. After a week of practice with x9 facts with Cover, Copy, Compare, she passed that fact family. At that time, she tested with a x6 fact family, and passed it as well. She scored 9/9 on a pretest for x7 facts, but did not finish in the required time. After Week 2 she was slightly less accurate on her x7 facts. After Week 3, this student passed her x7 facts, and passed x8 as well when assessed. She showed mastery of all multiplication fact families after Week 3. Overall this intervention was successful for her in finding weakness in her multiplication fact families, and making quick and immediate progress. This student is a good example of when students are able to master the foundational multiplication facts, they often move more quickly through the remaining facts. This may be because many facts on the later fact strips are overlapping, in that they have seen the same facts already with previous fact families. Also, as students pass more fact families, their confidence and motivation gains momentum. This student appeared confident that she could quickly master all of her multiplication facts through practice with CCC and was quite motivated to do so.

Student G	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	9 – P	9 - P	9 - P	9 - P				9 /	9 - P
Week 1						9 - P	9 /		9 - P	
Week 2							8			
Week 3							9 - P	9 - P		

Student H results: This student's Math Self-Concept score increased by 3 points. He initially had 3/10 fact families mastered, and gained 2 more fact families during this intervention. This student has a history of having difficulty with math facts, and any type of memorization. He is smart and intuitive in the General education classroom, but has needed modifications of standard timed-tests in the past to get through classroom requirements. The CCC intervention appeared to put him at ease, as he often appears very anxious when practicing for timed-tests. He reported on the Exit Survey that he liked CCC because it helped him remember his facts, and that it was not timed. He also said, "I feel better about my multiplication facts because I know which ones to work on more." By breaking down the multiplication facts into fact families, this student felt less overwhelmed with having to memorize an entire timed-test. It was something attainable for him and his abilities. He also noted that "I liked how you could see how you are getting better."

Student H	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10

Pre-test	9 - P	9 – P	7	8	8					9 - P
Week 1					8 ^					
Week 2					9 - P					
Week 3			9 - P	8						
Week 4				8 ^						

Student I results: This student's Math Self-Concept score increased by 3 points. Initially this student had 5/10 fact families mastered, and gained another 3 fact families during the intervention. After beginning practice with CCC, this student was able to make quick progress with x4 and x9 facts. He continued practicing with x7 facts, but did not pass by the end of the 4 week period. This student scored the lowest on the pretest for the Math Self-Concept Survey (18), yet showed an increase of 3 points by the end of the intervention. On the Exit Survey, he explained what he liked by writing "I like that it (was) <u>not</u> timed." He also said that "I think it got easier when Mr. E helped me with the fact sheet." This student was proud of himself and his progress, in particular when he was able to color in more rows and columns on his self-monitoring chart.

Student I	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	9 – P	9 - P	9	9 - P					9 - P
Week 1				9 - P					9 - P	

Week 2						8				
Week 3						9 - P	8	7		
Week 4							8 ^			

Student J results: This student's Math Self-Concept scored decreased by 4 points. I consider this Self-Concept score to be an outlier, being that this student passed all 10/10 points on the pre-test fact strips. Even with a change of -4, this student still had the highest scores I recorded for both pre and post Math Self-Concept scores. This shows a connection between student confidence and ability with math facts as well given his very high scores. He also passed a complete set of fact strips for division facts.

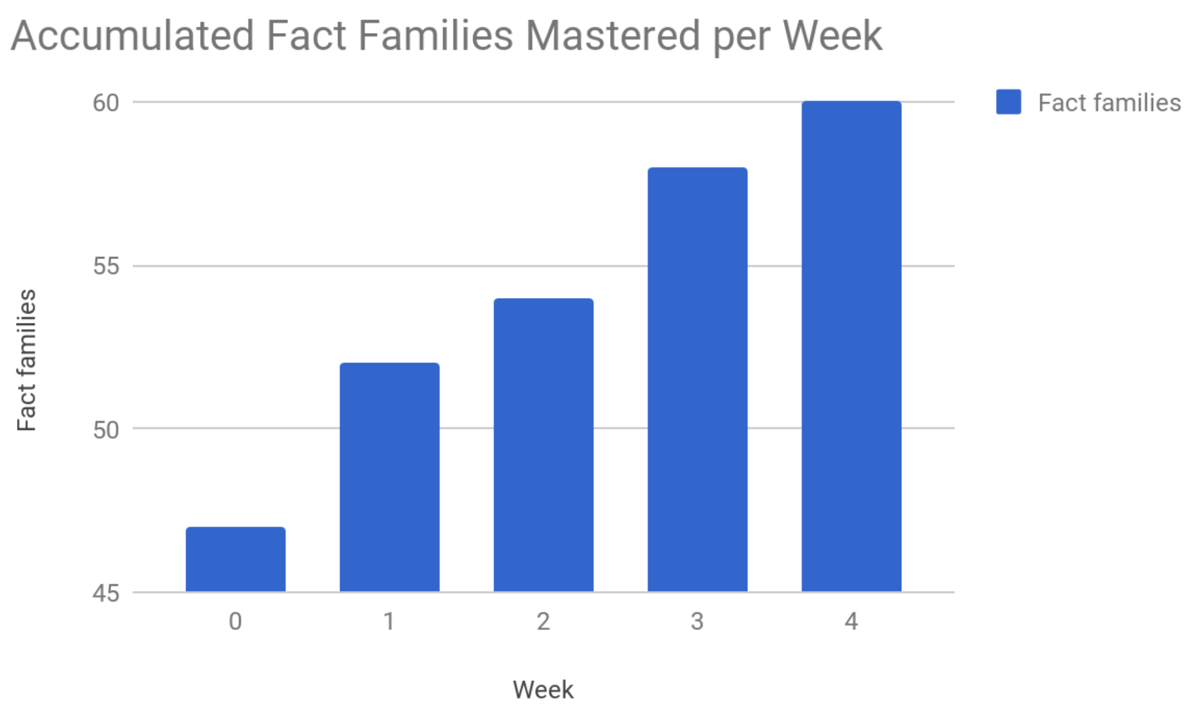
Student J	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	9 – P	9 – P	9 - P	9 - P	9 - P	9 - P	9 - P	9 - P	9 - P

Student K results: This student's Math Self-Concept scored increased by 1 point. He initially had 8/10 fact families mastered, yet passed 0 additional fact families. This student began with 8 fact families mastered. He had x7 and x9 facts yet to master. Throughout the 4 week intervention, he did not enjoy using CCC to practice. This student does not accept help readily, and has a difficult time controlling his emotions and behavior in the resource room. His performance with fact strips throughout the 4 weeks was very inconsistent. This student may benefit from more structure or a set routine for where and when he will practice. He commented on the Exit Survey that his math confidence did increase because of “practicing math.”

Student K	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Pre-test	9 - P	9 – P	9 – P	9 - P	9 - P	9 - P	9 /	9 - P	7	9 - P
Week 1									6	
Week 2									8	
Week 3									8	
Week 4									7	

The following graph shows an overall perspective of fact families passed by all participants from week to week. It is evident that there was progress made consistently by the group, with a total of 13 fact families mastered amongst the group of 11 students over the duration of the intervention period. Although some individual students struggled to pass fact families during the intervention, Chart C shows overall progress of math fact proficiency and success for the implemented interventions.

Chart C: Accumulated Fact Families Mastered per Week (all participants)



Lastly, in Chart D (below), I compare fact families mastered to change on the Self-Concept Survey, in order of least to greatest with the Self-Concept Survey score.

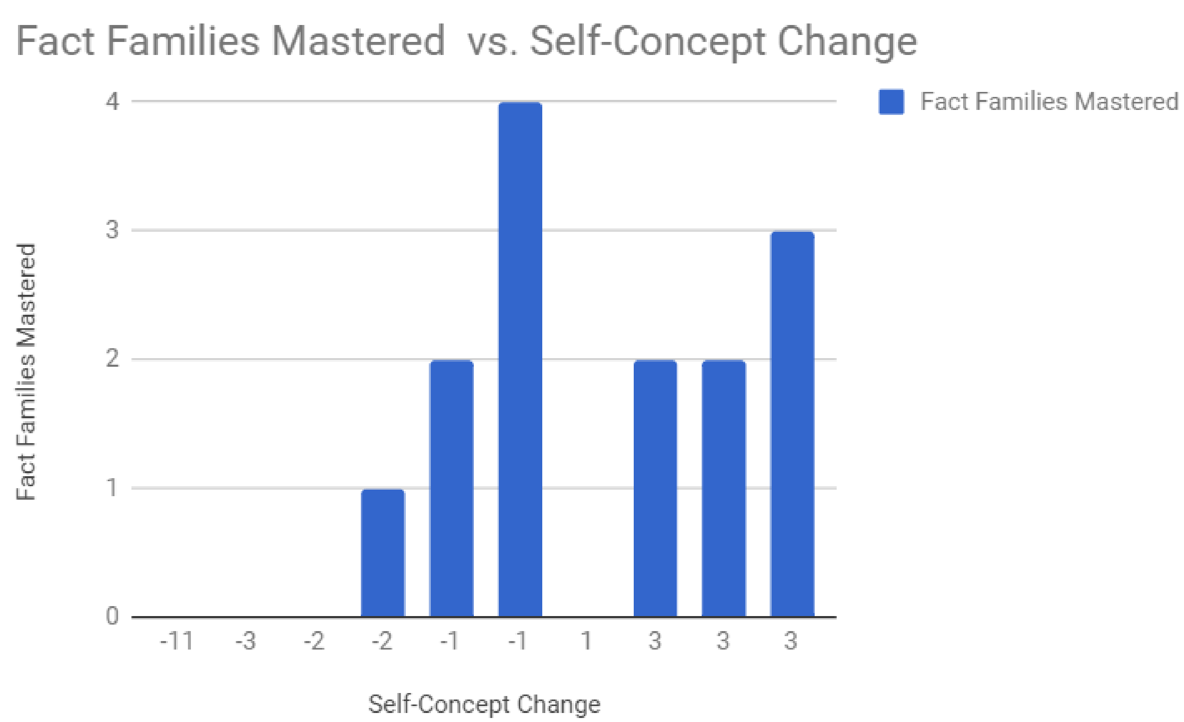
Chart D: Math Self-Concept Change vs. Fact Families Mastered

	Math Self-Concept Change	Fact Families Mastered
Student F	-11	0
Student J	-4	(all mastered)
Student A	-3	0
Student B	-2	0

Student C	-2	1
Student D	-1	2
Student G	-1	4
Student K	+1	0
Student H	+3	2
Student I	+3	3
Student E	+3	2

I transferred the data from Chart D into the graph below. I omitted Student J, who had a decrease of -4 on the Self-Concept Survey, but showed mastery with all fact families on the pretest.

Chart E: Math Self-Concept Change vs. Fact Families Mastered Bar Graph



This graph makes evident that students with a Self-Concept change of -1 or higher also generally passed 2 or more fact families throughout the duration of the study. Students with a change of -2 of less had 1 or fewer fact families passed. There were 3 students who showed a decrease in math self-concept of 1 or 2 points, yet gained 1, 2 and 4 fact families through the intervention. This is surprising, as one would expect confidence to increase as proficiency increases. It is possible that their change is insignificant, considering a change of 2 points out of a possible 40 is only a drop of 5%. I do reflect on how I can make the classroom environment more inclusive and motivating for these students, if the implemented interventions did in fact have a negative impact on their math self-perceptions.

Three additional student participants, with a change of +3 on the Math Self-Concept Survey each, had 2 or 3 additional fact families passed during the intervention. Given the self-monitoring that students did throughout this study, it is reasonable to assume that students gained confidence in their abilities after passing 1 or more fact families. Those that did not pass a fact family showed a more significant drop in confidence as well.

Exit survey results. The Exit Survey (Appendix C) provided additional information regarding what students like most about the multi-faceted intervention, what went well for them, and attempted to unveil any other factors that may have led to changes in proficiency or confidence for each student. For question 1, 9/10 students responded that their confidence with multiplication increased over the past 4 weeks of intervention. Student J did not complete the Exit Survey, since he passed all fact families on the pretest and did not participate in any intervention activities. Student F replied that her confidence decreased because “I waste my time by using my fingers.” This student had by far the most significant drop on the Math-Self Concept Survey, with a -11. I assume her difficulty using her memory on the fact strips was very frustrating for her. Based on my individual conferencing with this student, I observed her having difficulty with focus during CCC. This intervention may have highlighted for her (and myself) her challenges currently with focus and concentration. Although this study did not conclude with strong results for Student F, it is good information for me to take forward with her parents to determine next steps for her.

Student B, who did not pass any fact families but greatly improved his speed and accuracy with x2 facts, responded that his confidence increased and that “we learned different ways to solve problems like CCC. CCC helps me remember my facts.” Student A is another example of a student that struggled to pass any fact families, but said that her confidence increased as well. She said “my teacher told me to think of the number two times, like 2 x 9 = 18, think of the 9 two times like 9+9.” This student responded well to individual math talks and diagrams to give her a stronger foundation of multiplication understanding and strategies. Student E, who is a part of the Resource math group, said her math confidence increased as well, saying “the cover and copy, compare helped me see what I did wrong so then I could get the right answer stuck in my head and that’s what’s happening.” This student also had a Math Self-Concept change of +3, and passed 2 fact families during the duration of the study, with 5 fact families currently passed in all. She is a great example of a student that is building momentum with passing fact families, and is experiencing success. When responding to question 2, she also said “I like to take tests to see my progress.” Overall I was encouraged by the results from question 1 of the Exit Survey. It is possible, despite low post scores on the Math Self-Concept Survey, that students did feel a boost in confidence. The Self-Concept Survey may have been confusing for them, and consistency with responses may be problematic for that.

For question 2 of the Exit Survey, 5/10 students responded that they liked the CCC practice the most during the intervention. One student responded that he liked the fact that it was not timed. One student like the fact strips the best, so he could see his improvement. Another student also added that she liked discussing how she can get better through this intervention.

Question 3, which looked for other factors outside the study and intervention that may have directly affected results, did not generate a lot of information from students. One student did say she also practiced with flashcards, and another said that the recent state standardized test was something else she had done outside the intervention relating to multiplication.

Question 4, asking who else in their life helps them increase confidence, was interesting as well. One student said her dad helps increase her confidence in math, because “he is really good at math.” This reminds me of what Jameson (2014) again wrote about the implications of adults dispositions about math, and how that contributes to students’ perceptions of themselves and math. Other participants responded that their parents, family, or friends were people that helped them increase confidence. One student said “it is myself that makes me confident.”

Conclusion

Overall, the results of this action research study showed a connection between students reaching proficiency in fact families and increases in student’s confidence in math. Students that did not pass fact families had lower scores on the post-test for the Math Self-Concept Survey. Students that passed 2 or more fact families during the study generally had increases in math confidence, per the survey. The Exit Survey revealed, however, that when asked directly, 9 of 10 participants thought the intervention increased their confidence in their multiplication abilities. There was also a marked difference between overall lower ability students (those in the Resource math class) and the students that are in General education math. The self-monitoring techniques of CCC, as well as students documenting their own progress, also had an impact on their confidence and success. Students reported that knowing what facts specifically they had to work on was helpful to them. Many students also commented on the Exit Survey that they enjoyed the discussion shared through individual or group math talks.

To conclude, in response to the research question, *"What is the relationship between math operation fluency on a student's confidence and perception of math in general,"* the data presented in this chapter shows a clear connection between student mastery of fact families and higher levels of confidence. For students to gain confidence and autonomy as math students, they have to experience success first-hand. This intervention provided that direct for some of the participants. Others had less obvious success, but reported many benefits from the intervention on both their fact proficiency and confidence as math students.

CHAPTER 5

CONCLUSION

Introduction

This research study has provided me with a significant learning experience for myself as a teacher. Through personal reflection, a literature review, and development of an action research study, I was able to analyze and dig deeper into my research question, "*What is the relationship between math operation proficiency on student confidence and perception of math in general?"* In this chapter, I will discuss the process and what I have learned throughout as a researcher, writer, and learner. I will describe my reactions to my research findings, and how they related to my literature review. Lastly, I will discuss implications of this study, limitations to consider, and how I will use the findings of this study in the future.

What I Learned

The journey this research has taken me in all started with my desire as a teacher to better support my students. In my years teaching, as well as my own experience as a student, I have witnessed and experienced the detrimental effects of low confidence in school. Students that perpetually struggle tend to eventually give up on themselves, which as Kyriacou (2005) described, confidence and competence in math often goes hand in hand. It has always been a frustration personally when I work with a student that just never shows much growth. I always believe that all students, no matter one's ability level, condition, or disability, have the ability to learn and grow. It is the teacher's job to find what works for that student.

The question of math fact proficiency has long been a sticking point for me as a teacher. I have asked myself if it is worth spending so much time on, for students that show such limited growth regardless of the time that is put in. There is always pressure as a teacher to present students the full spectrum of curriculum, especially in times of high-stakes standardized testing. I have also wondered if letting students always use a calculator or multiplication chart is a fair trade off. Also, what alternative techniques for supporting student's growth will actually work for the population that I serve. This research showed me that given the appropriate research and best practice, it is worth it to establish a fact practice routine that works for your specific students, whether it is in elementary school, middle school, or high school, if it continues to be an area of need for them. Often I have observed at the middle school level, if students do not know their math facts, little direct intervention is done to help them. I have heard colleagues say that the student will simply never know their facts, and that it isn't worth the time considering everything else we are expected to teach. I now see that growth in fact proficiency is possible, and worth it, no matter the student or the age. It is something that can enhance their ability as a math student, gives them real-life math skills to utilize outside of school, and also can directly boost their confidence and perception of math in general.

What I have observed and learned through this research is that all students can make progress, and additionally, students must experience that growth in themselves first hand in order to develop positive perceptions of themselves as math students. Once students start to see growth in themselves, they begin building positive momentum. Throughout my action research, I saw several students that did just that. The format and development of the instruction, intervention techniques, and assessment can always be refined and improved, but it is my personal disposition about personal growth in students that I value so much from this study. This action research showed myself that even students that have always had significant delays can indeed find success with best practice interventions in place. I have a better understanding of how a thorough review of research literature can inform my decisions as an educator, in order to develop the best instruction and techniques possible to meet my students' needs. I also appreciate the importance of gathering a variety of data on student growth. The data collected from the Math Self-Concept Survey was not overly positive. However, the Exit Survey presented student feedback differently through open-ended questions, in which 9/10 students reported an increase in confidence as a result of this intervention.

The process of research has further instilled in me to be reflective as a teacher. The decisions we make for our students have great implications for their current and future success. It is a responsibility that no teacher can take lightly. However, I also realize that decisions we make for our students are never fixed. Teaching is a practice of continual reflection, contemplation, discovery, and growth. With applicable knowledge, skills, and resources available, teachers are able to provide what their students need to be a meaningful impact.

Literature Review

The literature review provided me with a foundation of philosophy and best practice to develop an intervention and research project that would fit my student caseload. I was able to develop an understanding of the scope of math anxiety in our students, and how and when it can develop. Andrews and Brown (2015) reported findings that feelings of incompetence in math can begin as early as age 6 in children. Also, they reported that in the intermediate years between grades 6 and 9, students with lower levels of achievement begin to feel more inferior with respect to higher achieving peers. I can make connections from Andrews and Brown to my own students as well. Based on the Math Self-Perception Survey, my students overall presented with an average level of confidence (26/40). Students in the Resource classroom initially had an average score identical to students in General education math, but had an average decrease of 2 points, whereas General education students maintained the same level from pre to post test.

Andrews and Brown explained the inverse relationship between math performance and anxiety related to math. This held true for my Resource math students, who experienced less success with the intervention.

Through the literature review I was able to make determinations on what type of instruction is best for my students. Constructivism, as described by Goldin and Schteingold (2001), is a learning theory that promotes learning through student self discovery and exploration. Through my work with colleagues in my district, we are aware that much of the education world today is feeling pressure from the Constructivism camps of educational philosophy. I learned however through my literature review that it is not always appropriate for all students. I was able to incorporate pieces of constructivist thought in my intervention, including journaling and math talks, but it was clear to me that a direct approach for student learning was very necessary. The Cover, Copy, Compare intervention that I found through the process of my literature review was a great fit for many of my students. It fulfilled their need for structure, modeling, and repetition, while giving them independence to practice at their own pace and direction.

Many of the authors I read had clear evidence between the connection of student proficiency and confidence in students. My research question related to how to best provide that for students in Special education, who do not thrive in constructivist environments like typical students may. Through a holistic approach to intervention, I sought to strike a balance between CCC and constructivists principles. My data revealed that students that had success with the intervention also had higher levels of confidence in general relating to math. Student feedback showed that students had different preferences of activities, but ultimately it was finding something that worked for them, to support them in becoming proficient, that led them to higher levels of confidence as a learner. I found that the path a student took to get to that point was less important than them achieving and feeling success for themselves. As educators, we often have very strong opinions on what is best for our students. The literature review provided me with best practices that allowed many of my students to find success.

Improvements

An element of this action research that I would develop more in the future was the math talks component. I had difficulty getting students to share their thinking and feelings verbally about their practice with the intervention. I understand that students in Special education sometimes have a limited ability to express their thinking as typical students may, and also those with large deficits in math achievement simply may not have many thoughts of their own to share. It is also plausible that these students may not be accustomed to sharing honestly their progress in an area that has always been difficult to them. This in part is why a practice routine such as CCC is very effective with this population of students. Kyricou (2005) highlighted the importance of an interactive classroom that includes dialogue, wait-time, and open discussions, in order to help all students develop their confidence. It was not always easy to make time for CCC throughout the 4 weeks of this study, and math talks as well were squeezed for time. To really emphasis the development of confidence and individual thinking, I would find ways to expand on the time dedicated to open discussions and dialogue, and possibly find more alternatives for students to express their ideas and thoughts about their fact practice in a way they are most comfortable.

Many students commented throughout the intervention that they preferred CCC over traditional timed-tests for multiplication. Ford & Usnik (2011) described the dominance of timed-tests in U.S. classrooms, and the negative consequences relating to math anxiety they have sown. The student with the lowest pretest score on the Math Self-Concept Survey (18/40) made a point to tell me several times that he did not like doing timed-tests because of the timing. He passed 2 more fact families during the study, and increased his Self-Concept score by 3 points. Students overall did not seem to be negatively affected by writing their time in seconds when completing the fact strips, nor were they overly stressed when working on CCC. Students did have trouble maintaining focus, which is common for this group.

Much of the literature I reviewed discussed the implication for under-achieving math students on their future in education and beyond. I cannot make judgements at this time on how growth through the intervention will further affect, positively or negatively, this group of students. As Skinner, Pappas, and Davis (2005) described, low ability with math facts makes all other math related skills more tedious and overwhelming for students. Accommodating for students lack of proficiency in other ways, such as using a calculator or chart, does not help maintain or develop confidence as a math student. Also, if we are preparing students for the world after formal education, one must be able to calculate basic numbers flexibly in their heads. As Jameson (2014) stated, those that struggle at math will start to avoid math more and more, which leads to a self-fulfilling prophecy of being a poor math student. Through this study, I was able to help children experience success and growth. This in itself may provide them with further motivation and belief in themselves. I plan on continuing the principles of intervention I began with my students through this research study, and am interested to see what implications or changes that brings to their math ability and confidence in general, in the future.

Implications of research

One difficulty I had during this intervention was to help students break old habits and strategies of the students. Many of the participants have become adept at always counting out facts on their fingers. Some are fairly quick and accurate with this technique, but they eventually reach a ceiling with how quick they can be. When my students multiply multi-digit numbers and have to count out each individual fact, I have observed many mistakes and frustrations. It was difficult throughout this intervention to help students make the leap to begin relying on their own memories, as practiced with CCC. I do not know if this represented a lack of confidence in students, or if they have been using a counting strategy for a number of years, and just could not move past this habit. More practice with CCC in the coming weeks will give me further information on their use of strategies, and if students are able to break those habits given more time with the intervention.

I would be interested in how this study and intervention would relate to the larger population of general education students. I hear many teachers, even for 7th and 8th grade, that complain of students not knowing their math facts. My assessment methods and data collection may be overwhelming for a teacher that has a hundred or more students in all, but it would reveal where actual gaps are in student fact proficiency. Some may find that it is only 2 or 3 facts that give them pause repeatedly. CCC could also be adjusted from strictly fact families, to any group of facts that give a student difficulty. I believe that addressing weak areas in a student’s learning, however, is always a time saver overall if it means they will have lasting growth. When I reassess my students throughout the last month of the school year outside the confines of this study, I will be interested if the gains made through CCC has staying power.

I would like to see the premise of this action research project used at least for intervention purposes in my school district. The norms of traditional timed-tests run deep in my district and throughout the country, and they do work just fine as a screening tool for many students. For students that do not show progress however, it was clear to me that CCC and the other components of instruction that I implemented were much more direct and appropriate for my students' needs. In my experience, when students know exactly what they need to work on, they are much more likely to work towards success.

Conclusion

The question of "*What is the relationship between math operation fluency on student confidence and math perception in general,"* was assessed through an action research study involving a mixed-methods design. Data collected on student achievement showed that with my group of students in Special education, there was clear growth in confidence as students began mastering multiplication fact families. The focus of the intervention technique, Cover, Copy, and Compare, worked for many of my students who have struggled greatly with traditional timed tests in the past. The implications of this study show that student achievement and confidence build off one another. When appropriate interventions for student learning are developed based on students' needs first, students are able to experience the satisfaction of setting and reaching the goals they have set. This action research study has helped me grow as a professional, by using research literature in developing the learning experiences that maximize student growth and achievement, which leads to confident, motivated, and empowered students.

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APPENDIX A

Math Fact Strips

"Times 1" Multiplication Facts

1 x 1 = ________   8 x 1 = ________   2 x 1 = _________

1 x 3 = ________   9 x 1 = ________   1 x 4 = _________

5 x 1 = ________   1 x 7 = ________   6 x 1 = _________

"Times 5" Multiplication Facts

2 x 5 = ________   5 x 8 = ________   4 x 5 = ________

7 x 5 = ________   3 x 5 = ________   5 x 5 = ________

5 x 6 = ________   1 x 5 = ________   5 x 9 = ________

"Times 2" Multiplication Facts

2 x 2 = _________ 8 x 2 = __________ 4 x 2 = __________

2 x 7 = _________ 9 x 2 = __________ 2 x 1 = __________

3 x 2 = _________ 5 x 2 = __________ 2 x 6 = __________

"Times 10" Multiplication Facts

10 x 4 = _________ 7 x 10 = __________ 5 x 10 = __________

10 x 1 = _________ 8 x 10 = __________ 10 x 3 = __________

6 x 10 = _________ 2 x 10 = __________ 9 x 10 = __________

"Times 3" Multiplication Facts

3 x 3 = ________ 3 x 8 = ________ 3 x 6 = _________

3 x 2 = ________ 9 x 3 = ________ 4 x 3 = _________

3 x 1 = ________ 5 x 3 = ________ 7 x 3 = _________

"Times 4" Multiplication Facts

4 x 4 = _________ 4 x 1 = _________ 4 x 9 = _________

7 x 4 = _________ 3 x 4 = __________ 5 x 4 = _________

4 x 2 = _________ 6 x 4 = __________ 4 x 8 = __________

"Times 6" Multiplication Facts

6 x 6 = _______ 2 x 6 = _______ 6 x 5 = _______

3 x 6 = _______ 6 x 8 = _______ 1 x 6 = _______

4 x 6 = _______ 7 x 6 = _______ 9 x 6 = _______

"Times 7" Multiplication Facts

7 x 7 = _______ 7 x 3 = _______ 8 x 7 = _______

2 x 7 = _______ 7 x 5 = _______ 4 x 7 = _______

7 x 1 = _______ 7 x 6 = _______ 9 x 7 = _______

"Times 8" Multiplication Facts

8 x 1 = ________ 9 x 8 = _______ 3 x 8 = _______

8 x 4 = ________ 2 x 8 = _______ 8 x 8 = _______

5 x 8 = ________ 8 x 6 = _______ 7 x 8 = _______

“Times 9” Multiplication Facts

1 x 9 = _______	9 x 4 = _______	2 x 9 = ________
3 x 9 = _______	9 x 5 = ________	8 x 9 = ________
9 x 7 = _______	6 x 9 = ________	9 x 9 = ________

APPENDIX B

Math Self Concept Survey

For each of the following questions, please circle a response for each prompt, as honestly as possible, based on how you are feeling about you and math today.

I like math class at school:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

I like to share my math thinking with my teacher and friends:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

I know my multiplication facts well:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

When I don't know a math fact right away, I have a strategy to figure it out quickly:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

I think math is an important part of my life:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

I would be interested in a job someday that uses a lot of math:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

Math class is fun at school:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

I am not afraid to make a mistake in math class:

1 (strongly disagree)

2 (disagree)

3 (neutral)

4 (agree)

5 (strongly agree)

APPENDIX C

Exit Survey

1. In the past 4 weeks, do you think your confidence with multiplication has increased or decreased? What did you/we do that made you feel better about your ability with multiplication facts, or what made you feel that you were not good at multiplication?

____

____

____

2. What did you like best about the last 4 weeks of multiplication practice?

____

____

____

3. Did you do anything else outside the classroom in the last 4 weeks that made you feel better about your multiplication facts?

____

____

____

4. Who else in your life helps you increase your confidence, in any area (not just math)?

____

____