Strength Braining: An Innovation Countering Fifth-Grade Underachievement in Mathematics Through Growth Mindset and Self-Regulation

by

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ABSTRACT

The problem of practice addressed in this mixed methods action research study is the underachievement of fifth-grade students in mathematics. This study explores the effects of an innovation designed to help students develop a growth mindset by utilizing self-regulation strategies to improve academic growth in mathematics. Students' underachievement in mathematics has been illustrated by both state and international assessments. Throughout the decades, mathematics instruction and reforms have varied, but overall students' psychological needs have been neglected. This innovation was designed to develop students' psychological characteristics regarding facing challenges in mathematics. For this purpose, two guiding theories were utilized to frame this research study, Dweck's mindset theory and self-regulation theory. To address the research questions of this study, pre- and post-questionnaire data, observational data and student work was analyzed. Results of the qualitative data indicated that the innovation positively impacted students' mindsets and use of self-regulation strategies. However, quantitative data indicated the innovation had no effect on students' use of self-regulation strategies or academic growth, and a negative impact on students' mindsets.

DEDICATION

This dissertation is dedicated to my parents, Steve and Kathy Plitt, whose unwavering support and belief in my abilities has fueled me to continually pursue the unimaginable. I also dedicate this dissertation to my husband, Trent Manchester, whose patience and ability to show me that the world was not ending each day allowed me to not only persevere through this process, but also be present throughout its entirety.

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Chapter 1

LARGER AND LOCAL CONTEXT OF THE PROBLEM OF PRACTICE

School should be a place for students to learn, question and explore the world around them in a low stakes environment so that they can become active participants in our society. As our world changes, education must follow suit. Elementary school, in particular, should build a foundation of inquiry, problem-solving, social skills and academic skills. This foundation is fundamental for student growth and career readiness (Dembo & Eaton, 2000; Kitsantas, Steen, & Huie, 2017; Yeager & Dweck, 2012). When our students enter the "real world," they must be prepared to face challenges and meet them with resilience. However, most schools do not explicitly teach resilience. Researchers are curious as to why some students meet challenges with initiative and others avoidance (Mueller & Dweck, 1998; Yeager & Dweck, 2012). With a primary focus of developing cognitive skills in multiple disciplines, teachers are overwhelmed with the amount of content they must cover (Cooper, Cibulka, & Fusarelli, 2008). This focus often fosters a controlled, proficiency-based climate dictated by students' achievement results on formal assessments (Boekaerts & Niemivirta, 2000; Middleton & Midgley, 1997). These proficiency focused initiatives in schools can lead to adverse effects on both students' psychological and academic growth (Blackwell, Trzesniewski, & Dweck, 2007; Mueller & Dweck, 1998). As students advance through school, they develop an academic history comprised of their previous learning experiences. These very experiences contribute to students' schemas of learning including what smart, dumb, and failure, among other constructs related to learning and intelligence, look like

(Boekaerts & Niemivirta, 2000). Furthermore, these experiences can lead to maladaptive or adaptive learning behaviors depending on the student's interpretation of failure and effort in various contexts (Boekaerts & Niemivirta, 2000; Dweck & Leggett, 1988; Sungur, 2007).

Not only do previous learning experiences alter students' perception of learning, but they also greatly affect their academic trajectory, motivation, and ability to self-regulate, making the primary years of learning instrumental (Kitsantas et al., 2017). Proficiency centered classrooms can lead students to practice maladaptive learning behaviors like putting forth minimal effort, refusal to engage in challenges, and minimal utilization of learning strategies (Sungur, 2007). These behaviors in return can lead to undesirable academic consequences.

Moreover, today's classrooms have been shaped into cognitive-centered, high-stakes environments for both teachers and students. School priorities have changed over the decades from basic understanding of mathematical concepts to conceptual understandings as measured on state-wide, high-stakes assessments. The added pressure of adequate performance on the mathematics portion of state tests has indirectly and directly influenced curricular and instructional reforms that focus on cognitive abilities and performance (Shoenfeld, 2004; Woodward, 2004). These factors highlight the problem addressed in this study.

The problem of practice being addressed in this study is the underachievement of fifth-grade students in mathematics. As a teacher practitioner for the past seven years, I have seen the effects of various reform efforts. For example, I have taught three different sets of standards (Arizona State Standards, Common Core State Standards, Arizona College and Career Readiness Standards), five different mathematics resources, and attended multiple trainings on instructional approaches, but the same problem has remained, students are underachieving in mathematics. A prevalent number of my students who have encountered a challenging mathematics problem have disengaged from the learning experience, while others have interpreted it as an opportunity to grow as a learner. Furthermore, per my experience, I have noticed that there are many forms of disengagement. Some students will put their heads down, some fidget with their supplies, others respond with tears of frustration when they feel that their incompetence is apparent to their peers, all result in work avoidance. These observations over the past seven years have been consistent and concerning. I have noticed that students who avoid these challenges, struggle to master learning objectives, most likely due to a lack of effort, strategies, and motivation, ultimately inhibiting their growth. Additionally, students' previous learning experiences in mathematics have shaped their dispositions towards the content, consequently dictating the amount of effort they put towards challenging mathematics problems.

After reading the research around mindset and academic growth, I have found that my observations align with the findings of multiple researchers in the field. Numerous researchers have discovered a correlation between students' mindsets and academic growth (Aronson, Fried, & Good, 2002; Blackwell et al., 2007; Dweck, 2016; Mueller & Dweck, 1998). In other words, students who believe that intelligence is a fixed asset are more likely to achieve at lower levels than their counterparts who believe that intelligence can change with effort (Aronson et al., 2002; Blackwell et al., 2007; Yeager & Dweck, 2012). Students' comments like "I am not good at math," or "I am dumb," have encouraged me to consider the root cause of students' performance in mathematics. This problem is evident in my local context, but it is situated within a larger national and international context.

Larger Context

The United States' performance on international benchmarking tests have indicated that students in the United States are underachieving in mathematics. One example is the United States' performance on the Programme for International Student Assessment (PISA), which has shown relatively low performance in mathematics (PISA, n.d.). Another international test called the Trends in International Mathematics and Science Study (TIMSS), which assesses performance in both mathematics and science, illustrates a decline in national ranking in regard to mathematics scores for the United States (Bybee & Kennedy, 2005). Furthermore, within the United States, Arizona is among one of the lowest achieving states in mathematics. According to the National Assessment of Educational Progress (NAEP), Arizona's average was lower than that of the United States (National Assessment of Educational Progress, n.d.). These formal assessments shed light on the problem of practice that is explored in this study.

In response to these international and national results, many reform efforts have been implemented by state and national governments to mitigate underachievement in mathematics. It is important to understand some of these key national policies because they have shaped the climate of my local context to be proficiency centered. Education is a controversial topic in politics. The application of federal policies has greatly impacted local education policies, and in return, classroom climates (Cooper, Cibulka, & Fusarelli, 2008). One of the most controversial topics in education is the measurement of student achievement and district, teacher, and principal accountability. Acts like Every Student Succeeds Act (ESSA) and Race to the Top (RTTT; United States Department of Education, 2009) prioritize student achievement contributing to the trickle-down effect of a high-stakes classroom environment. These are environments in which teachers feel the pressure to defend their practice with little more than their students' scores on a high-stakes test, regardless of their classroom demographics or circumstances (Dweck, 2016).

The issue of student mathematics performance has been primarily addressed with curricular reforms nationwide and this mirrors what I have witnessed at my school. Yes, curriculum matters, but recent research has indicated that more focus should shift to the psychological characteristics of learning, such as self-regulation and mindset (Perry & McConney, 2010; Yeager & Dweck, 2012). The purpose of this research is to examine a shift toward focusing on psychological characteristics of learning instead of primarily focusing on cognitive characteristics. Studying the effects of psychological characteristics, like growth mindset and self-regulation, on a cognitive characteristic, like academic achievement in fifth-grade mathematics, may direct attention to different reforms and approaches to teaching and learning.

Local School and Classroom Context

To orient this problem of practice, I will first describe the demographics of my local context. Next, I will explain my role as the researcher and describe the structure of mathematics instruction. I will then review some recent changes and their effects on classrooms and mathematics instruction. I conclude this chapter by outlining the initial findings that contributed to the identification of this problem of practice and introducing the four guiding research questions.

This action research study was conducted in a K-5 elementary school in a public-school district in Arizona in the 2019-2020 school year. Due to boundary changes in the 2016-2017 school year, the demographics of the school changed over the course of three years. However, in the 2018-2019 school year, the student body demographics were 37% White, 27% Hispanic, 13% Black, 8% Asian, 4% Native American, and 10% Two or More (biracial). Of the 2018-2019 student body, 26% of students qualified for free or reduced lunch, and 1% of students had Individualized Education Plans (IEPs).

Role of the Researcher

My role in this action research study was two-fold. I was a classroom teacher and action researcher simultaneously. I teach fifth-grade at the Southwestern Elementary School (pseudonym). The 2019-2020 school year was my eighth year as an elementary education teacher. I have taught fifth-grade for six years, and third-grade for two years. I am one of three fifth-grade teachers at my school in the 2019-2020 school year. Due to low enrollment, the fifth-grade team downsized from four fifth-grade teachers to three, making class sizes of at least 34 students in each grade level mathematics class. The increase in class size made this problem of practice even more prevalent as the fifth-grade team was tasked with helping all students make academic gains.

Mathematics Instruction

To illustrate a typical day of mathematics instruction, I will describe the components that make up the mathematics instructional block. In the 2019-2020 school year, fifth-grade students had mathematics first thing in the morning. The mathematics block was composed of 40 minutes of instructional focus groups (IFG) and 60 minutes of core instruction (e.g. whole group, grade-level instruction). The first portion of the mathematics block was mathematics IFG. Mathematics IFG time was used to provide focused instruction that was remedial, or guided, for students. In my classroom, students frequently engaged in mathematics stations designed to support their learning at their level, depending on what concept they are working on towards mastery. The 2019-2020 school year, students were divided into four levelled groups. I met with each group at least once a week and tailored my instruction to their needs by utilizing formative data. During this time, students worked on concepts or standards that were below a fifth-grade level.

After mathematics IFG, students had 60 minutes of core instruction. Unlike mathematics IFG, core instruction focused on grade-level standards and was paced to teach all of the fifth-grade standards by the end of the school year. The school district provided teachers with instructional focus units that paced and outlined mathematics instruction with the intention of students reaching mastery on all fifth-grade standards by the end of the year. Core instruction was primarily whole-group, but also included group-work, partner-work, or independent work. As a practitioner whose classroom dynamics continually varied, I had become overwhelmed with the needs of my students, as well as the challenge of showing academic growth, particularly in mathematics. Several recent changes contributed to this challenge. To paint a more accurate picture of current mathematics instruction and circumstances, changes that have affected mathematics instruction and students' behaviors were reviewed.

Recent Changes

One influential change that has affected students' mathematic growth and classroom climates was the state's adoption of new standards in 2010 which prompted the district to tailor mathematics instruction and resources to meet the new, rigorous mathematics standards. In light of federal reform efforts, like the adoption of the Arizona College and Career Readiness Standards (AZCCRS), the school district adopted a primary resource for mathematics called Eureka Math in 2016. This resource was free, comprehensive, and rigorous, but lacked differentiated support for teachers and students (New York State Education Department, 2017). Since the adoption of the AZCCRS, which was Arizona's replacement of the Common Core State Standards (CCSS), the school district went through the process of reviewing and adopting aligned mathematics resources that addressed the standards for the 2017-2018 school year (AZCCRS). After a year of reviewing various resources, the school district adopted Eureka Math as the primary mathematics resource for K-5. However, in order to address all of the standards, the modules of Eureka Math had been rearranged and amended with the incorporation of other supplementary adopted resources. The result of altering the progression of the resource and integrating other resources contributed to incoherence and inconsistency during mathematics instruction. However, in 2018-2019, the school district engaged in another mathematics resource review procedure. At the conclusion of this process, the district agreed to adopt a new mathematics program called *Ready Mathematics* by Curriculum Associates Publishing (2019) for the 2019-2020 school year. In the 2019-2020 school year, teachers taught this resource for the first time since its adoption. All teachers were required to attend a training about the resource to support instruction and fidelity of the resource.

Another influential change that has greatly shaped the climates of classrooms was the district's implementation of a compact mathematics program in the 2018-2019 school year. District leaders initiated a structural change for mathematics instruction in K-5 schools, creating a unique classroom climate during mathematics. To accommodate high achieving mathematics students, the school district implemented a new procedure to group students for mathematics instruction. At the end of the 2018-2019 school year, fourth-grade teachers and administrators examined student data to identify high achieving and gifted fourth-grade students in mathematics. The identified students would participate in a compacted mathematics class the next school year. As fifth-grade students in the 2019-2020 school year, the identified students received alternative instruction that taught them fifth-grade and sixth-grade mathematics standards. In order to accommodate the needs of the high achieving students, one of the three fifth-grade teachers were designated as the compacted mathematics teacher. Students who were identified as high achieving would leave their homeroom teacher and go to the compacted mathematics classroom for instruction. Meanwhile, students who were not identified as high-achieving or gifted in the compacted mathematics teacher's homeroom were assigned one of the remaining fifth-grade teachers for grade-level mathematics instruction. However, my school's population could not place a full class size of students in the compacted mathematics class making the grade level class sizes larger for the 2019-2020 school year. In the 2019-2020 school year, I taught grade level mathematics to a class of 35 grade-level or lower students during mathematics instruction. I found that the loss of high-achieving and gifted students, with the addition of more high-needs students, has made the problem of fifth-grade underachievement in mathematics even more daunting in my local context.

Effects of recent changes. All changes come with intended and unintended consequences. Since the adoption of the AZCCRS, the various adoptions of mathematics resources, and the larger class sizes of grade level or lower mathematics students, made some maladaptive patterns in students' learning behaviors noticeable. These behaviors were most likely due to the frequent changes that students had been experiencing. For the purpose of understanding maladaptive learning behaviors in my classroom, I kept a researcher's journal. The field notes in this journal were meant to document and prompt reflection on observations taken during the mathematics portion of the days in 2018-2019 school year. Since I had been keeping a researcher's journal, I noted that during whole-group, core instruction, students who consistently underachieved in mathematics rarely participated in classroom discussions or activities. From my observations, I noticed that when students were asked to collaborate with a partner or small group, underachieving students oftentimes did not contribute to collective discussions, nor did they pay attention to the dialogue that surrounded them. Furthermore, my journal reflected similar behavior patterns during the independent practice portion of core instruction. When students worked independently, I would walk around and informally monitor students' progress by being cognizant of their strategies, mistakes, and misconceptions, while also prompting their thinking and answering questions. Students who underachieved in mathematics seldom sought out help. As I monitored progress, it was typical that these students did not have anything written down. Additionally, it was common for them to not know what they were supposed to be working on. I found that I had to individually engage in a conversation that reviewed my directions, and the background knowledge necessary to understand the problem. Several of my students responded to challenges by saying, "I don't get it." Subsequently, I often prompted their process by chunking the problem for them. These observations led me to believe that many of these students did not have strategies to utilize when they faced a mathematical challenge. It is possible that this resulted in a lack of motivation and effort when faced with a challenge.

Likewise, the effects of the new compacted math model made it difficult for students to take ownership of their learning. In the past, I had the option to utilize high-achieving students to foster positive student interactions around content. Prior to this model, high-achieving students could guide low achieving students without teacher intervention, helping them understand the content, and empowering them to take charge of their own learning and outcomes. Without these leaders in the classroom, it became more difficult to group students in a way that would foster meaningful engagement. I sensed this was in part because my 2018-2019 mathematics class was less inclined to engage in challenging mathematics problems, most likely because of their previous learning experiences or lack of strategies. Additionally, my mathematics class had higher academic needs and less motivation to make growth. I found that students were less likely to ask for help or use their resources to problem solve when faced with a challenging problem. I also discovered that a lot of students would not participate in the task at hand, most likely because they lacked motivation and strategies to effectively approach a challenge.

Moreover, when I worked with underachieving groups of students in IFG, I found that, similar to whole group instruction, they tended to have a difficult time getting started. Consequently, they became easily distracted. At times when I worked one-on-one with students, they often became frustrated when they had difficulty answering questions. Sometimes they responded by putting their heads down on their desks. Other times these students were frustrated to the point of tears. Unlike whole group instruction, during mathematics IFG instruction, students knew they would be held accountable for their work and effort since they worked in smaller groups, and oftentimes with an adult. This resulted in a heightened sense of frustration when working on a challenging mathematical concept. In existing literature, all these observed maladaptive behaviors have been linked to lower academic achievement (Dembo & Eaton, 2000; Kitsantas et al., 2017).

Although academic performance is a primary concern in schools, one of the largest factors of the challenge to show academic growth in mathematics can be attributed to maladaptive behaviors like lack of effort, motivation, and effective learning strategies. Over the years, I found that I have been regulating maladaptive behaviors more often. As a result, this has affected my ability to instruct or support the learning process, particularly in mathematics. I also noticed that most of these behaviors occurred when content was challenging for students. With a class size of 35 students in the 2019-2020 school year, it was difficult to hold students accountable and keep them engaged and motivated throughout the mathematics block without addressing these patterns. These observations implied that some students did not have the mindset or the self-regulation strategies necessary to foster resilience when facing challenges in mathematics. Empowering students to take ownership of their own learning, may ultimately make me a more effective instructor by allowing me to effectively aid the learning progress rather than monitor students' engagement and motivation.

Research Questions

These circumstances and observations further illustrate the problem of underachievement of fifth-grade students in mathematics. With consideration of the behaviors that I have observed and the literature I have read, I believe that this problem should be approached with a psychological lens rather than a cognitive lens. The added pressure of performance on high-stakes tests, inconsistent mathematics resources, and students' lack of learning strategies all contribute to students' implicit theories of intelligence also known as their mindset. For these reasons, I constructed four research questions to guide this study.

1. To what degree does participation in a growth mindset program affect fifth-graders' understanding of mathematical concepts?
2. How, and to what extent, does participation in a growth mindset program affect students' mindsets?

3. How, and to what extent, does participation in a growth mindset program affect students' use of self-regulation strategies?
4. What were participants' attitudes towards the Strength Braining Program?

Chapter 2

THEORETICAL PERSPECTIVES AND RESEARCH GUIDING THE PROJECT

Introduction

To prepare students for the world outside of school, students must learn how to utilize key skills to regulate their behaviors and learning. Zimmerman (1986) asserts that students should develop self-regulated learning strategies by using their socially situated context to regulate their learning and behaviors. Research indicates there is a positive correlation between self-regulated learning and academic achievement (Zimmerman, 1986). However, schools tend to focus on cognitive learning to improve academic achievement while neglecting the role of psychological characteristics and strategies in academic achievement (Mueller & Dweck, 1998; Zimmerman, 1986). For the purpose of this research, self-regulation is operationalized as the ability to both motivationally and behaviorally participate in one's own learning process by being metacognitive about one's thoughts, feelings, and actions (Boekaerts & Niemivirta, 2000; Kitsantas et al., 2017).

With a primary focus of developing cognitive skills in schools, teachers are overwhelmed with the amount of content they must cover to show student growth. This focus often fosters a controlled, proficiency-based climate. In contrast, an environment that explicitly teaches self-regulation strategies will ultimately encourage students to engage in challenges and set personal learning goals, with a growth mindset, in order to develop psychological and cognitive skills (Kaplan & Midgley, 1997; Meece & Miller, 2001; Pintrich, 2000).

The problem of practice being addressed in this study is the underachievement of mathematics in fifth-grade. I hypothesized that self-regulation strategies could promote a growth mindset that would, in turn, positively affect academic growth in mathematics. Therefore, the goal of this action research was to design an innovation that would help low-achieving students in mathematics develop self-regulation strategies in order to promote a growth mindset, positively affecting their mathematical growth. In this chapter, existing literature is reviewed that frames the problem of practice and informs the development of a growth mindset and self-regulation innovation to address the problem.

To gain an understanding of the nation's position on this problem, I will first provide a brief review of the United States' performance on international and national mathematics achievement assessments. Second, I will review the progression of mathematical reform efforts over the decades, illustrating the current climate of today's classrooms. Next, two learning theories are reviewed and discussed in regard to the role of their guiding principles on the development of the applied innovation. Finally, related literature is examined to establish the current understandings.

Mathematics Achievement

International Perspective

The problem of practice addressed in this research is compelling because it has been shaped within an international context. I will first describe how the United States has performed in mathematics achievement on international tests. For the purpose of this study I will focus on two international mathematics assessments, the Trends in

International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). The findings and trends illustrated by these two assessments illuminate that underachievement in mathematics is not an isolated problem, but an international issue.

PISA is an international assessment that is designed and administered by the Organization for Economic Cooperation and Development (OECD), a non-governmental research organization established in 1961 and made up of 35 countries (OECD, 2019). The PISA was first administered to fifteen-year old students in 2000 and has been administered every three years since (Perry & McConney, 2010). The PISA assesses mathematics, reading, science, and problem solving. In 2000, 2003, 2009 and 2015, the United States scored below the OECD average in mathematics (Guglielmi & Brekke, 2017; Lemke et al., 2004; NCES, n.d.; OECD, 2019). In addition to mathematics, the PISA also assesses problem-solving skills. PISA defines problem-solving as the ability to use cognitive processes to address real situations in which the solution is not obvious. Similar to mathematics, the United States scored below the OECD average in problem solving in 2003 (Lemke et al., 2004). These scores not only indicate that the United States is underachieving in mathematics, but they also imply that students' abilities to confront and resolve real life challenges is also a concern.

The TIMSS assessment is another international assessment that assesses fourth and eighth-grade students in mathematics and science. Close to 50 nations participate in the TIMSS assessment (NCES, n.d.). Although the United States scored higher than the TIMSS center point score set at 500, the gap between the United States and the top scoring nations has only become larger over the years (Bybee & Kennedy, 2005; Guglielmi & Brekke, 2017; Hanushek, Peterson, & Woessmann, 2014). For example, the United States ranked 11th for fourth graders on the 2011 TIMMS with a scale score of 541 in mathematics (TIMMS and PIRLS International Study Center, n.d.). However, in 2015 the United States ranked 14th with a scaled score of 539 in mathematics. The gap between East Asian countries and the next highest-ranking country had a difference of 23 in 2015, the gap difference has not changed from 2011 (TIMMS and PIRLS International Study Center, 2019). In fact, across all of the PISA and TIMMS assessment cycles, East Asian countries have continued to outperform the United States (Guglielmi & Brekke, 2017). The drop in the ranking of the United States indicates that it is not closing this substantial gap. Additionally, these observations reveal that the United States is underachieving in mathematics and losing ground to industrialized countries (Bybee & Kennedy, 2005; Guglielmi & Brekke, 2017). This data illustrates that the United States' progress has not been rapid enough to keep up with the leaders, industrialized countries, calling attention to the United States' education system and performance (Hanushek et al., 2014).

National Mathematics Perspective

The United States' national performance in mathematics is also concerning. The National Assessment of Educational Progress (NAEP) is a national assessment of the knowledge and attitudes of fourth, eighth, and twelfth-grade students in various domains, including mathematics. The mathematics portion of the assessment is aligned to the National Council of Mathematics Standards (NCTM) and assesses five different mathematics strands including number sense properties and operations, measurement, geometry and spatial sense, data analysis, statistics, and probability, and algebra and functions (NCES, n.d.). Participants' scores are sorted into three levels: "Basic," which indicates partial mastery of skills, "Proficient" which indicates competency of challenging content, and "Advanced" which indicates advanced mastery of the content matter. In 2017, only 40% of the nationally tested fourth graders scored at "Proficient" or above on the mathematics portion of the 2017 NAEP assessment. Some might argue that since the start of the NAEP in 1990, fourth-grade performance has measurably increased over time in mathematics (NCES, n.d.). For example, in 2017, 80% of fourth graders performed at or above basic, whereas in 2015 82% of fourth-grade students performed at or above "Basic." In 1990 the mathematics scale score was 213, whereas, the 2017 mathematics scale score was 240. Although there has been documented growth in fourth-grade mathematics since 1990, still less than half of fourth-grade students who took the NAEP in 2017 are considered proficient. Most recently, there were no significant gains in fourth-grade mathematics from 2015 to 2017 indicating that growth towards proficiency has slowed. Furthermore, the scores obtained by the students in the bottom 10th and 25th percentiles are lower, indicating that students who are below the "Basic" level are actually losing ground.

Arizona's achievement. In comparison to the nation, 34% of the Arizona fourth graders tested proficient or above on the mathematics portion of the 2017 NAEP, making Arizona's average lower than the already low national average. Moreover, Arizona's average on the 2017 fourth-grade mathematics test was lower than the average obtained in 2015. Arizona's average has been consistently lower than the national average since 2000 (NCES, n.d.). Only five states scored significantly lower than Arizona, while 33 states scored significantly higher than Arizona. Fourteen states were not statistically different from Arizona's score (NCES, n.d.). Between 2015 and 2017, Arizona was one of 10 states whose performance decreased (NCES, n.d.). In 2017, 73% of Arizona's fourth graders scored at or above "Basic." In comparison, 79% of Arizona's fourth graders scored at or above "Basic" in 2015. These data portray the alarming progression of Arizona's mathematical performance nationally (NCES, n.d.). Likewise, these statistics illustrate the problem addressed in this study. Not only are Arizona students underachieving in mathematics, but students in the lower percentiles are losing ground (NCES, n.d.).

Reform Efforts

The nation's performance on international and national tests has prompted many educational policies and reforms (Perry & McConney, 2010). To understand the circumstances and impact of these policies and reforms, a historical perspective and overview of major reforms over the decades follows.

1950s - 1960s. During the 1950s and 1960s, colleges and universities became concerned about the lack of mathematical knowledge obtained by K-12 students. Universities felt as though incoming students lacked critical computational and conceptual knowledge in mathematics (Schoenfeld, 2004; Woodward, 2004). The decreasing enrollment of students in mathematics courses, and their inability to apply mathematics to different domains of learning, alarmed both the collegiate and K-12 education systems. Furthermore, during these decades, the United States found themselves competing with other nations, like Russia, in the field of engineering (Schoenfeld, 2004; Woodward, 2004). For these reasons, the nation pushed for excellence in education. At the time, education was largely a product of behaviorism. With behaviorism as a guiding pedagogy, schools focused on memorization and rote practice. Teachers were instrumental in the delivery of this instruction. However, some mathematicians fueled a new mathematics movement in which they emphasized the understanding of mathematical procedures instead of manipulation. This new way of looking at mathematics became known as discovery learning. The new mathematics curriculum focused on exposing students to abstract mathematical concepts as early as elementary school. Teachers were encouraged to foster an environment in which students observed, explored, and discovered patterns in mathematics (Woodward, 2004). By the late 1960s, teachers moved further away from behaviorism and began to facilitate discovery learning in mathematics.

1970s - 1980s. In the following decades, many inner-city families believed that their children were being ignored because they lacked basic skills. Businesses alike, found that the incoming workforce was not prepared with the necessary skills to execute their jobs. These realizations prompted schools to shift back to the basics (Schoenfeld, 2004; Woodward, 2004). Teachers again became a dominant leader in the classroom. Mathematics instruction resembled the instruction that took place in the early 1950s and 1960s (Schoenfeld, 2004). Additionally, within the back-to-basics movement, standardized tests became fundamental tools of measurement (Woodward, 2004). The use of standardized tests to measure student growth and the quality of schools began to shape the climate of classrooms. Education policy and the evaluation of districts paved the road to formulaic teaching methods and curriculum. Lessons became scripted and prescribed, ultimately minimizing the number of liberties teachers could take in regard to curriculum, instruction, and their response to the learning of their students (Schoenfeld, 2004; Woodward, 2004). Like the early 1950s and 1960s, these shifts were primarily derived from behavioral theory. However, by the end of the 1980s, testing results showed that students not only lacked the ability to problem solve, but also the ability to perform the basics (Schoenfeld, 2004). Likewise, the United States' poor performance on the Second International Mathematics Study (SIMS), between 1980 and 1982, prompted change in mathematics instruction (Schoenfeld, 2004). As a result, many cognitive researchers began exploring constructivist theory as a framework for mathematics instruction. This shift refocused instruction around the learner who was believed to construct, rather than retain, both procedural and conceptual knowledge (Woodward, 2004). Additionally, research at the time indicated that students required a knowledge base, problem-solving strategies, metacognition, and a positive disposition about one's abilities in mathematics to be competent learners in mathematics (Schoenfeld, 2004).

1990s. By the 1990s, the United States was motivated to become one of the leading nations in both mathematics and science. In response to this desire, the National Council of Teachers of Mathematics (NCTM) created streamlined standards in 1989; these standards prioritized excellence in education, particularly in mathematics (Schoenfeld, 2004; Woodward, 2004). NCTM recognized that the combination of technology, communication skills, and mathematical literacy were important to the future of mathematics and students (Woodward, 2004). The new NCTM standards focused on developing learners into well-rounded citizens who would soon join the workforce. The establishment of these standards sparked the standards movement (Schoenfeld, 2004). During this movement, standards-based curricula was developed to align with the NCTM standards (Schoenfeld, 2004). It is worth noting that at the time, there was no empirical proof to demonstrate success of the standards, nor the reformed curricula (Schoenfeld, 2004). In other words, it could not be certain that students who were educated under these reforms emerged more competent in mathematics or the workplace (Schoenfeld, 2004). Alongside the development of the reformed curricula, scholars became critical of standardized tests and how they were utilized in the 1980s, prompting them to be conscious of standardized tests and how they were designed and used in the 1990s. For example, reviews of standardized assessments criticized the focus on basic skills over complex understanding. After the results of the third TIMMS assessment were released in 1995, reports scrutinized the United States' performance, which was significantly lower than Asian and industrialized countries (Woodward, 2004). These results sparked a new wave of reforms to address academic achievement in mathematics.

2000s. Prior assessment results and reforms have paved the way to the climate of today's classrooms. Currently, one of the most controversial topics in education is the measurement of student achievement and school accountability. In the past two decades, federal reform efforts have lured states into government programs by promising educational funding in exchange for compliance with federal initiatives.

Federal influence on public education has increased over the years (Cooper et al., 2008). Legal mandates like the No Child Left Behind (NCLB) and Every Student Succeeds Act (ESSA) had good intentions, but stressed proficiency on high-stakes testing in order to hold schools accountable. ESSA replaced President George Bush's NCLB in 2015. ESSA, like NCLB, holds schools and teachers accountable for student achievement, ultimately influencing classroom climates. Districts, principals, and teachers are more inclined to focus on students' academic abilities with the intention of showing growth on state and national assessments. Consequently, classroom climates have become high-stakes environments shaped by the efforts to cultivate student performance and achievement. The purpose of this legislation was to provide all students with a quality education and equal opportunities, with the purpose of closing the achievement gap that has been illustrated by PISA, TIMSS, and NAEP. Although it is hard to disagree with the ethical intentions of these laws, their execution have often been problematic. The lofty goals and requirements of these laws were not supplemented with the key resources or funding necessary to meet their purposes (Cooper et al., 2008).

More recently, Race to the Top (RTTT) is a contentious piece of legislation that was brought forth by the Obama administration. RTTT designated $80 billion to K-12 education through formula-based programs and competitive grants (Cooper et al., 2008). States, starved for educational funding, submitted applications that ultimately initiated educational reform with a federal influence. In order for states to receive RTTT funding, they had to meet certain criteria including the use of student achievement data for evaluation of schools and teachers, along with the adoption of the Common Core State

Standards (CCSS; Cooper et al., 2008). Under the Obama administration, streamlined standards were created to maintain consistency in schools across the nation. Prior to the CCSS, states had their own sets of standards and formal assessments. To accommodate the change in standards, Arizona school districts adopted new curricula aligned to the newly adopted CCSS. In particular, the mathematics curricular resources required higher-order thinking skills and the ability to deconstruct numbers and problems in multiple ways. In comparison, resources aligned to the Arizona State Standards were more focused on procedural knowledge. The adoption of these new standards required a new way of thinking about mathematics and the delivery of instruction along with substantial funding. Cooper et al. (2008) asserts that this type of federal curricular reform is contingent on the implementation of these standards by classroom teachers. Perry and McConney (2010) found that the effect of school resources on academic achievement is small. However, the effect of school composition (school demographics) had a stronger association with students' academic achievement. They also found that the higher a student's socioeconomic status, the stronger their academic performance (Perry & McConney, 2010). These findings indicate that curricular reforms may not accomplish their intentions of improving students' academic achievement, which is the United States' ultimate goal. Actually, these findings could indicate that reform efforts focused on the psychological characteristics of learners may have a larger effect on academic achievement.

A different type of reform. Changes in curricular materials, performance accountability measures, and changes in standards have transformed over the decades, but the United States has remained in a state of discontentment perpetuated by mediocre results of the TIMMS, PISA, and NAEP (Guglielmi & Brekke, 2017). Although these assessments have yielded some data that have been largely ignored, they could potentially inform future reform efforts that attend to students' psychological and cognitive needs. The great majority of mathematical reforms over the decades have incorporated different ways to address the cognitive abilities of students, but there has been an overall lack of attention to students' psychological characteristics when it comes to learning mathematics (Yeager & Dweck, 2012). Addressing students' psychological needs could promote student motivation and achievement in the classroom (Yeager & Dweck, 2012). For example, East Asian countries have consistently outperformed the United States in both the TIMMS and PISA (Guglielmi & Brekke, 2017). The findings of the third TIMMS suggest that East Asian students are more likely to believe that effort is a key component of success. In contrast, North American students are more likely to possess a disposition in which they believe that mathematical intelligence is a fixed asset that cannot be changed through effort (NCES, n.d.). Within the United States, McGraw, Lubienski, and Strutchens (2006) found that when responding to the attitudinal measures of the NAEP, female students were less likely than their male counterparts to agree with the statement, "I like mathematics," and "I am good at mathematics." These findings allude to the idea that some students, particularly girls, could have a fixed mindset in mathematics.

Schoenfeld (2004) states that classroom instruction puts knowledge at the center of learning; however, research shows that students' failure to solve problems can be attributed to inefficient use of resources. Today, many researchers believe that mathematical competence depends on knowledge, problem-solving strategies, metacognition, and mindset (Hong, Chiu, & Dweck, 1999; Schoenfeld, 2004; Yeager & Dweck, 2012). Reforms focused on cognitive attributes of learning are not the only answers to the United States' underperformance in mathematics. Shifting reform efforts to acknowledge and develop students' mindsets and self-regulation strategies to become efficient problem solvers can potentially improve student achievement in mathematics.

Theoretical Frameworks

Two guiding theories were utilized to frame the research addressing this problem of practice, mindset theory and self-regulation theory. In this portion of the literature review, each theory is described by its key principles. Existing literature is then reviewed to further illustrate the principles of each theory.

Mindset Theory

Dweck's mindset theory theorizes that students have a mindset that is determined by their implicit theories of intelligence (Hong et al., 1999). A mindset is a person's beliefs about their intellect. These beliefs, or implicit theories of intelligence, lead to the creation of a meaning framework that then generates attributions of failure and success (Hong et al., 1999). Dweck's mindset theory identifies two mindsets: growth mindset and fixed mindset. Initially Dweck hypothesized about two phenomena in learning: maladaptive and adaptive responses to challenges. There are several components of this theory that have evolved as research findings have informed the theory over time. In this portion of the literature review, I review the development of this theory over time, introducing key terms and their role in research.

The mindsets. As mindset theory evolved, Yeager and Dweck (2012) explored implicit theories or mindsets that promote learning and academic achievement. They assert that mindsets are developed by core assumptions that learners use to determine the malleability of personal qualities, like intellect. These implicit theories serve as a framework through which learners interpret, predict, and judge the world around them. Yeager and Dweck (2012) described two mindsets: a fixed mindset, which is derived from an implicit entity theory with the belief that intellect is a fixed asset, and malleable mindset, which is derived from an implicit incremental theory with the belief that intellect is not a fixed asset but an asset that can grow through effort. For this study, a growth mindset is operationalized as the belief that mathematical intelligence is something that can be grown through effort, strategies, and help from others (Dweck, 2016). On the other hand, a fixed mindset is operationalized as the belief that a person possesses a certain amount of mathematical intelligence and not much can change it (Dweck, 2016).

Mindset influences the lens in which people make sense of learning experiences, mistakes, and failures. It is worth noting that failure can be painful for those with both mindsets. However, people with a fixed mindset believe that they are defined by their failures. Their response to failure is to attribute their failure to factors not within their control or stop putting forth effort towards that learning experience in an effort to maintain their intellectual reputation (Diener & Dweck, 1978; Dweck, 2016). People with a fixed mindset prefer progress to be comfortable and within their grasp. If tasks become too challenging or they feel incompetent, they are likely to lose interest in the task at hand. In contrast, those with a growth mindset see failure as an opportunity to learn. People with a growth mindset seek challenges because they view them as opportunities to learn from mistakes and engage in the learning process (Diener & Dweck, 1978; Dweck, 2016). A person's mindset has a great impact on their disposition towards learning and their effort towards challenging tasks. Not only does it impact their responses to failure, but it also impacts the goals that they set.

Patterns and goals. Mindset theory originated from two observable patterns in students' responses to challenges. One of these patterns are maladaptive, or helpless, responses to a challenge, which include avoidance of challenging tasks, or deterioration of performance when faced with obstacles. In contrast, adaptive, or mastery-oriented, responses are observed as seeking out a challenge or putting forth effort even when previous approaches to solving a problem have not been successful (Dweck & Leggett, 1988). Several researchers have found that students who exhibit adaptive responses to challenging tasks tend to set learning goals that focus on growth and mastery, while students who exhibit maladaptive responses are more likely to set performance goals that focus on performance in comparison to others (Aronson et al., 2002; Blackwell et al., 2007; Yeager & Dweck, 2012). Students' responses to challenges may indicate the type of goals they set in their learning.

Dweck and Leggett (1988) explain maladaptive and adaptive responses to challenges by investigating the role of these patterns in goal setting and learning. They assert that goals provide a learner with a framework in which they understand and approach tasks. They hypothesized that there are two types of goals: performance goals and learning goals. Performance goals are set by learners to judge their own competence of a skill. This type of goal aligns with maladaptive or helpless patterns making learners more vulnerable and helpless. On the other hand, learning goals are set by learners to increase competence and are mastery oriented. This type of goal aligns with adaptive, mastery-oriented patterns of learning (Blackwell et al., 2007; Hong et al., 1999). The difference between these two goals is the criteria for success. Learning goals focus on the process of learning and individual growth towards a goal, whereas performance goals focus solely on outcomes that meet the goal.

Since the key difference between these two goals lies in one's interpretation of progress towards the goal that has been set, it is beneficial to understand a potential profile for a student who sets performance goals and learning goals. When considering a student who has set a performance goal, their intention is to document their ability. These students may believe that putting forth effort is an indication that they lack natural ability. Additionally, if their progress towards the goal does not indicate mastery, then they are less likely to engage in challenges to avoid looking "stupid" in comparison to their peers (Blackwell et al., 2007; Yeager & Dweck, 2012). This behavior aligns with a fixed mindset orientation, whereas a student who sets learning goals is more likely to focus on the process of learning instead of solely on the outcomes or mastery. Students who set learning goals are more likely to interpret mistakes as opportunities to learn, rather than a reflection on their ability. Additionally, they believe that effort and seeking help are tools that can help them make progress towards their goal (Blackwell et al., 2007; Yeager & Dweck, 2012). For this research study a learning goal is operationalized as a goal that focuses on improvement and increased understanding of a mathematical concept. A performance goal is operationalized as a goal that focuses on one's ability and how it compares to the ability of others (Kitsantas et al., 2017; Middleton & Midgley, 1997; Midgley & Urdan, 2001).

Resilience. Resilience is an asset that is instrumental in academic success in today's school. Yeager and Dweck (2012) define resilience as a positive reaction to challenges, emphasizing that responses to adversity can shape academic outcomes. These positive reactions can range from willingness to learn from mistakes, to interpreting challenges as an opportunity to learn. However, when learners have a fixed mindset, they believe that intelligence is unchangeable regardless of effort. Within this mindset, learners interpret obstacles as signs that they lack adequate intelligence (Dweck, 2016). Since challenges are understood as a measure of intelligence, they serve as a threat to learners who have a fixed mindset. In return, this interpretation of challenges compromises resilience and effort resulting in maladaptive learning behaviors. In contrast, a malleable mindset engenders the idea that intellect can be developed over time. Challenges are interpreted as assisting learning and growth (Diener & Dweck, 1978; Yeager & Dweck, 2012). This disposition towards challenges fosters resilience in learners. Within the growth mindset, challenges and mistakes fuel the learning process by providing learners with feedback that the learner interprets to guide the learning process in an adaptive way. For the purpose of this research, resilience is operationalized as any response to an academic challenge that is positive or helpful to the development of mathematical skills. At times a person's metacognition and self-talk determines the amount of resilience they have when facing a challenge.

Feedback. Although previous learning experiences can shape a student's mindset, the feedback they receive when engaging in a task also greatly influences their mindset (Mueller & Dweck, 1998; Dweck, 2002). Today's schools tend to praise students' outcomes rather than their learning process. Feedback like, "You are smart" facilitates a fixed mindset making students believe that their intelligence can be measured by a single outcome (Blackwell et al., 2007; Mueller & Dweck, 1998; Yeager & Dweck, 2012). Mueller and Dweck (1998) describe two forms of feedback, intelligence feedback and process feedback. Feedback that focuses on outcomes as a measurement of ability is considered intelligence feedback. Comments like, "You are smart" are considered intelligence feedback since it praises an outcome of the learning process. In contrast, process feedback focuses on the learning process. This feedback emphasizes effort, strategies used, and resilience rather than a performance outcome (Mueller & Dweck, 1998; Paunesku, Yeager, Romero, & Walton, 2012; Yeager & Dweck, 2012). Comments like, "That is a good grade. You must have worked hard" encourages a growth mindset because it acknowledges that the outcome was attributed to the process of learning, not innate intelligence. Feedback provided by surrounding members of a learning community can have great effects on a student's disposition towards learning. In fact, Dweck (2016) measured the brain waves of participants with both mindsets. She found that the brain waves of those with a fixed mindset only showed interest in feedback when it reflected on their ability. Additionally, participants with a fixed mindset lost interest in feedback that was geared towards helping them learn. However, the brain waves of participants with a growth mindset paid attention to feedback that focused on the learning process. These findings indicate that those with a growth mindset are more likely to put forth effort into learning from mistakes than their fixed mindset counterparts. Feedback also impacts students' self-talk. Providing students with intelligence praise instead of process praise undermines the power of *yet*. That is, process praise emphasizes the capacity to develop intelligence by communicating that effort, strategies, and help will pay off, even if it has not yet.

The components of this theory that have guided the development of this innovation are the identification of the two mindsets, developing learning goals as opposed to performance goals, fostering resilience when encountering mathematical challenges, and encouraging positive self-talk in mathematics.

Related research to mindset theory. The following studies illustrate the two mindsets and how learners attribute academic failures and successes. The purpose of reviewing these studies is to understand how one's mindset shapes how one faces challenges and makes sense of failure. Multiple studies have examined the effects of mindset on effort, resilience, and learning. I have selected three seminal studies that investigated the role of attributions on one's mindset and resilience.

Rattan, Good, and Dweck (2012) set out to understand how participants' mindsets dictated their attribution of failure and success. In a study involving 41 undergraduate students from a private university on the West Coast, researchers designed a study to determine how mindsets affected resilience and learning (Rattan et al., 2012). Volunteers completed an online survey about their dispositions towards mathematics. This survey assessed participants' mindset regarding mathematics. After participants took the survey, they were given a task to imagine themselves as a seventh-grade mathematics teacher who was meeting with students about their performance on a mathematics test. Rattan et al. (2012) provided a profile of a student who received a 65% on the mathematics test. Participants were asked to provide attributions for the student's performance on the mathematics test. Specifically, researchers asked how much they believed that she scored 65% because she is not smart enough in mathematics.

Results of this study showed that participants who endorsed more of a fixed mindset were more likely to attribute the student's score to not being smart enough. In contrast, those who endorsed a growth mindset attributed the student's grade to the amount of effort the student applied. The results of this study indicate that those with a fixed mindset believe that intelligence cannot be changed through effort, whereas students with a growth mindset are more likely to attribute failure to a lack of effort rather than intelligence.

Correspondingly, Diener and Dweck (1978) yielded similar findings. Diener and Dweck (1978) conducted two studies to determine the nature of learners' attributions of failure by analyzing their verbalizations amid a challenge as well as their use of problem-solving strategies. The first study involved 70 fifth-grade students, and the second study involved 60 fifth-grade students, both from a semi-rural community. Researchers began by administering a 10-item subtest of the Intellectual Achievement Responsibility Scale

(IAR) to understand the relationship between attribution of failure and lack of effort. These initial scores allowed researchers to categorize participants into two groups, the *helpless* group and the *mastery-oriented* group. Participants in both groups were given tasks. Participants were asked to identify one solution that applied to each task. Students participated in eight training sessions and four test questions to familiarize them with the format of the task with varying levels of feedback (Diener & Dweck, 1978). During the first two training sessions, participants were provided with feedback in the form of "right" or "wrong" after each problem. As the training sessions progressed, feedback was provided less frequently. During the test sessions, researchers provided feedback after every fourth response. Throughout the tasks, Diener and Dweck (1978) monitored strategy changes after failure feedback. At the end of the test, participants were asked why they believed the task was so difficult for them. Responses to this prompt were categorized for further analysis regarding participants' attributions and responses to failure.

From this study, Diener and Dweck (1978) found that helpless participants attributed failure to uncontrollable factors, whereas mastery-oriented participants did not have explanations for their failure. Furthermore, mastery-oriented participants engaged in self-instructions (e.g., reminding themselves to slow down or concentrate) and self-monitoring (e.g., making solution-oriented statements or comments on effort) when faced with a challenging task. When mastery-oriented participants were asked about task difficulty, responses showed that regardless of the attribution to difficulty, they did not see their efforts as failures, only information that they would use to solve the problem.

This set of studies in conjunction with the findings of Rattan et al. (2012) further illustrate that those with a fixed mindset are less likely to use strategies or apply effort to challenging problems since they tend to attribute failure to uncontrollable factors. Additionally, it indicates that those with a growth mindset monitor their progress, failures, and successes, to appropriately apply strategies showcasing their resilience in the face of a challenge.

Although it is enlightening to understand how people with both mindsets attribute their successes and failures, it is also helpful to understand the factors that shape these attributions. In a study conducted by Mueller and Dweck (1998), researchers explored the effects of two types of praise on students' performance and mindset. Participants of this study included fifth-grade students who were divided into three groups. All three groups were given three trials of logic problems. The first set of logic problems were at grade level. After the completion of the first trial of logic problems, the first group of students received intelligence praise focused on their outcome (e.g., "That was a high score, you must be smart"), the second group received process praise that focused on effort, strategies, and resilience (e.g., "That was a high score, you must have put a lot of effort into that."), and the third group received neutral praise (e.g., "That was a high score."). After the first round, participants were then given a second trial of logic problems that were difficult for all participants, on which all the participants performed poorly. Finally, students were given a third round of logic problems that were the same level of difficulty as the first round so that researchers could measure students' resilience and performance after encountering a challenge and each type of praise.

Researchers found that students who received intelligence praise only wanted to work on easy problems and overall, they completed fewer problems during the third trial than in their first trial. Furthermore, their performance and overall enjoyment declined in the third trial of grade level logic problems. On the other hand, students who received process praise performed better on the third trail than on the first trial. Additionally, their enjoyment did not decline, and they were more likely to ask for more challenging problems (Mueller & Dweck, 1998). These findings indicate that learning environments should encourage resilience by praising the process of learning rather than the outcomes. These three studies imply that a fixed mindset has adverse effects on resilience when it comes to approaching a challenge. They also indicate that feedback and attributions of failure greatly impact resilience and effort (Deiner & Dweck, 1978; Mueller & Dweck, 1998; Rattan et al., 2012).

In order to properly frame the problem of practice addressed in this research study, the following studies contribute to a literature review of research addressing the effects of mindset on academic growth. Additionally, the following studies also informed the innovation focused on developing a growth mindset in mathematics with the intention of improving academic growth in mathematics. Another purpose of this portion of the literature review involves the key findings that indicate that when students transition from elementary school to middle school, it is common for their mathematics grades to decline (Blackwell et al., 2007). Within my local context, fifth grade is the year before students transition to middle school, making this an alarming finding that is worth considering when designing this innovation.

For example, Good, Aronson, and Inzlicht (2003) explored the effect of promoting a growth mindset on recently transitioned middle school students on their academic growth throughout the year. Participants in the experimental group of this study received emails throughout the year explaining a growth mindset, whereas students in the control group did not receive emails promoting a growth mindset.

Good et al. (2003) found that students who received emails about a growth mindset throughout the year scored significantly higher on the statewide assessment in mathematics than those in the control group. This finding indicates that promoting a growth mindset has an influence on students' mathematical academic growth. Moreover, this study shows the positive impact that fostering a growth mindset can have on students who are enduring a transition between two schools.

Blackwell et al. (2007) discovered similar findings in a series of studies that investigated the role of mindset on resilience and academic achievement during a transitional year. In a longitudinal study involving four successive groups of seventh-grade students (n = 373) from a New York City public school, researchers found a direct connection between mindset, resilience, and academic growth in mathematics (Blackwell et al., 2007). Blackwell et al. (2007) aimed to examine the relation between mindset and academic growth while also testing mediators of this relation, such as resilience. Upon entering seventh grade, participants completed a motivational questionnaire, assessing their mindset, goals, beliefs about effort, and helpless versus mastery-oriented responses to failure. In conjunction, they obtained Citywide Achievement Test (CAT) scores from the spring term of sixth grade and term grades from the fall and spring semesters of seventh and eighth grade.

Blackwell et al. (2007) found that students who thought that intelligence was malleable set learning goals (versus performance goals) and were more likely to believe that effort was necessary to make progress. They also concluded that students who set learning goals and put forth effort made fewer helpless attributions when faced with challenges. Additionally, data showed that students who entered junior high with a growth mindset were outperforming those who entered with a fixed mindset in mathematics. This study, in conjunction with the study conducted by Good et al. (2003), complements the innovation research since they both investigated and found positive effects of a growth mindset on academic growth during a transition between elementary school and middle school.

To further explore these findings, Panunesku et al. (2012) conducted a study that built on the study conducted by Blackwell et al. (2007). In this study, researchers investigated the effects of a growth mindset on resilience and academic growth within a community college setting. Participants of this study included 200 online students enrolled in a developmental mathematics class. Participants were assigned to read an article. The control group read an article about the brain that did not mention how the brain can grow. In contrast, the experimental group read an article about the brain that taught about the malleability of the brain even as an adult. The experimental article emphasized strategies, resilience, and the ability to grow your brain regardless of previous learning experiences. After reading the article, both groups wrote mentoring letters to future students including components of the article that they read.

Panunesku et al. (2012) found that participants in the experimental group exhibited more resilience and an overall higher performance in the class. Additionally, students in the experimental group were less likely to fail or withdraw from the course. This study explicitly addresses previous learning experiences, resilience, and academic growth. Participants who read about brain plasticity were more likely to exhibit resilience in the face of challenges, ultimately improving their academic performance in the course. This study illuminates the role of explicitly teaching brain plasticity as a tool to develop a growth mindset in mathematics.

Aronson et al. (2002) also investigated the effects of an intervention that explicitly described and taught brain plasticity to participants. The focus of this study was to investigate the effects of the intervention on students' resilience and academic achievement. This study was conducted with a control group and experimental group of community college students. Aronson et al. (2002) explicitly taught the experimental group of college students about the science behind brain plasticity. Researchers had participants imagine their neurons creating new pathways when they faced a challenge. In the control group, students were taught that everyone has different intellectual strengths, so it is not worth worrying about performance. Both groups of students were then tasked with writing a letter to a struggling middle school student incorporating key learnings about the brain.

Like Panunesku et al. (2012) and Blackwell et al. (2007), Aronson et al., (2002) found that students in the experimental group had significantly higher grade-point averages by the end of the year than those in the control group. These findings support the assertions that a growth mindset is beneficial to academic growth. These results have also been found internationally. The next two research studies investigated the impact of a growth mindset on academic growth in Hong Kong and Chile.

Hong et al. (1999) conducted a study involving college students in Hong Kong. This college instructs in English even though many of the admitted students are not fluent in English at the time of their admission. For this reason, it is important for students to believe that intelligence is not fixed but malleable. Researchers were interested in students' mindsets upon entering the university. Similar to the previous studies, participants were divided into two groups, a control group and experimental group. The control group read an article promoting a fixed mindset while the experimental group read an article promoting a growth mindset. After reading the articles, all participants wrote about what they read. They were then given a challenging task. Results of this study indicated that students who read about a growth mindset were more persistent when completing the given task making them more resilient when faced with a challenge.

Additionally, Claro, Paunesku, and Dweck (2016) conducted a large-scale study with 75% of the 10-grade students in Chile's public schools. There were 168,553 students included in the study representing 2,392 public schools. The purpose of this study was to explore the relationship between mindset and socioeconomic status and academic performance. Researchers collected data from standardized tests in both reading and mathematics. They also utilized a student survey to measure students' mindsets about the malleability of intelligence. Findings showed that students who had a growth mindset outperformed those who had a fixed mindset. Also, those from the lowest income families were twice as likely to report fixed mindset, which was also found to be a strong predictor of achievement.

These nine studies illustrate the role of implicit theories of intelligence in resilience and academic growth. Rattan et al. (2012), Deiner and Dweck (1978), and Mueller and Dweck (1998) found that students who had a fixed mindset tend to attribute failure to uncontrollable factors deeming themselves helpless in the wake of challenges. Additionally, they all found that students who had a growth mindset were more likely to put forth effort and utilize strategies when given failure feedback, highlighting their resilience. Furthermore, Good et al. (2003), Blackwell et al. (2007), Panunesku et al. (2012), Aronson et al. (2002), Hong et al. (1999), and Claro et al., (2016) all assert that students who adopted a growth mindset were more likely to set learning goals, having a positive impact on their academic success. Additionally, these researchers assert that explicitly teaching brain plasticity can foster a growth mindset and improve academic growth among students. These studies highlight that mindsets play a critical role in education and academic success.

Relevance to problem of practice. Yeager and Dweck (2012) described the implications of mindsets on academic growth through intervention research studies. They concluded that students' mindsets can affect academic behavior. They also asserted that mindsets can be explicitly taught in a school setting. With the adoption of the Arizona

College and Career Readiness Standards, mathematics curricula have increased the rigor making mathematics more academically demanding. Yeager and Dweck (2012) mention that increasing the rigor of standards, but not addressing resilience, can make facing challenges more stressful, consequently negatively affecting academic behavior. Additionally, in fifth grade, students are preparing for a transition into a different school, middle school. Yeager and Dweck (2012) assert that students who transition with a fixed mindset are more likely to regress in academic achievement. They believe that moving students towards a growth mindset can decrease the stress of a transition and positively affect academic growth and behavior. These findings inform the problem of practice being addressed in this action research study. They suggest that fostering a growth mindset is critical to encourage academic growth since research shows that a growth mindset can help students develop learning goals and adjust to transitions more readily with resilience. Additionally, these studies enabled me to design an innovation geared towards fostering a growth mindset and resilience. It is important to use the existing literature to design and create an innovation that has worked in different settings and conditions. The first phase of the innovation was informed by the findings of these research studies.

Self-Regulation Theory

As reviewed above, existing literature suggests that many students who do not perform well in school attribute their poor performance to a lack of intelligence; however, it could be because they were never taught how to learn (Dembo & Eaton, 2000). Research has shown that self-regulation strategies have a positive impact on the goals that students set for themselves and their academic growth (Boekaerts & Niemivirta, 2000; Dembo & Eaton, 2000; Kitsantas et al., 2017). For the purpose of this study, self-regulation is operationalized as students' self-generated thoughts, feelings, and actions which assist in the attainment of a goal (Schunk & Zimmerman, 1989). Self-regulation processes reside in the interpretation, and assessment, of one's opportunity to learn. Self-regulated learners utilize and adapt both cognitive and metacognitive strategies to learn. These students meet failure with increased effort and enthusiasm by planning and monitoring the next steps in the learning process (Boekaerts & Niemivirta, 2000). Similar to students with a fixed mindset, students who do not self-regulate often attribute their failures to a lack of ability or uncontrollable factors. These students avoid challenges and do not see failure as an opportunity to learn. Self-regulated learners employ self-regulation strategies when they face a challenge.

There are two categories of self-regulation strategies: cognitive strategies and metacognitive strategies (Sungur, 2007). Cognitive strategies are strategies that are task-oriented (e.g., note taking, summarizing, outlining, etc.), whereas metacognitive strategies refer to planning and monitoring the learning process by being aware of what cognitive strategies are suitable for the learning experience (Sungur, 2007). Since metacognition is the deliberate control of cognitive processes through planning and monitoring, it is critical that students have metacognitive strategies to effectively and efficiently utilize their cognitive strategies appropriately (Boekaerts & Niemivirta, 2000; Corte, Verschaffel, & Eynde, 2000). At times, schools are so focused on developing cognitive strategies that metacognitive strategies are overlooked. It is possible that underachieving students have not learned how to learn efficiently or effectively because they lack essential metacognitive strategies (Corte et al., 2000; Dembo & Eaton, 2000). Since research shows that students' beliefs about their own abilities play a role in establishing a context in which they make sense of their learning experiences, it is important to develop self-regulation strategies at an early age. Research indicates that it is critical that these strategies should be taught in the elementary schools (Corte et al., 2000). If schools teach metacognitive self-regulation strategies, students will be able to apply the cognitive strategies they learn more effectively. There is a positive relationship between use of self-regulation strategies and academic growth (Kitsantas et al., 2017).

For the purpose of this study, I will review three metacognitive self-regulation strategies, goal setting, self-monitoring, and seeking help. Next, I will discuss the role of these components in students' motivation and effort control. Last, I will review research studies that have investigated the effects of self-regulation strategies on motivation and academic achievement. Strategies will be defined as mental processes that learners deliberately utilize to aide themselves in learning and understanding something new (Somuncuoglu & Yildirim, 1999). One such strategy is goal setting.

Goal setting. Dembo and Eaton (2000) assert that establishing and attaining goals encourage students to be more attentive during instructional time, put forth more effort in the face of challenges, and improve confidence. Furthermore, the goals that students set influence the self-regulation strategies they utilize during the learning process (Kitsantas et al., 2017). Middleton and Midgley (1997) describe goals as a framework in which students interpret and react to learning events. Like Dweck's (2016) idea of learning goals and performance goals, self-regulation strategies also focus on two types of goals: mastery-oriented goals and performance-oriented goals. There are many parallels between these sets of goals. Schunk and Zimmerman's (1998) mastery-oriented goals refer to goals that define success as growth towards mastery of something new through effort. This type of goal is very similar to Dweck's (2016) learning goal since both of these are linked to positive perceptions of one's abilities and strategies. Mastery-oriented goals have been linked to higher levels of effort and persistence. Students who set mastery-oriented goals are more likely to effectively use self-regulation strategies, change strategies when one has failed, and engage in challenging tasks, even after failure (Dembo & Eaton, 2000; Kitsantas et al., 2017; Sungur, 2007). These goals have been found to correlate with adaptive motivational beliefs like seeing failure as an opportunity to learn and developing an action plan to achieve a challenging goal (Boekaerts & Niemivirta, 2000; Middleton & Midgley, 1997). These behaviors and outcomes align closely to mindset theory's growth mindset and learning goals.

On the other hand, Schunk and Zimmerman's (1998) performance-oriented goal is a goal that focuses on one's competence or ability in comparison to others. This is very similar to Dweck's (2016) performance goals. Students who set these goals have less adaptive attributions of failure. Sungur (2007) asserts that students who set performance-oriented goals are more likely to have a heightened sense of anxiety, put forth less effort, give up when challenged, and employ surface level strategies. Moreover, these goals are linked to maladaptive motivational beliefs including work avoidance and attribution to uncontrollable factors, yielding less adaptive outcomes (Middleton & Midgley, 1997).

These characteristics are very similar to Dweck's (2016) fixed mindset and performance goals. For this research study I will refer to the two different types of goals as learning goals and performance goals.

Self-monitoring and seeking help. Somuncuoglu and Yildirim (1999) believe that learning is a lifelong process that requires the learner to be an active participant in the process. This perspective promotes autonomous learning and independence by emphasizing the key of learning to learn. Self-monitoring is an essential component to the learning process. The ability to self-monitor one's learning is a metacognitive strategy that can help students monitor their cognitive strategy use and progress towards a goal. Somuncuoglu and Yildirim (1999) assert that it is important to teach students when to use particular strategies so that they can apply them more efficiently. Self-monitoring includes recognizing when a strategy has failed, changing strategies appropriately, identifying the source of confusion, or seeking help when necessary (Boekaerts & Niemivirta, 2000; Middleton & Midgley, 1997). One way for students to self-monitor their learning is by setting learning goals, developing a plan, and considering strategies (Dembo & Eaton, 2000). If students are unable to identify their next steps, they should seek help or guidance from others instead of disengaging from the learning experience.

Motivation and effort. Another component of self-regulation strategies is motivation. Dembo and Eaton (2000) assert that motivation deteriorates when students transition from the primary grades to the middle grades. This finding concerns this action research study since the participating fifth graders are preparing for their transition to middle school the following year. Dembo and Eaton (2000) also found that many students believe that parents and teachers are responsible for their motivation. Unfortunately, Kitsantas et al. (2017) found that motivation is influenced by prior academic achievement. This indicates that students who have underachieved in the past are more likely to be less motivated, resulting in reduced achievement effort. Students who are more motivated are more likely to put forth effort even in the face of challenges (Sungur, 2007). Additionally, motivated students are more likely to use failure as an opportunity to learn and try different strategies to improve the learning process (Corte et al., 2000; Sungur, 2007). These students are more likely to have higher academic achievement (Corte et al., 2000; Sungur, 2007). In contrast, students who are less motivated tend to exhibit maladaptive behaviors, such as deliberately withholding effort in order to control the attribution of their performance (Boekaerts & Niemivirta, 2000).

Students who are able to self-regulate view themselves as competent learners who have self-efficacy and a sense of autonomy to make decisions and act in their learning. Behaviorally, students who self-regulate the construction of knowledge are also able to select, structure, and create environments that will foster learning and motivation. Students who self-regulate set goals, utilize strategies to achieve goals, and cope with challenges along the way; conversely, lack of motivation is detrimental. What students say to themselves when engaged in a challenge can encourage persistence, but it can also be detrimental (Dembo & Eaton, 2000). Like mindset theory literature that addresses feedback, self-talk can be taught and used as a tool to fuel motivation and a growth mindset, ultimately improving academic growth in mathematics. Since prior learning experiences are linked to motivation, this innovation addressed negative prior learning experiences by explicitly teaching brain plasticity and self-monitoring one's attributions to performance (Corte et al., 2000).

Related research on self-regulated learning. Self-regulation strategies have been found to improve academic growth. For example, Blair, Ursache, Greenberg, and Vernon-Feagans (2015) examined multiple aspects of self-regulation in relation to academic growth in a longitudinal study. Participants were comprised of 1,292 low-income families in rural communities of high poverty from Pennsylvania and North Carolina. The researchers collected data from home visits at various ages and school visits between prekindergarten and second grade. During home visits, self-regulation tasks were performed. During school visits, children were assessed in mathematics and reading using subtests from the Woodcock-Johnson III, including a mathematical word problem subtest and a letter-word identification subtest. Additionally, parents and teachers completed ratings of their child's effortful control (i.e., control over amount of effort exerted). Findings showed that participants' initial level of self-regulation affected growth in both reading and mathematics (Blair et al., 2015). Results from this study support the need for a focus on self-regulation abilities in early childhood since they are precursors to the development of academic achievement.

Other researchers investigated the role of previous academic achievement on self-regulation strategy use and present achievement. Kitsantas et al. (2017) focused on the effects of self-regulation strategies and prior achievement on low-achieving students in mathematics. Participants of this study included 81 fifth-grade students in a public elementary school. Researchers utilized two different scales to assess the application of self-regulation strategies and motivation of participants. Results showed that both self-regulation strategies and prior achievement accounted for a significant amount of variance in current academic achievement as measured by students' GPAs and scores on standardized tests. These results further indicate that self-regulation strategies play an important role in a students' mathematical experiences and success, making it a critical component of primary education.

Ruff and Boes (2014) also conducted an action research study with the intention of gathering data about the effects of a counseling intervention involving students underachieving in mathematics. The primary goal of this study was to evaluate an intervention's effectiveness in order to create new practices to improve student outcomes. The intervention explicitly taught self-regulation strategies to determine the effects and application of these strategies on motivation and achievement in mathematics. This study involved students whose results on various assessments indicated that they possessed high levels of mathematics anxiety and low performance in mathematics ($n = 13$). Additionally, volunteer fifth-grade teachers who had taught mathematics to one or more of the participants in prior years of education, participated in interviews about group effectiveness. Researchers developed a small intervention group with fifth-grade participants that met twice a week for six weeks. Each session was facilitated by a counselor. Researchers utilized post-tests and post-interviews to determine the influence of the intervention on students' attitudes towards mathematics (Ruff & Boes, 2014).

Results showed that participants experienced a decrease in anxiety in mathematics and an increase in mathematics achievement after receiving the intervention. Teacher responses indicated that there was a decrease in stress levels of students after the intervention. There was also an overall increase in participation. These findings suggest that the intervention was moderately effective among the intervention group by increasing confidence and achievement and reducing mathematics anxiety in participants. Since these researchers uncovered a positive relationship between students' use of self-regulation strategies and academic achievement, the studies next described focus on students' motivation.

Sungur (2007) conducted a study involving 391 high school students. The focus of this study was to determine the relationship between students' motivation and use of metacognitive self-regulation strategies and control of effort. Sungur (2007) administered a questionnaire to measure students' motivation, use of metacognitive strategies, and effort. Results indicated students' beliefs about the value of a task, mastery-oriented goals, and self-efficacy are predictors of metacognitive strategy use. Sungur (2007) concluded that students need motivation to effectively use metacognitive strategies and engage in learning. Sungur (2007) suggested that to foster positive motivational beliefs their progress should be emphasized and celebrated. Additionally, they should be provided specific feedback to determine their next steps while also stressing past accomplishments to motivate their progress. If students become motivated to make progress, they are more likely to utilize self-regulation strategies ultimately positively influencing their academic achievement (Blair, Ursache, Greenberg, & Vernon-Feagans, 2015; Kitsantas et al., 2017; Ruff & Boes, 2014; Sungur, 2007)

Similar to Sungur (2007), Cleary and Chen (2009) explored the relationship between self-regulation and motivational beliefs across grade levels. These researchers also set out to recognize the factors that predict students' use of self-regulated behaviors. To meet these objectives, researchers conducted a study in an upper-middle class, suburban school district in the United States. Cleary and Chen recruited 880 participants (468 sixth graders and 412 seventh graders). Cleary and Chen (2009) employed various measures to assess participants' self-regulation. Researchers found that seventh graders showed a more maladaptive, self-regulatory and motivation profile than sixth graders. Additionally, seventh graders differentiated more in both self-regulation and motivation than sixth graders. Moreover, data showed that task interest was a central motivational predictor of regulatory strategies during mathematics across both grades. This finding in particular aligns with Sungur's (2007) finding that task value influenced students' motivation.

The following three studies investigated the role of goal setting in self-regulation strategies. Meece and Miller (2001) sought to understand the change of elementary students' goals in reading and writing from the third to the fifth grade. Researchers were also interested in exploring how these changes impacted students' uses of self-regulation strategies. Results indicated that students who adopted a mastery-oriented goal were more likely to use self-regulation strategies effectively.

Pintrich (2000) was also interested in understanding the relationship between students' goals on motivation and self-regulation strategies. This study involved 150 middle school students. Researchers employed a set of scales measuring these constructs at the beginning and end of participants' eighth-grade year and the beginning of their ninth-grade year. Results of this study showed that students who set mastery-oriented goals were more likely to use self-regulation strategies. Results also indicated that these students had a higher level of self-efficacy than students who were performance goal oriented. Comparably, Kaplan and Midgley (1997) wanted to understand the role of students' perceived competence on their goal orientation and behaviors in middle school. These researchers found that mastery-oriented goals were positively related to adaptive learning behaviors and self-regulation strategies, whereas performance-oriented goals were positively related to maladaptive behaviors.

These studies indicate that self-regulation strategies are critical for goal setting, student motivation, and academic achievement (Kaplan & Midgley, 1997; Meece & Miller, 2001; Pintrich, 2000). It is beneficial for students to learn and apply self-regulation strategies so that they are more likely to put forth effort in the face of challenges. Not only does the use of self-regulation strategies improve academic achievement, but it fosters motivation and effort (Blaire et al., 2015; Cleary & Chen, 2009; Kitsantas et al., 2017; Ruff & Boes, 2014; Sungur, 2007). Also, helping students develop mastery-oriented goals will allow students to interpret learning experiences, failures, and challenges as an opportunity to learn and make growth (Kaplan & Midgley, 1997; Meece & Miller, 2001; Pintrich, 2000).

Mindset Theory and Self-Regulation

There are many similarities between mindset theory and self-regulation theory that complement the problem of practice addressed in this research (Dweck & Leggett, 1988; Schunk & Zimmerman, 1986). Mindset theory focuses on learners' beliefs about their intelligence and the patterns that are a result of that mindset. For example, students who have a fixed mindset tend to frame learning with performance goals (as opposed to learning goals). Mindset theory also focuses on the types of goals students set and how those goals dictate their response to challenges. In comparison, students who have self-regulation skills pursue learning goals and overcome challenges, whereas students who lack these strategies disengage from challenges. It was my hypothesis that developing an innovation that promotes a growth mindset with self-regulation strategies would improve academic growth in mathematics. Mindset theory was applied to identify the mindset and patterns of my participants, whereas self-regulation strategies were utilized to support a shift in mindset ultimately improving academic growth in mathematics.

Implications

With my school's focus on academic growth, I found that instructional and curricular resources have been neglecting psychological development that could ultimately influence academic success. Research has established a correlation between mindset, self-regulation skills, and academic success. Students who have a fixed mindset are more likely to adopt performance goals and attribute their performance to lack of intelligence instead of effort. They are not equipped with the self-regulation strategies necessary to set learning goals and utilize effective strategies to meet and cope with challenges. The existing literature elicits further examination of interventions that develop a growth mindset and the self-regulation skills necessary to self-monitor progress towards learning goals. The reviewed literature illustrates the importance of both self-regulation strategies and growth mindset in academic achievement. I hypothesized that the development of these strategies would help students adopt a growth mindset that would positively affect their growth in mathematics.

Chapter 3

METHOD

The methods for this research project were designed to determine the effect of implementing a growth-mindset and self-regulation innovation, called the *Strength Braining Program,* on academic growth and students' perceptions in mathematics. This chapter focuses on the different aspects of the research methodology while also framing the purpose of the research within the setting. In order to describe the design of the methodology, first, the paradigm applied to the design will be discussed. Next, the characteristics of the design will be described, including the participants, sampling procedures, data collection, instruments, and data analysis.

Setting

This action research took place at an elementary school the Southwestern region of the United States. It is a K-5 school in an Arizona school district. Since I was a fifth-grade teacher, this research took place in two fifth-grade classrooms within the fall semester of the 2019-2020 school year. To fully understand the setting, it is first necessary to describe the structure of the instructional mathematics block.

At the beginning of the 2018-2019 school year, teachers and administrators looked at student data to identify high achieving and gifted students. It was decided that students who were identified as high achieving or gifted would leave their homeroom classroom to go to a classroom with other high achieving or gifted students for the entire mathematics block. Students whose homeroom teacher was designated as the teacher for these high achieving students, but they themselves were not assigned to the high achieving classroom, were equally dispersed among the remaining two fifth-grade teachers who taught grade level mathematics. Of the three fifth-grade teachers, there were two fifth-grade teachers who taught mathematics at grade level and one fifth-grade teacher who taught the compacted (fifth and sixth grade) mathematics class. I am one of the two grade level mathematics teachers in fifth-grade.

Mathematics was the first subject taught in the school day with instruction beginning at 7:40 a.m. On a typical school day, mathematics instruction took place for a total of 100 minutes. In the grade level mathematics classes, the first 40 minutes of the mathematics block was referred to as instructional focus group (IFG) time. During this time, teachers delivered instruction that was individualized to learners' needs. Instruction focused on grade level, below grade level, or above grade level objectives, depending on the groups of students the teacher was working with at the time. To make mathematics IFG more effective, teachers often employed flexible groupings to accommodate students at their level of instruction. To accomplish this, teachers used formative data from teacher-created assessments to determine student groupings. Some low achieving students were identified for tier III support and would leave for intensive intervention with an interventionist or resource teacher. These groupings were fluid, and they changed as students showed growth or were identified for remedial support.

At the conclusion of mathematics IFG block, mathematics core instruction took place for 60 minutes. Mathematics core was typically whole group instruction that taught grade level standards to all students, no matter their academic level. Apart from high achieving or gifted students, students were taught and assessed on grade level objectives.

Teachers organized students in different ways to interact with the content (i.e. small groups, partner work, independent work, whole group etc.). To address the practice effect, the innovation was delivered over the course of two weeks, but then there was an application period of three weeks. The built-in application time allowed students to apply their learnings from the innovation in real time as they progressed through the mathematics curriculum. For this reason, the data collection process took place over the course of multiple mathematical units.

Role of Researcher

I was a fifth-grade teacher at the school in which the research took place. The 2019-2020 school year was my eighth year as an elementary education teacher. I taught fifth-grade for five years and third-grade for two years. As a fifth-grade teacher, I noticed behaviors that were not conducive to learning, particularly in mathematics. These behaviors varied from disengagement and lack of participation to defiance and aggression as a result of frustration. Existing literature suggested that these behaviors could be symptoms of a fixed mindset or lack of self-regulation strategies (Blackwell et al., 2007; Claro et al., 2016; Diener & Dweck, 1978; Dweck & Leggett, 1988; Hong et al., 1999). Additionally, research shows that students who have a fixed mindset are more likely to compare themselves to others (Blackwell et al., 2007; Claro et al., 2016; Diener & Dweck, 1978; Dweck & Leggett, 1988; Hong et al., 1999). I found that this was also true in my classroom. Students who presented with a lack confidence were reluctant to participate for the fear of looking stupid. Students with a fixed mindset were also more susceptible to avoiding challenges with the intention of protecting themselves from the embarrassment of failure (Blackwell et al., 2007; Claro et al., 2016; Diener & Dweck, 1978; Dweck & Leggett, 1988; Hong et al., 1999). These observations prompted me to take on the role of an action researcher and teacher in the classroom. I delivered the Strength Braining Program and collected research data in my own mathematics classroom to explore the effects of the program on students' understandings of mathematical concepts, as well as students' mindsets and use of self-regulation strategies.

Participants

To recruit participants, I sent a recruitment letter home to the parents of my fifth-grade mathematics students in my classroom and my colleague's classroom via hard copy and email (Appendix A). Students who returned the consent form with a parent signature were included in the study's data collection process. Students who did not have parental consent were not included in the data collection process. Students were also given an assent form prior to the collection of the survey data (Appendix B). However, all students participated in the Strength Braining Program unless parents requested an alternative activity. I employed convenience sampling, to acquire my participants (Teddlie & Yu, 2007).

At the end of the 2018-2019 school year, administration and classroom teachers placed students in classrooms for the 2019-2020 school year. In this case, the team (fourth-grade teachers and administration) placed the fourth graders into fifth-grade classrooms. During this time, the team considered academic performance, student demographics, behaviors, individualized plans, and teacher personality with the intention of dividing students equally. Students were assigned to fifth-grade classrooms by administration and fourth-grade teachers, making the samples selected for convenience (Gelo, Braakmann, & Benetka, 2008; Teddlie & Yu, 2007). Because I had access to my mathematics fifth-grade class, with parental consent my mathematics students made up the participants of the experimental group, whereas students in the other fifth-grade level mathematics classroom were the participants in the control group.

Although there were around 35 students in each fifth-grade level class, only some students turned in parental consent to participate in this study. Participants included fifth-graders in grade-level mathematics who had parental consent to participate in this research cycle. I received 32 consent forms from the experimental group and 24 consent forms from the control group. Of those students, 22 students signed the assent forms from the experimental group and 20 students signed the assent form from the control group. I delivered the Strength Braining Program to all fifth-grade students in the two participating classrooms, but I only obtained observational and academic data from the students who had parental consent. I only collected survey data from students who had parental consent and signed the assent form. Although both groups of students received the Strength Braining Program, the control group did not receive the program until after the collection of all data.

An experimental design was applied to address threats to internal validity. Participants were in one of two different groups: the experimental group or the control group. As mentioned before, participants in my mathematics class are considered the experimental group, whereas students in my colleague's mathematics class were considered the control group. During this research, the experimental group received eight lessons of a program called the Strength Braining Program which was designed to develop a growth mindset and self-regulation strategies. The control group did not receive the Strength Braining lessons until after the conclusion of the research cycle.

Strength Braining Program: Phase 1

Phase 1 of the Strength Braining Program was comprised of four lessons that introduced and explained the characteristics of the two different mindsets, fixed and growth. The purpose of this phase was for students to differentiate between the two mindsets so that they could recognize when they had a fixed mindset and to develop an awareness of the triggers that put them into a fixed mindset. This phase also utilized the science around brain plasticity as a way to help students recognize that intellect is not a fixed asset. This understanding was necessary for the success of Phase two. It was crucial for students to believe that developing self-regulation strategies can lead to a growth mindset improving their overall experience and academic growth.

Prior to the delivery of the program, I administered the Mindset Self-Regulation Questionnaire (MSRQ) to participants of both groups in two different sessions. I also administered the Mindset Letter protocol to the experimental group.

Lessons 1 and 2: Growth and fixed mindset. The Strength Braining Program that I designed to address the problem of practice consisted of eight, research-based, 45-minute lessons taught in the morning over a span of two weeks. Instruction occurred on Monday, Tuesday, Thursday, and Friday since Wednesdays are early release days. The supporting materials of the Strength Braining Program can be found in Appendix E. The Strength Braining Program was informed by existing literature on students' mindsets and use of self-regulation strategies. This program consisted of two phases. The first phase was comprised of four lessons focused on mindsets. The first two lessons began with defining and operationalizing a fixed mindset and growth mindset in student-friendly terms (Yeager & Dweck, 2012). To define these terms, students were explicitly taught the difference between the two mindsets. Additionally, the lessons connected real-life examples to each mindset so that students could connect their experiences with each way of thinking. Afterwards students identified their fixed mindset triggers and recorded them in their Strength Braining journals. Once students recorded their triggers, they gave their fixed mindset a persona by giving it a name and description in the fixed mindset profile worksheet (Appendix E). The closure of these lessons included role-playing and dialogue to practice and solidify these concepts in simulated situations.

Lesson 3: Brain plasticity. In the third lesson, I provided students with scientific evidence that supported brain plasticity via a video explaining neurons in kid-friendly terms. Students watched a three-minute video from Khan Academy (2018) on the brain's plasticity including explanations of how engaging in challenges allows the brain to make new neuro pathways, strengthening it like a muscle. Students watched the video three times. First, they watched the video all the way through without stopping. Second, they watched the video and took notes on the content in their Strength Braining journals. After watching the video for the third time, students shared the main ideas with a partner and added anything new to their notes. Lastly, they reflected on how the video made them feel about challenges and learning new things.

Lesson 4: Talk the talk and walk the walk. The last lesson of the first phase focused on developing a language that promoted a growth mindset. In this lesson, I discussed the steps that students could take when they recognized that they had a fixed mindset. The steps presented were as follows: first, they considered past successes that could negate their ideas about intelligence as a fixed asset. Second, they considered what specifically triggered their fixed mindset. Third, they changed what they told themselves. Last, students considered strategies to help them change their mindset. I provided the class with a relevant, fixed mindset situation and modeled my thinking as I progressed through the steps. In small groups, students then interacted with the steps. Each group was given a situation in which to respond. Students demonstrated their application of this process to the situation on a poster. As closure, I introduced the Strength Braining bulletin board in the classroom. I explained to the class that the board would be used to highlight students who exhibited a growth mindset, I made sure to carefully distinguish between a growth mindset and academic growth. The purpose of the bulletin board was to showcase students who engaged in a challenge and used failure as a learning opportunity. My intention was to shift the classroom culture to recognize and honor adaptive responses to failure instead of fearing it. This new approach to learning gave students the opportunity to see their struggles as possibilities rather than faults. The purpose was to make students less likely to be defiant or disengage from a learning experience when encountering a difficult problem. To conclude this lesson, students watched a three-minute episode of a Growth Mindset series, produced by ClassDojo

(2016). This series followed a character named Mojo who realized that a growth mindset was not conducive to learning new things.

Strength Braining Program: Phase 2

The second phase of the Strength Braining Program was designed to help students develop self-regulation strategies that encouraged a growth mindset to set and progress towards goals. In this phase, students were explicitly taught self-regulation strategies such as goal-setting, self-monitoring, and seeking help (Kitsantas et al., 2017; Ruff & Boes, 2014; Yowell & Smylie, 1999; Zimmerman, 1986). The lessons were designed to help students understand the strategy and guide them through the application of these strategies when students faced challenges.

Lesson 5: Goal setting. In this lesson students learned the difference between a performance goal and a learning goal. Through modeling and discussion, students read goals and student profiles to classify them into two categories, learning and performance. Additionally, the class discussed the outcomes of each type of goal. Then student watched and took notes on a three-minute video from Kahn Academy (2018) that outlined how to set goals that were specific, measurable, actionable, realistic, and timely. Students then set individual learning goals in mathematics in their Strength Braining journals. This lesson concluded with Episode 4 of ClassDojo's (2016) Growth Mindset series, which discussed brain plasticity. The ClassDojo (2016) lessons were utilized to reinforce already learned material through the program.

Lesson 6: Self-monitoring. The purpose of this lesson was to explicitly teach students how to track and interpret their progress on their goals. Since the key differentiation between a learning goal and performance goal is the way students think about their progress, this lesson focused on improvement and growth rather than competence or ability. During this lesson, students developed action steps that they believed were stepping stones to reaching their goal. I provided students with an example and modeled the development of actions steps aligned to an example goal. After this lesson, students had the opportunity to reflect on their action steps after each mathematics lesson. At the end of this lesson, students reflected on their goals and their mindset in their Strength Braining journals. This lesson concluded with Episode 2 of ClassDojo's (2016) Growth Mindset series which discussed making mistakes.

Lesson 7: Seeking help. This lesson was designed to help students develop strategies to identify when they needed help and what resources they could use to obtain that help. The class discussed how to identify when they needed help with a mathematics problem. In groups, students then brainstormed resources that they could use when they were stuck on a problem. After groups had a chance to record their ideas, the class shared ideas to make a master list of resources. This list was then displayed on the mindset bulletin board for students to reference during mathematics. This lesson concluded with Episode 3 of ClassDojo's (2016) Growth Mindset series, which discussed seeking help and positive self-talk.

Lesson 8: Putting it all together. This lesson reviewed the previous lessons and focused on applying the learning from the lessons to everyday learning. In order to accomplish this, students created a thinking map outlining the steps, strategies, and resources available to them when they were stuck. The intention of this map was to serve as a reference for students to develop metacognitive awareness and a growth mindset. Students were then placed in teams to complete an escape the room activity. The purpose of this activity was for students to apply their learnings to the challenges they faced in the activity. This lesson concluded with the final episode of ClassDojo's (2016) Growth Mindset Series. In this episode, the main character applied his learnings from previous episodes to his life.

Throughout Phase two, I continued to utilize the interactive growth mindset bulletin board. The board served as a reference and a reminder of the Strength Braining lessons, but it also recognized one student each week who met a challenge with resilience and effort, further supporting a growth mindset and self-regulatory climate in the classroom.

Instruments and Data Collection

Mathematics Growth Test

Quantitative data, in the form of mathematics growth test data (MGT), was collected to inform me of students' academic growth prior to the Strength Braining Program and then again after the program's application period. Both the control group's teacher and I administered an online diagnostic mathematics test created by the *Ready Mathematics* resource that was adopted for the 2019-2020 school year (Curriculum Associates, 2019). The Ready Mathematics diagnostic was designed to give students questions from each of the mathematics domains, to assess their level of mastery within each domain. When a student got a question correct or incorrect, the diagnostic path would alter to determine their academic level in each domain. The diagnostic was an online assessment that took between 45 and 120 minutes for students to complete. After the diagnostic, students were administered a growth check at the end of September 2019 that was designed to assess students' progress in each domain. The diagnostic was administered to the experimental and control group as a pre-test in early August. After the Strength Braining Program and the application period, both groups took a growth check as a post-test. The purpose of the growth check was to determine the amount of growth each student made since the diagnostic assessment. This quantitative data addressed research question one: *To what degree does participation in a growth mindset program affect fifth-grade students' understanding of mathematical concepts?* I administered the diagnostic test to both groups with the intention of analyzing student academic growth in mathematics. The pre-test was administered the week before the Strength Braining Program began. The post-test was administered six weeks after the pre-test. To compare students' change in mathematics growth, I utilized a Wilcoxon signed-rank test.

The Mindset and Self-Regulation Questionnaire

In addition, I administered the Mindset and Self-Regulation Questionnaire (MSRQ) which I created from two existing questionnaires. This questionnaire was comprised of 26 Likert-scale items that were designed to help understand students' mindsets and use of self-regulation strategies prior to the Strength Braining Program. This questionnaire was adapted from two previously established questionnaires, the Self-Regulation Formative Questionnaire and Dweck's Mindset Questionnaire (Erickson & Noonan, 2018). This questionnaire measured four constructs addressed by the Strength

Braining Program. The first three constructs addressed in the questionnaire pertain to self-regulation strategies. The first construct is *self-monitoring*. These six items focused on students' ability to keep track of their progress in mathematics. For example, one item read "I track my progress towards my goals in math." The second construct related to self-regulation was *seeking help*. These six items were meant to determine students' ability to utilize the resources around them when they were struggling. For example, one item read "As soon as I see things aren't going right in math, I ask for help." The last construct assessed in self-regulation was *goal setting*. These six items focused on students' ability to set attainable goals in mathematics. For example, one item read "I think about how well I am doing on math problems to set goals." The last construct addressed in the questionnaire was *mindset*. These eight items were intended to determine whether the participant had a growth or fixed mindset in mathematics by asking students to rate their level of agreement with statements like "You have a certain amount of intelligence in math, and really can't do much to change it."

After the Strength Braining Program was delivered, I administered the Mindset and Self-Regulation Questionnaire again as a post-assessment with the addition of six new items focused on students' *attitudes towards the innovation*. Only students in the experimental group were asked to answer the *attitudes towards the innovation* post-test questions. Since items on this questionnaire were grouped by construct (*self-monitoring, seeking help, goal setting, mindset* and *attitudes towards innovation*). I looked at each construct for the purpose of data analysis. I discuss this analysis in more detail in the data analysis section of this chapter. The intention of the post-MSRQ was to determine the *mindset* and *self-regulation* differences between groups, as well as the experimental students' opinions about the Strength Braining Program. I collected the results of the pre-MSRQ (Appendix C) from both groups to address research questions two, three, and four: *How, and to what extent, does participation in a growth mindset program affect students' mindsets? How, and to what extent, does participation in a growth mindset program affect students' use of self-regulation strategies? What were participants'' attitudes towards the Strength Braining Program?*

Mindset Letter

In order for me to effectively understand my problem of practice, I prompted participants to share their perceptions of intelligence in their own words. I collected a form of qualitative data in which students wrote a *Mindset Letter* in response to a simulated situation. At the beginning and end of the Strength Braining Program, students were presented with a simulated situation wherein there was a second grader who I ran into after school one day. I told my students that this second-grade student was crying and explaining to me that she thought she was stupid because she could not do her mathematics homework due tomorrow since she did not understand it. I asked students to write a letter to the second grader in response to the challenge she was facing. After the program, I presented the class with the same situation and asked them to rewrite their letter, considering everything that they have learned in the Strength Braining lessons. This data was analyzed to answer research questions two and three. I will refer to these letters as the Mindset Letters. The protocol can be accessed in Appendix D.

Observations

Throughout the Strength Braining Program and the application period, I conducted semi-structured observations. These semi-structured observations gave me the opportunity to not only attend to various events occurring simultaneously, but to also shift my focus as different interactions arose (Mertler, 2014). I observed consented participants in the experimental group during mathematics instruction. The purpose of these observations was to observe students' application of the Strength Braining Program's components in real time. This included students' responses to challenges and use of self-regulation strategies. This form of qualitative data illustrated the effectiveness of the program on students' learning process and disposition towards mistakes and challenges by documenting students' verbal and nonverbal reactions. Additionally, this allowed me to gather data that documented students' behaviors, some of which students may not have been able to report themselves (Mertler, 2014). To document these observations, a field note journal that had two columns, field notes and comments was kept. Field notes were written observations of what was happening in the classroom. The comments column of the journal included initial interpretations of the observations.

Data Analysis

Quantitative Analysis

First, I collected the pre-MGT and the pre-MSRQ from both groups to explore the correlations between student academic growth and the MSRQ constructs: (1) *self-monitoring*, (2) *seeking help*, (3) *goal setting*, (4) *mindset*. I accomplished this by calculating Spearman's correlation coefficients (p-values) which allowed me to determine the strength of correlations between student academic growth and the four constructs.

To further analyze the data from the pre- and post-MSRQ, I calculated the means of the four constructs: (1) *self-monitoring*, (2) *seeking help*, (3) *goal setting*, (4) *mindset* for both groups. For the experimental group, the mean for the construct *attitudes towards the innovation* was also calculated. To understand the effectiveness of the Strength Braining Program, I applied the Mann-Whitney U test to assess differences between the experimental and control groups. First, I examined changes in mathematics academic growth, as measured by pre- to post-MGT scores. Next, I examined changes in the four main constructs of the MSRQ, from pre- to post-assessment. Results of the Mann-Whitney U test allowed me to understand the influence of the program on the experimental groups' mindset, goal setting, self-monitoring, and seeking help in comparison to the control group.

Qualitative Analysis

Students' Mindset Letters provided me with qualitative data to illustrate the findings of this study with students' perspectives. To analyze data from the Mindset Letters, I employed *inductive coding* (Saldaña, 2015). I chose to employ this approach because it was a method that included students' actual words to enhance my understanding of the data. I collected and coded students' Mindset Letters with words and phrases found in the letters to better understand the effects of the Strength Braining Program on students' mindsets and use of self-regulation strategies. As part of the coding process, the Mindset Letter data was categorized using a constant comparative method

(Ivankova, 2014). This process utilized the assignment of codes that were then categorized into larger themes by comparing segments. I created a qualitative codebook providing a systematic approach to categorizing codes into larger themes.

Similarly to the Mindset Letter coding process, I utilized a similar process when coding observational data. After keeping a field note journal over the course of six consecutive weeks, I had an enormous amount of data making inductive analysis an effective approach to reducing the amount of data. I accomplished this by creating a coding scheme to guide the categorization of patterns and themes that emerged from the collected observational data by identifying words and phrases that indicated particular actions or observations (Mertler, 2014).

To ensure the quality of the qualitative data, I employed member checking as a means of verifying the accuracy of my representation of participants' ideas (Mertler, 2014). I shared my observations, comments, and analysis with participants in an effort to verify my assertions from the collected data. This procedure, in combination with prolonged engagement and persistent observation, allowed me to gain participants' trust and understand the classroom culture to accurately represent their ideas in my analysis (Mertler, 2014).

Threats to Validity

Smith and Glass (1987) assert that maturation is a threat to internal validity. Maturation has to do with the natural progress of psychological development (Smith & Glass, 1987). Students in both the control and experimental groups made academic gains; however, comparing two student groups in the same grade-level allowed me to more effectively isolate the independent variable of the program. Another possible threat to internal validity is the practice effect. The practice effect occurs when participants become more familiar with a measure because they have been exposed to the measure in the pre-test administration. Students had a form of practice with the measure during the pre-test making it more familiar during the post-test administration. This level of familiarity could be a threat to the internal validity of the measure (Smith & Glass, 1987). To address the practice effect of the pre- and post-assessments, the Strength Braining Program was delivered over the course of two weeks, but the post-assessments were not administered until five weeks after the administration of the pre-tests.

Chapter 4

DATA ANALYSIS AND RESULTS

> Mindset change is not about picking up a few pointers here and there. It's about seeing things in a new way. When people change to a growth mindset, they change from a judge-and-be-judged framework to a learn-and-help-learn framework.
>
> — Carol Dweck, *Mindset: The New Psychology of Success*

The first set of goals this action research study addressed focused on effects of the growth mindset and self-regulation innovation, the Strength Braining Program, on students' (a) understanding of mathematical concepts, (b) mindsets, and (c) use of self-regulation strategies. Additionally, this study explored participants' attitudes towards the Strength Braining Program. In this chapter, results of the measures used to understand these effects are presented by addressing the four research questions sequentially.

Effects on Students' Understanding of Mathematical Concepts (RQ1)

To investigate the effects of the Strength Braining Program on students' academic growth, mathematics growth data were collected from the experimental and control groups before and after the implementation of the Strength Braining Program. These data were used to answer research question one: *To what degree does participation in a growth mindset program affect fifth-graders' understanding of mathematical concepts?* To address this question, results from the Mathematics Growth Test (MGT) were examined.

Mathematics Growth Test (MGT)

Both the experimental and control group completed the MGT prior to the Strength Braining Program, and then again five weeks later at the end of the research cycle. Tests of normality were utilized to determine the types of statistical tests that would be run to explore the data further. Results indicated data were not normal. Therefore, nonparametric tests were applied including the Mann-Whitney U test and the Wilcoxon signed-rank test. To determine if the experimental and control groups were equivalent at the onset, A Mann-Whitney U test was applied to the pre-MGT data. Results showed there was no significant difference between the two groups of participants ($p = .425$).

Table 1 shows the MGT scores of the experimental and control groups. Wilcoxon signed-rank test results showed both groups of students made statistically significant growth, as measured by the MGT ($p < .05$). The experimental group's mean increased by 21.3 points ($p < .001$) and the control group's mean increased by 15.9 points ($p = .011$) as displayed in Table 1. A Mann-Whitney U test was applied to the MGT post-data to determine if the groups were statistically different after the experimental group participated in the Strength Braining Program. Results showed that the two groups remained statistically the same ($p =.382$) indicating that the Strength Braining Program had no effect on students' understanding of mathematical concepts.

Table 1

Mathematics Growth Test Results

	Experimental Group (n = 18)			Control Group (n = 14)		
	Pre	Post	Change	Pre	Post	Change
Mean	459.6	480.9	21.3	456.6	472.5	15.9
SD	26.2	15.9	-	14.5	24.3	-
p	-	-	< .001	-	-	.011

Summary of RQ1 Results

Although growth on the MGT was statistically significant for both groups, results did not indicate math achievement was positively affected by participating in the Strength Braining Program. Although the experimental group's post-MGT mean was higher than the control group's post-MGT mean, the difference was not statistically significant.

Effects of Growth Mindset Program on Mindsets (RQ2)

To determine the effects of the Strength Braining Program on students' mindsets, quantitative and qualitative data were collected using the MSRQ, Mindset Letters, and observations. These data were employed to answer research question two: *How, and to what extent, does participation in a growth mindset program affect students' mindsets?*

Mindset and Self-Regulation Questionnaire (MSRQ)

The MSRQ consisted of four constructs; *mindset*, *seeking help*, *self-monitoring*, and *goal-setting*. To address research question two, the *mindset* construct was analyzed. Within the *mindset* construct, there were four growth mindset items, and four fixed mindset items. The mean per item scores for the *mindset* construct were calculated. Participants recorded their level of agreement with six-point Likert scale items, from *strongly disagree* (1) to *strongly agree* (6). To interpret the results, growth mindset statements were coded to match the Likert scale (i.e., a *strongly agree* equated to a 6). However, fixed mindset statements were reverse coded (i.e., a *strongly disagree* equated to a 6).

Table 2 presents mean per item and standard deviation statistics of the *mindset* construct, which consisted of eight items, for the control and experimental groups' pre- and post-MSRQ. A Mann-Whitney U test was conducted to determine if there was a significant difference between the control and experimental groups' pre-MSRQ results for the *mindset* construct. There was no significant difference between the groups' pre-MSRQ *mindset* scores (p = .576).

As displayed in Table 2, the calculated mean per item scores of the experimental and control groups were similar on the pre-MSRQ within the *mindset* construct. Both groups' means were between *agree* and *slightly agree*. The control group's mean per item score for the *mindset* construct items did not significantly change from the pre- to post-MSRQ (p = .476). However, the experimental group's mean per item mindset score decreased from 4.2 to 3.8 from pre- to post-MSRQ (p = .012). Possible reasons for the experimental group's decrease will be discussed in Chapter 5.

Table 2

Mindset and Self-Regulation Questionnaire Results for the Mindset Construct

	Experimental			Control		
	N	Mean Per Item	Std. Dev.	N	Mean Per Item	Std. Dev.
Pre-Test	21	4.2	.58	17	4.4	.77
Post-Test	20	3.8	.35	17	4.2	.69
p		.012			.476	

Note: Likert-scale rated from 1 (*strongly disagree*) to 6 (*strongly agree*)

In addition to calculating the descriptive statistics for the pre- and post-MSRQ *mindset* items, the percentage of students who selected each Likert response was also recorded. The six different responses were collapsed into three categories: *strongly agree* and *agree*, *slightly agree* and *slightly disagree*, and *disagree* and *strongly disagree*. Participants' responses are indicated as percentages in Table 3. Considering these data, it seems that a larger percentage of the experimental participants reported to *strongly agree* or *agree* with growth mindset statements and *disagree* or *strongly disagree* with the fixed mindset statements on the post-MSRQ than on the pre-MSRQ.

The interpretation of the percentages appears to contradict the findings in Table 2, which indicates that the experimental group was less likely to *strongly agree* or *agree* with growth mindset statements on the post-MSRQ than the pre-MSRQ. This seeming contradiction prompted me to run a series of Wilcoxon signed-rank tests for both groups for each *mindset* item. Results indicated there was no statistically significant difference for any of the control groups' *mindset* items when comparing the pre-MSRQ items to the post-MSRQ items ($p > .05$). This aligns with the findings in Table 2. Four of the eight *mindset* items for the experimental group indicated a statistically significant decrease from pre- to post-MSRQ ($p < .05$). These items were most likely responsible for the outputs displayed in Table 2, showing a statistically significant decrease in the experimental groups' mean per item score from the pre- to post-MSRQ in *mindset*. The contradiction in Table 3 could be a result of collapsing the different responses, ultimately hiding details that explain the data. In other words, although the percentages of students in the experimental group who *strongly agreed* or *agreed* with growth mindset statements appear to increase from the pre- to post-MSRQ, a series of Wilcoxon signed-rank test suggest that the Strength Braining Program had a negative effect on students' mindsets.

Table 3

Student Responses to Mindset Items of MSRQ in Percentages

	Experimental Group Percentages						Control Group Percentages					
	StA/A		SlA/SlD		D/StD		StA/A		SlA/SlD		D/StD	
Items Truncated	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Growth Mindset Statements												
No matter who you are, you can significantly change your intelligence	81.0	85.7	19.0	14.3	0.0	0.0	78.9	82.4	21.1	17.6	0.0	0.0
You can always substantially change how intelligent you are	71.4	81.0	19.0	19.0	9.5	0.0	35.2	82.4	10.5	11.8	5.3	5.9
No matter how much intelligence you have in math, you can always change it	61.9	81.0	33.3	19.0	4.8	0.0	73.7	64.7	26.3	35.3	0.0	0.0
You can change even your basic intelligence	66.7	90.5	28.6	0.0	4.8	9.5	57.9	76.5	36.8	23.5	5.3	0.0
Fixed Mindset Statements												
You have a certain amount of intelligence, and you really can't do much to change	33.3	9.5	52.4	28.6	14.3	61.9	47.4	29.4	31.6	29.4	21.1	41.2
Your intelligence in math is something about you that you can't change	52.4	9.5	33.3	14.3	14.3	76.2	42.1	29.4	36.8	23.5	21.1	47.1
To be honest, you can't really change how intelligent you are	23.8	9.5	23.8	23.8	52.4	66.7	29.4	29.4	17.6	11.8	52.9	58.8
You can learn new things, but you can't change your basic intelligence	19.0	14.3	42.9	28.6	38.1	57.1	47.4	35.3	31.6	17.6	21.1	47.1

Note: StA=*Strongly Agree*, A=*Agree*, SlA=*Slightly Agree*, SlD=*Slightly Disagree,* D=*Disagree,* StD=*Strongly Disagree*

Mindset Letters

Prior to the Strength Braining Program, experimental group participants responded to a prompt and wrote a Mindset Letter. The prompt presented a fictitious second grader who believed she was stupid because she did not understand her mathematics homework. Students in the experimental group wrote a letter to this student, providing her with advice. Students wrote one letter before the Strength Braining Program and another letter five weeks later, after the Strength Braining Program. To confirm my interpretations of students' statements in the Mindset Letters, member checking was applied. After coding the data, I met with some students to share my interpretations of their letters to validate the conclusions drawn from their written words.

An inductive coding process was used to compare and categorize students' ideas into larger key ideas. This method provided a systematic approach to coding and categorizing students' key ideas for analysis. Table 4 displays the number of letters that contained key ideas related to the *mindset* construct in the pre- and post-Mindset Letters. Neither the pre- nor post-Mindset Letters contained any *fixed mindset* statements. However, the effects of the Strength Braining Program can be seen in the frequency of *growth mindset* key ideas from the pre- to post- Mindset Letters. In other words, although there is not a clear contrast of ideas represented in the pre- to post- Mindset letters (i.e. fixed mindset statements versus growth mindset statements), the frequency of which students mention growth mindset key ideas increased after the Strength Braining Program. Four key ideas emerged from the inductive coding process: *positive self-talk, effort, intelligence is flexible,* and *growth mindset* to answer research question two.

Table 4

Number of Letters Containing Mindset Ideas of the 26 Pre/Post Mindset Letters

Key Idea	Pre-Intervention Letters	Post-Intervention Letters
Positive self-talk	6	15
Effort	10	20
Intelligence is flexible	3	7
Growth mindset	1	9

Positive self-talk. The Strength Braining Program encourages students to utilize *positive self-talk* when facing a challenge. This behavior is reflective of a growth mindset. In the post-Mindset Letters, *positive self-talk* was mentioned in 15 of the students' letters. In comparison, only six students mentioned *positive self-talk* in their pre-Mindset Letters. On the post-Mindset Letters, one student indicated that saying positive things to one's self when facing a problem can help overcome challenges. He wrote:

> When I get stuck I leave and get a snack and the come back and try the problem again. And if that doesn't help then I start saying positive things to myself like you got this you can do it.

Other students demonstrated advocacy for *positive self-talk* when writing the following in their post-Mindset Letters: "Don't say that you are stupid because you are not. You just don't get it YET!" and "Don't say that you are stupid. Just say positive things to yourself." On the post-letters, students were more apt to acknowledge that the second grader did not get it *yet*, but they reassured her that through effort and continued practice, it was possible for her to understand the homework. These data suggest the Strength

Braining Program explicitly taught students to utilize *positive self-talk* when in a fixed mindset (i.e., giving up, feeling inadequate, etc.). Since the second grader felt stupid, students encouraged her to say things like "you can do it," "you just don't get it YET," and "say positive things to yourself." These students identified that the second grader was in a fixed mindset and *positive self-talk* was one coping strategy that they believed could help her think with a growth mindset.

Other students utilized growth mindset mantras to encourage positivity. For example, one student concluded his post-Mindset Letter by stating, "You can do this conquer your fear." In another post-Mindset Letter, a student included a daily mantra as her favorite quote by writing: "My fav quote is Failure is the key to success." As a part of the Strength Braining Program, every mathematics lesson began with a growth mindset mantra. Students were taught to utilize the daily mantras when they faced a challenging problem in mathematics. Students mentioning these mantras in their post-Mindset Letters implies that their use of these mantras positively affected their mindsets in mathematics. All of these statements indicate that students who participated in the Strength Braining Program utilized *positive self-talk* to navigate mathematical challenges indicating a growth mindset. Although the pre-Mindset Letters did not include statements that encouraged negative self-talk, the frequency of *positive self-talk* statements increased from six students to 15 students, after the implementation of the program. This indicates that the Strength Braining Program fostered a growth mindset through the utilization of *positive self-talk*.

Effort. The idea of *effort* was comprised of two key sub-ideas: *learning from mistakes* and *resilience*. Twenty students mentioned *effort* in their post-Mindset Letters, while only 10 students wrote about *effort* in their pre-Mindset Letters. This increase suggests that the Strength Braining Program encouraged students to consider *effort* when approaching a challenge. On one student's post-Mindset Letter, she said that making mistakes was evidence of *effort* by writing, "Mistakes mean that you are trying." The Strength Braining Program incorporated multiple discussions about *effort* and mistakes. When participants expressed their belief that mistakes were positive in the post-Mindset Letters by writing "even if you make mistakes it is okay," it could be inferred that they approached challenges with a growth mindset. Viewing mistakes as evidence of *effort* signifies that participants believed making mistakes and learning from them was an important part of a learning experience. This belief is an indication of a growth mindset.

Furthermore, many students encouraged resilience in the face of a challenge in their post-Mindset Letters. For example, one student wrote, "Don't give up. If you give up you will never get it." Another student indicated that being resilient can pay off by making the following declaration in her post-Mindset Letter:

> It doesn't matter if you get the answer right it only matters that you put 100% of your effort into it. And it only matters that at least you tried your hardest and your best. All you have to do is try that's all that matters. So try your best.

The fact that these participants encouraged the second grader to not give up and to try her hardest supports the ideas taught in the Strength Braining Program. A large component of the program explicitly taught students that struggling through a challenge makes the brain grow. These participants believed that through continued *effort* in the face of a challenge, the brain would grow, and it would get easier, which is an attribute of a growth mindset. These comments accentuate the belief that intelligence is not innate, but a characteristic that is malleable by learning from mistakes and resilience, further indicating a growth mindset. The impact of the Strength Braining Program on students' perspective of *effort* is seen in the number of students who used *effort* to encourage the second-grader on the post-Mindset Letters. Twenty out of the 26 post-Mindset Letters mentioned *effort* as a response to the second grader's challenge. Only 10 of the pre-Mindset Letters mentioned *effort*.

Intelligence is flexible. This key idea represents the awareness that intelligence is not fixed, but a characteristic that is flexible. One student's statement in their post-Mindset Letter said, "You are not stupid no one is." This accentuates the belief that one can learn something that is challenging. Two more examples of this belief are represented in post-Mindset Letters with these statements: "[not understanding a mathematical concept] does not mean that you are stupid. That means that you are trying and growing," and "struggle helps your brain grow." These students do not believe that intelligence is a fixed characteristic but something that is within their control to change. When students expressed ideas that *intelligence is flexible*, they showed characteristics of a growth mindset. Saying that no one is stupid suggests that this participant had a growth mindset after the Strength Braining Program because he believed that people could learn new concepts. Only three pre-Mindset Letters mentioned the key idea that *intelligence is flexible,* but seven of the post-Mindset Letters did. This increase was less than the other key ideas represented in the Mindset Letters, but the difference indicates that more students believe that intelligence is flexible after the Strength Braining Program. Understanding that *intelligence is flexible* can help learners make sense of difficult mathematical concepts as well as foster a growth mindset.

Growth mindset. *Growth mindset* is the idea that one can improve their intelligence. On the other hand, a fixed mindset is the belief that one cannot improve their intelligence. Student sentences in post-Mindset Letters read, "Tell your fixed mindset to get out of here," and "it is bad to have a fixed mindset. Tell your fixed mindset to leave." These statements suggest that students connected giving up or saying negative things, with a fixed mindset. One lesson in the Strength Braining Program had students assign their fixed mindsets a persona. Afterwards, when students felt that they were in a fixed mindset, they practiced strategies to make their fixed mindset leave. These students recognized that the second grader was in a fixed mindset and encouraged her to apply strategies to make her fixed mindset leave, indicating a growth mindset and the application of their learnings from the Strength Braining Program.

Another part of this key idea included brain plasticity which is the belief that repetition, and practice can change the brain and grow new neuro pathways, making one smarter. Some students mentioned ideas of brain plasticity by saying "Your brain is like a muscle the more you work hard the smarter you will be," and "Connect all of your neurons together to get smarter." These notions were introduced in the Strength Braining Program to help students understand how the brain grows. Lessons in the program explicitly taught students about the brain to encourage a growth mindset. The fact that these students incorporated ideas of brain plasticity implies their belief that the brain grows like a muscle suggesting that the Strength Braining Program positively affected students' mindsets. As displayed in Table 4, *growth mindset* was mentioned in one pre-Mindset letter. In comparison, *growth mindset* was mentioned in nine post-Mindset Letters. This increase indicates that students were more aware of the mindsets after the

Strength Braining Program. Additionally, this increase suggests that participants may be more likely to approach a challenge with a *growth mindset* after the implementation of the Strength Braining Program.

Observations

Throughout the Strength Braining Program, observational field notes were collected. These observations included students' behaviors and their application of the concepts introduced in the Strength Braining Program. Observational data were collected a few days prior to the Strength Braining Program, during the two-week implementation period and throughout the three-week application period. Field notes were taken throughout mathematics instructional focus groups and core instructional time. Using inductive coding, the observational data were sorted into codes and then categorized into larger behavior patterns. After coding the field notes, four mindset-related behavior patterns emerged: *effort*, *response to mistakes*, *attitudes towards mathematics*, and *self-talk*. To confirm my conclusions, I employed member checking when appropriate. The changes of these behavior patterns are displayed in Table 5. This table includes the emerging behavior patterns that changed over the course of the program, observational data that illustrates that change in behavior pattern, and my assertions derived from the changes in behavior.

Table 5

Observed Changes in Mindset Behavior Patterns

Observed Changes in Behavior Patterns	Observations	Assertions
Effort	Trying different mathematical strategies Attending review sessions Active working Productive conversations Requests challenges	Students were more willing to put in effort towards their mathematics by the end of the program suggesting that they have a growth mindset.
Response to Mistakes	Identification of mistake Sharing mistake Learning from mistakes	Students were willing to identify, share, and learn from their mistakes suggesting that they have a growth mindset.
Attitude Towards Mathematics	Positivity Motivation	Students who are motivated and approach mathematics with positivity are more likely to have a growth mindset.
Self-Talk	Positive affirmations Power of yet Pride in work Use of mantras	By the end of the program lessons, students were verbalizing positive affirmations and taking pride in their work suggesting a growth mindset.
Response to Challenges	Attempts difficult problems Asks for difficult problems	Some students were more willing to attempt difficult mathematics problems after the program, indicating a growth mindset.

Effort. While collecting field notes prior to the implementation of the Strength Braining Program, lack of *effort* was a concern. Behaviors such as fidgeting during instruction and leaving problems blank were common. It was evident that some students did not apply *effort* when they faced a challenging mathematical problem. For example, multiple students doodled on their papers instead of actively solving a mathematics problem.

However, during the implementation of the Strength Braining Program and afterwards, the observed behaviors pattern shifted and included active participation which seemed to represent a drive to get better. For example, on one occasion a student attempted to solve a volume-related mathematics problem and started by labeling and writing down the formula for volume. This approach indicated the student was activating their knowledge of volume and actively working on making sense of the dimensions. This student never reached an answer, but he worked on it for the duration of the allotted five minutes, demonstrating resilience and a growth mindset.

Additionally, there was increased participation in review sessions after the Strength Braining Program. During instructional focus groups, review sessions were held for students who believed they needed additional support with difficult mathematical concepts. Prior to the lessons, the review group was comprised of one or two students; however, at the end of the Strength Braining Program, review sessions grew to 10 to 12 students. This increase of participation suggests that students were more willing to put in *effort* to understand mathematical concepts even when they could have been participating in a computer or game station. Students' attendance after the program also indicates that they believed that although they were struggling with the concept, they could learn the concept with practice, showing a growth mindset. These observations support the conclusion that the Strength Braining Program helped motivate students to put forth *effort* in mathematics because they believed that *effort* would help them succeed, indicating growth mindsets.

Response to mistakes. One characteristic of a growth mindset is responding to mistakes with resilience. Resilience is defined as a positive response to an academic challenge that develops mathematical skills. Before the implementation of the Strength Braining Program, many students did not make mistakes because they did not try the problems. It was clear that when students were asked to work on a problem, many students would just stare at the problem and not write anything down. This behavior aligns with a profile of a student with a fixed mindset. It is possible some students did not attempt mathematics problems to attribute their failure to lack of effort. Moreover, at the beginning of the program, students who made mistakes were oftentimes not forthcoming about their thinking. For example, during mathematics after the second Strength Braining lesson, one student made a mistake in one of the first steps of a problem. When asked how he arrived at his answer, he responded with a curt "I don't know". Body language, including covering his paper and looking around at his peers, while being talked to, suggested he was uncomfortable with the attention to his mistake. In this situation, there were a couple of behaviors that indicate a fixed mindset. First, when asked how he calculated the numbers he wrote down, he was unable to explain his work. Additionally, covering up his paper and looking around suggested he was embarrassed he did not know how to solve the problem. This behavior implied he had a fixed mindset, which oftentimes prompts students to compare their ability to their peers. This is an example of a negative response to a mistake, indicating a fixed mindset. The behavior was common prior to the program.

After the Strength Braining Program, when students made mistakes, many were willing to share their mistakes with the class. For example, after the program, one student explained what he did wrong while solving a multiplication problem by saying, “I see my mistake. I multiplied my carry over instead of adding it.” On another day after the program, one student shared, “I accidentally misread the problem. That is why I got it wrong.” When learning volume in the middle of the program, one student stated that the most confusing part of volume was finding the missing dimensions. After the student said this, eight students in the class showed their agreement with this comment by using a hand signal. Sharing mistakes in front of the class suggested that these students did not associate mistakes or not understanding a concept with their overall intelligence. These observations further indicated that students were trying to understand their mistakes demonstrating a growth mindset. The observations after the Strength Braining Program illustrate the change in students’ behavior patterns from the beginning of the program to after. Many students went from being ashamed of their mistakes to learning from them and sharing their growth with the class. These displays of a positive response to mistakes indicates a growth mindset.

Attitude towards mathematics. Students’ *attitudes towards mathematics* shifted noticeably after the Strength Braining Program. At the beginning of the Strength Braining Program, many students expressed their distaste for mathematics. When asked to get out materials prior to the Strength Braining Program, many students would moan or even put their heads on their desks. Moaning or putting their heads down showed that they were not motivated to approach a challenge. One student even commented, "When I get mad about a problem, I want to put my head down and flip my desk." This comment and these actions suggest that these students were frustrated by mathematics and tended to give up rather than exhibit resilience when challenged. Furthermore, these behaviors not only indicate that some students had a negative disposition towards mathematics, but that they also fostered a fixed mindset in mathematics.

By the end of the Strength Braining Program, more students responded to mathematics with enthusiasm and resilience. Although, not all students' attitudes shifted from negative to positive dispositions, the field notes suggested that many students adopted a more positive attitude towards mathematics after the Strength Braining Program. Statements like, "I am actually excited for this test," and "I think I am finally getting division," demonstrate students who had a positive disposition towards mathematics and their learning after the Strength Braining Program. Comments like these show that students are viewing their mathematics learning experiences positively indicating a growth mindset. Additionally, students' positive responses to mathematics such as smiling, fist pumps, and clapping, further demonstrated that many students had a positive outlook towards mathematics by the end of the Strength Braining Program.

Self-talk. Carol Dweck emphasizes the impact of *self-talk*, which are negative thoughts or positive affirmations that one thinks or says when navigating a challenge. Students who have positive *self-talk* are more likely to adopt a growth mindset when facing a challenge. Prior to the Strength Braining Program, no spoken *self-talk*, positive or negative, was overheard.

However, after the *self-talk* lesson, there were multiple occasions when students expressed positive affirmations. For example, when division was introduced for the first time, one student exclaimed, “Yes! We got this,” to which another responded “Yes!” There were multiple occasions where students used the word “yet” to punctuate their learning process by saying statements like “I don’t get it, yet.” Moreover, students used the daily mantras from the Strength Braining Program when facing a challenging problem. These examples of positive *self-talk* demonstrate students’ growth mindsets and motivation regarding challenging mathematical concepts. Because there were no observed accounts of *positive self-talk* prior to the Strength Braining program, the increase of spoken *positive self-talk* after the program imply that the Strength Braining Program positively affected students’ mindsets’ by encouraging them to utilize *positive self-talk* as a tool to approach challenges in mathematics.

Response to challenges. Resembling mistakes, challenges are another event that can reveal one’s mindset. Prior to and at the beginning of the Strength Braining Program, many students were disengaged from learning. For example, at the beginning of the Strength Braining Program, many students were avoiding their work by doodling or fidgeting instead of working on problems. These behaviors indicated that they were avoiding challenging work. However, by the fourth lesson of the Strength Braining Program, these behaviors began to decrease. By the end of the Strength Braining Program, these behaviors were infrequent. Although maladaptive behaviors, like work avoidance, continued to be true for some students, many students seemed motivated by their goals to push themselves. After the Strength Braining Program, several students appeared proud to set new goals that were more challenging than the last. This was indicated by students who were excited to show their parents their accomplished goal or students who were excited to show me their accomplishment with a grin. Additionally, several students requested practice problems to bring home towards the end of the program. When a challenge problem was introduced, many students appeared excited and would eagerly prepare their materials. After the Strength Braining Program, more students were eager to "grow" their brain by putting forth effort, indicating a growth mindset.

Summary of RQ2 Results

Results of the MSRQ did not show a significant difference in the *mindset* construct for the control group (p = .476), but it did show a statistically significant decrease in *mindset* for the experimental group (p = .012). Although the results of the MSRQ showed a statistically significant decrease in the experimental groups' mean score related to *mindset*, the Mindset Letters and observations indicated otherwise. In particular, the Mindset Letters suggested that after the Strength Braining Program, students were more likely to utilize positive self-talk, put forth more effort in mathematics, believe that intelligence is flexible, and foster a growth mindset. Additionally, after the Strength Braining Program, observational data indicated students were more likely to put forth effort, have positive responses to mistakes and challenges, have a positive disposition towards mathematics, and utilize positive self-talk. These data indicate that the Strength Braining Program had a positive effect on students' mindsets in mathematics, even though there was a statistically significant decrease from the pre- to post-MSRQ results in *mindset*. Possible reasons for this discrepancy will be discussed in Chapter 5.

Correlations Between Students' Mindsets and Mathematics Achievement

Although there was not a research question addressing the correlation between students' mindsets and their mathematical growth, I found this to be a topic of interest in my research. Spearman correlation analysis did not indicate a significant correlation between students' mindsets (i.e. beliefs about intelligence) and mathematics achievement.

Effects on Students' Use of Self-Regulation (RQ3)

To evaluate the effects of the Strength Braining Program on students use of self-regulation, three constructs on the MSRQ, *seeking help, self-monitoring,* and *goal-setting,* along with students' Mindset Letters and observational data were considered. These data were evaluated to answer research question three: *How, and to what extent, does participation in a growth mindset program affects students' use of self-regulation strategies?*

Mindset and Self-Regulation Questionnaire

On the MSRQ, participants recorded their level of agreement with related six-point Likert scale items, from *strongly disagree* (1) to *strongly agree* (6). To address research question three, the three self-regulation constructs were analyzed: *seeking help, self-monitoring,* and *goal-setting*. To interpret MSRQ results the non-seeking help, non-self-monitoring, and non-goal-setting statements were reverse coded (i.e., a *strongly disagree* equated to a 6). The mean per item scores for each construct (*seeking help, self-monitoring,* and *goal-setting)* were calculated. Table 6 presents the descriptive statistics of the three self-regulation constructs for the control and experimental groups' pre- and post-MSRQ.

As reviewed in Chapter 2, *seeking help* is operationalized as the ability to utilize resources when uncertain of the next steps. To start, a Mann-Whitney U test was applied to determine if the two groups were statistically different on the pre-MSRQ for the *seeking help* construct. It was determined that the two groups were not statistically different (p = .293). Both groups reported between *agree* and *slightly agree* when responding to the six *seeking help* items. The control group's *seeking help* per item means score remained at 4.3, from pre- to post. This was similar to the experimental group's *seeking help* per item mean which remained 4.5 from pre- to post-MSRQ. Neither the experimental groups' nor control groups' change was statistically significant from the pre- to post-MSRQ (p = 1.00).

These findings are consistent with the findings of *self-monitoring*. *Self-monitoring* is operationalized as the ability to plan and monitor the learning process by being aware of what strategies are suitable for the learning experience. The application of a Mann-Whitney U test indicated there was not a statistically significant difference between groups on the pre-MSRQ in *self-monitoring* (p = .929). The experimental groups' mean per item score of the six *self-monitoring* items was 4.6 and the control groups' mean per item score was 4.5, placing both groups in the *agree* to *slightly agree* range. The experimental groups' mean per item score slightly decreased to 4.5. This change was not statistically significant (p = .116). Additionally, the control groups' mean decreased from 4.5 to 4.3, also indicating no significant difference (p = .162).

The last construct of self-regulation evaluated was *goal-setting.* One type of goal that was encouraged in the Strength Braining Program was learning goals. Learning goals focus on improvement and increased understanding of mathematical concepts rather than comparison of abilities. A Mann-Whitney U test determined no statistically significant difference between the groups' pre-MSRQ results for *goal-setting* (p = .881). The experimental groups' mean per item score of the six *goal-setting* items started at 4.7 and decreased to 4.6 on the post-MSRQ showing no significant difference (p = .599). The control groups' mean per item score also did not significantly change (p = .703), remaining at 4.7 from the pre- to post-MSRQ.

Table 6

Mindset and Self-Regulation Questionnaire Results for the Self-Regulation Constructs

	Experimental			Control		
	N	*M*	*SD*	*N*	*M*	*SD*
Seeking Help						
Pre-Test	21	4.5	.55	19	4.3	.58
Post-Test	21	4.5	.55	19	4.3	.58
p		1.00			1.00	
Self-Monitoring						
Pre-Test	20	4.6	.44	18	4.5	.63
Post-Test	20	4.5	.67	17	4.3	.82
p		0.116			0.162	
Goal-Setting						
Pre-Test	21	4.7	.72	19	4.7	.78
Post-Test	20	4.6	.55	17	4.7	.66
p		0.599			0.703	

Note: Likert-scale rated from 1 (*strongly disagree*) to 6 (*strongly agree*)

After evaluating the descriptive statistics of each *self-regulation* construct, the percentage of students who selected each answer for each item among the three self-regulation constructs was calculated. As mentioned before, I collapsed the six different responses intro three categories: *strongly agree* and *agree*, *slightly agree* and *slightly disagree*, and *disagree* and *strongly disagree*. Participants' responses are indicated as percentages for the *seeking help* construct in Table 7.

The outcomes within the *seeking help* construct vary depending on the item. However, since the sample size was small for both groups, these variations are not as significant as they may seem. One students' selection can account for a four to six percent change depending on the sample size for that item. Some items display an overall increase in the percentage of the experimental group that *strongly agreed* or *agreed* with *seeking help* statements from the pre-MSRQ to the post-MSRQ. However other items show a decrease in the percentage of the experimental group that *strongly agreed* or *agreed*. None of these changes are significant enough to conclude that the Strength Braining Program had a positive or negative effect on students' use of self-regulation strategies.

In Table 8, participants' responses are indicated as percentages for the construct *self-monitoring*. This construct, within self-regulation, showed no significant differences between groups or from pre-MSRQ to post-MSRQ. From the pre-MSRQ to the post-MSRQ, there were some increases and decreases that represent a larger percentage of students who selected *strongly agree* or *agree* and *disagree* or *strongly disagree* for some items. However, none of these fluctuations indicate that the Strength Braining Program had an effect on students' ability to *self-monitor,* which is a self-monitoring strategy.

Table 7

Student Responses to Seeking Help Items of MSRQ in Percentages

	Experimental Group Percentages						Control Group Percentages					
	StA/A		SlA/SlD		D/StD		StA/A		SlA/SlD		D/StD	
Items Truncated	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Seeking Help Statements												
I do what it takes to get my math work done	85.7	81.0	9.5	19.0	4.8	0.0	78.9	88.2	21.1	5.9	0.0	5.9
I make choices to help me succeed in math	81.0	85.7	14.3	14.3	4.8	0.0	84.2	76.5	15.8	23.5	0.0	0.0
As soon as I see things aren't going right in math, I ask for help	57.1	66.7	38.1	28.6	4.8	4.8	68.4	52.9	26.3	47.1	5.3	0.0
I keep trying as many different strategies	71.4	66.7	28.6	33.3	0.0	0.0	64.4	76.5	21.1	23.5	10.5	0.0
Non-Seeking Help Strategies												
I have difficulty maintaining my focus	42.9	47.6	33.3	28.6	23.8	23.8	36.8	29.4	10.5	35.3	52.6	35.3
When I get behind on my work in math, I often give up	19.0	9.5	33.3	14.3	47.6	76.2	10.5	5.9	26.3	17.6	63.2	76.5

Note: StA=*Strongly Agree*, A=*Agree*, SlA=*Slightly Agree*, SlD=*Slightly Disagree,* D=*Disagree,* StD=*Strongly Disagree*

Table 8

Student Responses to Self-Monitoring Items of MSRQ in Percentages

	Experimental Group Percentages						Control Group Percentages					
	StA/A		SlA/SlD		D/StD		StA/A		SlA/SlD		D/StD	
Items Truncated	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Self-Monitoring Statements												
I keep track of how I am doing in math	71.4	57.1	28.6	38.1	0.0	4.8	78.9	70.6	21.1	23.5	0.0	5.9
I know when I am behind in math	60.0	71.4	40.0	28.6	0.0	0.0	73.7	70.6	15.8	11.8	10.5	17.6
I track my progress towards my goals	65.0	81.0	25.0	14.3	10.0	4.8	55.6	70.6	33.3	23.5	11.1	5.9
I know what my math grade is	52.4	33.3	28.6	47.6	19.0	19.0	47.4	35.3	42.1	47.1	10.5	17.6
Daily, I identify things I need to get done	95.2	66.7	4.8	28.6	0.0	4.8	72.2	64.7	22.2	29.4	5.6	5.9
Non-Self-Monitoring Statements												
I have trouble remembering	23.8	14.3	42.9	52.4	33.3	33.3	31.6	23.5	31.6	23.5	36.8	52.9

Note: StA=*Strongly Agree*, A=*Agree*, SlA=*Slightly Agree*, SlD=*Slightly Disagree,* D=*Disagree,* StD=*Strongly Disagree*

Participants' responses to *goal-setting* items are indicated as percentages in Table 9. The percentage of the experimental group that *strongly agreed* or *agreed* with the *goal-setting* statements decreased for all items except, "I feel a sense of accomplishment when I finish a difficult math problem," which increased from 81.0% to 90.5% from the pre-MSRQ to the post-MSRQ. The control group also reported increased agreement with this statement, from 78.9% to 94.1% on the pre-MSRQ to the post-MSRQ. One possible reason for the experimental group's increase is because the experimental participants received explicit instruction on what a goal is, changing their perception of *goal-setting* on the post-MSRQ. None of these changes are substantial enough to conclude that the Strength Braining Program had a positive or negative effect on students' use of self-regulation strategies.

Table 9

Student Responses to Goal-Setting Items of MSRQ in Percentages

	Experimental Group Percentages						Control Group Percentages					
	StA/A		SlA/SlD		D/StD		StA/A		SlA/SlD		D/StD	
Items Truncated	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Goal-Setting Statements												
I think about how well I am doing on math problems to set goals	71.4	61.9	19.0	33.3	9.5	4.8	68.4	64.7	26.3	29.4	5.3	5.9
I feel a sense of accomplishment	81.0	90.5	19.0	9.5	0.0	0.0	78.9	94.1	21.1	5.9	0.0	0.0
I think about how well I've done in the past when I set new goals	81.0	61.9	4.8	28.6	14.3	9.5	73.7	58.8	10.5	35.3	15.8	5.9
When I get a math problem wrong, I try to learn from my mistakes	88.2	85.7	11.8	14.3	0.0	0.0	78.9	88.2	15.8	11.8	5.3	0.0
When I keep making the same mistakes, I set a new goal	57.1	47.6	28.6	19.0	14.3	33.3	36.8	58.8	31.6	23.5	31.6	17.6
Non-Goal-Setting Statements												
I have trouble making plans	28.6	38.1	52.4	33.3	19.0	28.6	42.1	29.4	31.6	41.2	26.3	29.4

Note: StA=*Strongly Agree*, A=*Agree*, SlA=*Slightly Agree*, SlD=*Slightly Disagree*, D=*Disagree*, StD=*Strongly Disagree*

Mindset Letters

To further explore the effects of the Strength Braining Program on students' use of *self-regulation*, two forms of qualitative data were analyzed: Mindset Letters and observations. The inclusion of qualitative data helped to better understand the effects of the Strength Braining Program because it allowed for the analysis of students' words and behaviors with member checking to verify conclusions.

When the Mindset Letters were analyzed and coded using the process of inductive coding, two self-regulation themes emerged: *cognitive strategies* and *self-regulation strategies*. As mentioned in Chapter 2, strategies are mental processes that learners deliberately utilize to aid themselves in learning and understanding something new. Cognitive strategies are task-oriented strategies (e.g., note-taking, summarizing, outlining, etc.). In comparison, self-regulation strategies are considered metacognitive strategies that help one plan and monitor the learning process by being aware of which cognitive strategies are suitable for the learning experience (Sungur, 2007). In other words, self-regulation strategies help learners efficiently and effectively determine which cognitive strategies are appropriate for their learning experience. This includes recognizing when one should switch cognitive strategies. Table 10 provides the number of letters in which students included ideas involving *cognitive strategies* and *self-regulation strategies* in their pre- and post-Mindset Letters. Since there are different cognitive strategies and self-regulation strategies, participants could have included more than one cognitive strategy or self-regulation strategy in their letter.

As displayed in Table 10, the pre-Mindset Letters did not contain any *cognitive strategies* and only 11 letters included *self-regulation strategies*. In contrast, seven post-Mindset Letters included *cognitive strategies* and 21 letters included *self-regulation strategies*. These numbers indicate that students were more likely to suggest the utilization of self-regulation strategies after receiving the Strength Braining Program. Furthermore, more students promoted the use of cognitive strategies as a possible approach for the fictional second grader's problem.

Table 10

Number of Letters Containing Self-Regulation Ideas of the 26 Pre/Post Mindset Letters

Idea	Pre-Intervention	Post-Intervention
Cognitive Strategies	0	7
Self-Regulation Strategies	11	21

The number of Mindset Letters in which students mentioned the two different types of strategies increased, but the statements they made in their post-Mindset Letters further support their dispositions towards using cognitive strategies and self-regulation strategies. For this reason, students' written statements were examined to understand the effects of the Strength Braining Program on students' uses of self-regulation strategies.

Cognitive strategies. In the Strength Braining Program, one lesson focused on self-monitoring, and students collectively created a list of mathematical cognitive strategies for their reference. The purpose of the lesson was to help students monitor their use of cognitive strategies when facing a challenging mathematical concept. Some of the cognitive strategies the participants offered included referring to notes, taking a break, rereading the problem, etc. All of the cognitive strategies mentioned in the post-Mindset Letter were on the list of cognitive strategies the class composed together. One student's post-Mindset Letter encouraged the second grader to look at her notes when attempting her mathematics homework by stating, "One solution is to read over notes." It appears that this student was aware that the use of cognitive strategies could help clarify concepts. On another student's post-Mindset Letter, the student suggested using a different cognitive strategy by saying, "Draw a picture or look at your notes. Use materials." This student mentioned multiple cognitive strategies indicating that she was encouraging the second grader to try different cognitive strategies when one fails. Another student's post-Mindset Letter included the comment, "Reread the problem, if might make sense if you reread."

These statements indicate that after the Strength Braining Program, more students were considering cognitive strategies as possible solutions to challenging mathematical concepts. These comments also indicate that these students were recalling the Strength Braining lesson that focused on cognitive strategies as a way to approach a problem strategically. Since students mentioned multiple strategies that were discussed in the program, this implies that the Strength Braining Program taught them to self-regulate cognitive strategies when facing a challenge. In the pre-Mindset Letters, not a single participant mentioned a *cognitive strategy* when responding to the second grader's challenge. In the post-Mindset Letter, seven students included a *cognitive strategy* in their response to the second graders' situation. This increase indicates that the Strength

Braining Program encouraged students to utilize multiple cognitive strategies when facing a challenge.

Self-regulation strategies. There was a significant increase in the number of letters that mentioned *self-regulation strategies* from students' pre-Mindset Letters to their post-Mindset Letters. On the pre-Mindset Letters, 10 of the 11 occurrences of *self-regulation strategies* suggested *seeking help* and one of those statements encouraged the student to ask questions. In contrast, 21 post-Mindset Letters mentioned *self-regulation strategies* in.

Asking questions. Nine students mentioned *asking questions* in their post-Mindset Letter, whereas only one student mention *asking questions* in their pre-Mindset Letter. This shift supports the conjecture that the Strength Braining Program had a positive effect on students' self-regulation strategies, including seeking help. For example, in one student's post-Mindset letter she stated, "Maybe try asking a friend or parent or ask questions in class." Statements like this suggest that students were more willing to *ask questions* when something did not make sense after receiving the Strength Braining Program. For students to ask questions, they need to first recognize that they are having trouble understanding a concept. Then they need to have the belief that they can make growth using different strategies and tools like *asking questions*. Suggesting that the student should ask different people questions further supports the idea that students believed *asking questions* could lead to understanding of a difficult concept after receiving the Strength Braining Program.

Self-monitoring. In the post-Mindset Letters, seven students suggested behaviors that indicated *self-monitoring*; in comparison, none of the students suggested these behaviors in the pre-Mindset Letters. The fact that none of the pre-Mindset Letters mentioned that the second-grader could use *self-monitoring* to approach her problem suggests that the Strength Braining Program affected students' use of self-regulation strategies since seven students mentioned these ideas in their post-Mindset Letters.

Self-monitoring refers to the ability to monitor the use of cognitive strategies and progress. Setting goals is one way for students to monitor their progress. In her post-Mindset Letter, one student mentioned a personal experience that encouraged her to different self-regulation strategies to succeed by stating, "I have recently been trying to get past a level on iReady game called Cloud machine but it just seemed impossible. Setting goals, not giving up, asking for help is what I did." In this example, it seems that the student acknowledged that it was the use of multiple strategies that led to success. The two self-regulation strategies she mentioned were setting goals and asking for help, both of which indicated that she monitored her learning and use of strategies accordingly. In another student's post-Mindset Letter, he said, "It's fine that you don't understand it you can just ask your teacher. If you want to avoid embarrassment you can ask her in private." This example indicates that this student believes some avoid seeking help for the fear of looking stupid. By suggesting a private conversation, the student was most likely offering another way the second grader could use self-regulation strategies to monitor her own progress and be strategic about her next steps in a low-stakes environment. Both comments acknowledge the second grader's emotions of frustration, while also integrating strategies to help her overcome those emotions. This suggests that the Strength Braining Program encouraged students to monitor their learning, impacting their use of self-regulation strategies.

Some of the self-regulation strategies mentioned by students focused on behaviors that would help students *self-monitor* their progress when facing a challenge. For example, on one student's post-Mindset Letter she said, "Take breaks. Why? Well if your stresses about your struggle take a break." Comments like these show that students recognized when they were getting frustrated to a point that they were no longer productive. Recognizing these moments and regulating their behavior with coping mechanisms, like breaks, indicates that students are aware of the effects of their frustration on progress. Additionally, several students mentioned the utilization of self-regulation strategies that both monitored behavior and cognitive strategies. In one student's post-Mindset Letter they said, "If you have trouble ask someone, reread the problem, then things will be okay." This student's statement incorporates the cognitive strategy of rereading the problem with the self-regulation strategy of asking for help. The fact that some students incorporated both types of strategies in their suggestions to the second grader implies that they believed regulating behaviors and strategies could lead to success. These comments further support the idea that the Strength Braining Program had a positive effect on students' use of self-regulation strategies when facing a challenge.

Observations

The collected observational data also indicated that after receiving the Strength Braining Program students were more likely to utilize self-regulation strategies in mathematics. As mentioned before, the observational data were collected throughout the Strength Braining Program and the three-week application period. Table 11 displays the observed changes of behavioral patterns and the assertions concluded from those observed changes. In order to analyze these data, the field notes were coded and categorized into three larger themes: *self-monitoring*, *use of cognitive strategies*, and *goal-setting*.

Self-monitoring. At the beginning of the Strength Braining Program, it seemed that many students did not monitor their learning progress for fear of bringing attention to their deficits. Prior to the Strength Braining Program, behaviors such as copying a neighbor's answers, not seeking help when stuck, and talking during work time, all signified that students were not monitoring their understanding of mathematical concepts. For example, prior to the implementation of the program, one student was not working during independent work time. When approached, he appeared uncomfortable with the attention for a couple of reasons. First, he immediately began to show he was working by suddenly picking up his pencil and looking at his paper. When asked if he needed help he said, "no." After being left to work for a minute, he still had not begun the problem indicating that he did not know how to start. In a private conversation, he was asked some prompting questions. He looked around the room to see if any other students noticed the attention he was receiving. He appeared distracted by the possibility that his peers might notice him. Furthermore, he did not answer any of the prompting questions. Behaviors like these indicate that students who exhibited similar behaviors were too self-conscious to attempt the problems.

However, after the Strength Braining Program, students showed *self-monitoring* when they asked clarifying questions, identified the source of their confusion, and asked for help in class or privately. All these behaviors indicated that students were monitoring their use of cognitive strategies and their progress. By the application period of the Strength Braining Program, students would raise their hand to share the first step they took to solve a problem with the purpose of seeking guidance for their next step. After the program many students would wait until the class was working to approach me privately about their questions having to do with difficult mathematical concepts or problems. Additionally, when reviewing the answer to a problem after the program, some students would raise their hands and share with the class where they made their mistake and how they corrected it. These observed behaviors indicate that these students were monitoring their understanding of mathematical concepts and taking the steps necessary to overcome challenges.

Although some students still struggled with self-monitoring their learning after the Strength Braining Program, more students monitored their learning and took the steps necessary to make growth than they did before the program. The increase of positive self-monitoring behaviors after the implementation of the Strength Braining Program implies that the program positively affected students' use of self-regulation strategies when facing a mathematical challenge.

Use of cognitive strategies. Cognitive strategies were present throughout all five weeks of the field notes. However, the efficiency and diversity of cognitive strategies improved after the program, indicating that the Strength Braining Program allowed students to monitor their use of cognitive strategies more effectively. For example, at the beginning of the five-week-period students were learning about volume of rectangular prisms. When students were working on a problem that showed a picture of a rectangular prism composed of cubes, one student repeatedly counted the edges of the cubes. This is an example of a *cognitive strategy*. However, when this strategy failed, the student continued with the same strategy instead of switching to a more effective strategy. This behavior indicates that although the student seemed motivated to get an answer, he did not appear to monitor the effectiveness of his strategy. Ideally, he would have noticed that the strategy was not effective to reevaluate his approach. In other occurrences, some students would compare their answer to the answer key and re-solve the problem in the exact same way, getting the same answer. This behavior pattern was common prior to the Strength Braining Program.

In contrast, after the Strength Braining program, there was a shift in this behavior pattern suggesting a positive effect of the program on students' ability to monitor cognitive strategies. For example, after the program, one student was working on a three digit by two-digit multiplication problem. She first started to solve the problem using the standard algorithm, but when she got lost on what to do next, she switched strategies and began solving the problem using partial products. On another day after the Strength Braining program, a student solved a multiplication problem using standard algorithm and checked his work with a calculator. When he recognized that he got the wrong answer, he raised his hand for help. These behaviors imply that students were monitoring their progress by picking cognitive strategies and changing strategies or seeking help when it failed. Although this behavior change was not present throughout the participants, this behavior pattern was more noticeable after the Strength Braining Program. This shift in the behavior pattern indicates that the Strength Braining Program had a positive effect on students' use of cognitive strategies and self-regulation strategies.

Goal-setting. At the beginning of the Strength Braining Program, there were no observed indications of *goal-setting*. However, by the end of the Strength Braining Program, students were aware of their personal goals, and they worked towards mastery of those goals. After the Strength Braining program, when students met their goals, they set a new goal. Students made comments like, "Yay, I met my goal," and "Mrs. Manchester, I need a new goal." Students appeared proud to have met their goals and share their growth with their parents. For example, throughout the second phase of the Strength Braining Program, one student's goal involved division. He indicated that he was nervous about focusing on division by expressing his frustration with past experiences involving division in fourth grade. During his division learning experience, he asked questions and had to solve the same problems multiple times. When he met his goal, he celebrated by exclaiming his accomplishment to his neighboring peers and me. Additionally, he appeared to be eager to set a new goal, immediately asking for my guidance. This observation implies that this student employed *goal-setting* as a tool to make growth and overcome challenging mathematical concepts. These behaviors indicated that after the Strength Braining Program, students were more likely to set goals and be motivated to master their goals. Since there were no observed examples of *goal-setting* prior to the Strength Braining Program, the observed change in the behavior pattern indicates that the Strength Braining Program positively affected students' use of goal-setting which is a self-regulation strategy.

Table 11

Observed Changes in Self-Regulation Behavior Patterns

Observed Change in Behavior Patterns	Observations	Assertions
Self-Monitoring	Asking clarifying questions Identifying source of confusion Seeking Help	Students were more likely to utilize self-monitoring strategies in the face of a challenge after the Strength Braining Program.
Use of Cognitive Strategies	Using materials Underlining information Rereading problems Referring to notes	Students were more likely to self-monitor their use cognitive strategies in math making their approach to challenges more efficient.
Goal-Setting	Learning from mistakes Persisting	Students who are more motivated are more likely to set mastery-oriented goals encouraging persistence and resilience.

Summary of RQ3 Results

Results of the self-regulation constructs of the MSRQ, *seeking help, self-monitoring,* and *goal-setting,* indicate no statistically significant difference in either the experimental group nor the control group after the Strength Braining Program. However, the post-Mindset Letters indicate that the Strength Braining Program encouraged students to use both cognitive strategies and self-regulation strategies more efficiently and effectively. Furthermore, the observational data showed an increase of self-regulatory behaviors such as *self-monitoring, use of cognitive strategies,* and *goal-setting.* These findings indicate that the Strength Braining Program had a positive effect on students' use of self-regulation strategies.

Students' Attitudes Towards Innovation (RQ4)

To explore students' attitudes towards the innovation, the last construct, *attitudes towards innovation,* of the post-MSRQ was analyzed. Only the experimental group responded to the statements about their *attitudes towards the innovation* on the post-MSRQ. These data were used to answer research question four: *What were participants' attitudes towards the Strength Braining Program?*

Mindset and Self-Regulation Questionnaire

After participating in the Strength Braining Program and the three-week application period, students completed the post-MSRQ in which they indicated their attitudes about the Strength Braining Program. There were six items about students' attitudes towards the innovation. Participants did not respond to these items in the pre-MSRQ because they had not yet received the Strength Braining Program. Table 12 presents the per item mean and standard deviation for the MSRQ attitude items. The mean per item score of the six *attitudes towards innovation* items were between *strongly agree* and *agree*, indicating students believed that the Strength Braining Program was beneficial to their learning.

Table 12

Mindset and Self-Regulation Questionnaire Results for the Attitudes Construct

	Experimental		
	N	*M*	*SD*
Post-Test	19	5.2	.53

The percentage of students who selected each answer for each item among the six attitude items was calculated (Table 13). These data suggest students found value in the lessons regarding their progress in mathematics. Furthermore, these results reveal that the experimental participants not only found value in the Strength Braining Program, but that they also believed learning self-regulation strategies had a positive impact on their mathematics learning.

Table 13

Attitudes Towards Innovation Items of Post-MSRQ in Percentages

	Experimental Group Percentages		
	StA/A	SlA/SlD	D/StD
Strength Braining Statements	Post	Post	Post
I believe that Strength Braining was helpful in math.	90.5	9.5	0.0
Strength Braining helped me in math.	81.0	19.0	0.0
I liked learning about mindsets.	85.0	15.0	0.0
I liked learning to use self-regulation strategies.	81.0	19.0	0.0
Self-regulation strategies were helpful in learning math.	81.0	19.0	0.0
By using self-regulation strategies, I learned math better.	81.0	19.0	0.0

Conclusion

The Strength Braining Program did not significantly affect students' mathematics growth scores. However, some results indicate the Strength Braining Program positively affects students' mindsets and use of self-regulation strategies. After collecting and analyzing the different sources of data, there were some inconsistencies between the results of the MSRQ data and the qualitative data regarding research questions two and three. In Chapter 5, possible reasons to explain these discrepancies are discussed.

Chapter 5

DISCUSSION

Introduction

The problem of practice that was addressed in this action research study was the underachievement of fifth graders in mathematics as illustrated by mediocre results on national and international assessments, like the TIMMS, PISA, and NAEP (Guglielmi & Brekke, 2017). Today's climate in the classroom is proficiency-based, focusing attention on students' development of cognitive skills. Research suggests that fostering the development of students' psychological skills along with their cognitive skills can lead to academic growth (Yeager & Dweck, 2012). This problem of practice inspired the creation of the Strength Braining Program to be implemented in a fifth-grade classroom.

The purpose of the Strength Braining Program was to foster growth mindsets through usage of self-regulation strategies when facing challenging concepts in mathematics. The two-part program consisted of eight, forty-five-minute lessons over the course of two weeks. The program's first four lessons focused on developing students' growth mindsets by explicitly teaching about the mindsets and brain plasticity. The second phase of the Strength Braining Program consisted of four lessons that focused on developing students' repertoire of self-regulation strategies to navigate challenges and improve students' understanding of mathematical concepts.

The primary purpose of this mixed-methods action research study was to determine the impact of the Strength Braining Program on students' mindsets and use of self-regulation strategies in mathematics. The secondary purpose of this study was to test the hypothesis that developing students' growth mindsets and self-regulation strategies would help students understand mathematical concepts better. For these purposes, four research questions guided this action research study:

1. To what degree does participation in a growth mindset program affect fifth-graders' understanding of mathematical concepts?
2. How, and to what extent, does participation in a growth mindset program affect students' mindsets?
3. How, and to what extent, does participation in a growth mindset program affect students' use of self-regulation strategies?
4. What were participants' attitudes towards the Strength Braining Program?

This chapter will first discuss the results of the quantitative and qualitative measures in relation to the research questions. Next, the findings of the study will be related back to the two guiding theoretical frameworks. Thereafter, the limitations of the study will be discussed followed by the implications of the research. Finally, a conclusion will be provided.

Consideration of Quantitative and Qualitative Results

Quantitative results of the MGT, although showing statistically significant growth for both groups, did not indicate that the implementation of the Strength Braining Program positively affected students' understandings of mathematical concepts. This conclusion is drawn from the fact that there was not a statistically significant difference between the control group and experimental group on the post-MGT. There are a couple of possible reasons there was no significant change. First, the pre- and post-MGT were collected only five weeks apart. To truly see the effect of the Strength Braining Program on students' growth, students may have needed to apply their learnings for a longer period of time to see the effect on their academic growth.

The second form of quantitative data collected was the MSRQ. Although data collected from the MSRQ indicated that students found value in the Strength Braining Program, results showed that the Strength Braining Program had a negative effect on students' mindsets and no effect on students' use of self-regulation strategies. The comparison of the experimental groups' pre-MSRQ results to the post-MSRQ showed a statistically significant decrease in student's agreement with growth mindset statements after the Strength Braining Program.

Qualitative data from students' Mindset Letters and observations do not support the findings of the quantitative data. In fact, findings from students' Mindset Letters suggest that the Strength Braining Program positively influenced students' mindsets in mathematics. Through the systematic comparison of students' pre-Mindset Letters and post-Mindset Letters, data indicated that students were more likely to utilize positive self-talk, put forth more effort in mathematics, believe that intelligence is flexible, and foster a growth mindset after the Strength Braining Program than before the program. All these ideas reveal the Strength Braining Program had a positive effect on students' mindsets. Additionally, the Mindset Letters indicated that the Strength Braining Program had a positive effect on students' use of self-regulation strategies. The increased representation of both *cognitive* and self-regulation strategies in students' post-Mindset Letters indicated that the Strength Braining Program had a positive effect on students' use of self-regulation strategies. This suggests that the Strength Braining Program encouraged students to use both cognitive strategies and self-regulation strategies more efficiently and effectively.

Observational data corroborates the Mindset Letter findings by revealing changes in behavior patterns observed prior to the Strength Braining Program and after its implementation. These behavior pattern changes include a change in students' ability to put forth effort, have positive responses to mistakes and challenges, have a positive disposition towards mathematics, and utilize positive self-talk after the Strength Braining Program. These changes in behavior patterns suggest that the Strength Braining Program had a positive effect on students' mindsets. Moreover, changes in behavior patterns exposed by the observational data indicated that after the program, students were more likely to *self-monitor, use cognitive strategies,* and utilize *goal-setting* when facing mathematical challenges. These findings further support that the Strength Braining program had a positive effect on students' use of self-regulation strategies.

The MSRQ data that suggests a negative effect of the Strength Braining Program on students' mindsets, could be a product of the Dunning-Kruger effect. The Dunning-Kruger effect is the idea that participants who lack knowledge of the topic they are self-reporting on tend to overestimate their abilities. However, once they gain knowledge of the topic, mitigating their incompetence, they are more likely to accurately self-report their abilities (Dunning, Johnson, Ehrlinger, & Kruger, 2003; Kruger & Dunning, 1999). When considering the MSRQ, participants may have lacked understanding of the topics presented on the pre-MSRQ. The development of students' mindsets through the utilization of self-regulation strategies was the primary focus of the Strength Braining Program. Students' lack of knowledge about mindset could have led to students overestimating their own growth mindset. However, on the post-MSRQ, the experimental participants had not only learned about mindsets, but also applied their learnings to experiences in mathematics. The program helped them develop a more thorough understanding of what a growth and fixed mindset were and what they looked like. This development most likely increased their competence in this area and consequently promoted greater accuracy when self-reporting on their mindsets. In other words, prior to the Strength Braining Program, students may have overestimated their ability to have a growth mindset in mathematics. However, when they learned about the mindsets and how self-regulations strategies could help them develop a growth mindset, students were likely able to reflect on their learning experiences and align them to their learnings of mindset, possibly allowing them to more accurately self-report. This could have led to a negative effect of the Strength Braining Program from pre- to post-MSRQ in *mindset.*

Connections to Theoretical Frameworks

The development of the Strength Braining Program was guided by mindset theory (Dweck, 2016) and self-regulation theory (Schunk & Zimmerman, 1989). The following portion of this chapter will describe how these theories contributed to the development of the program and how they align to the outcomes of this study.

Relevance of Mindset Theory

The Strength Braining Program was designed to help students foster a growth mindset in mathematics. Dweck's (2016) mindset theory provided guiding principles for the development of the program. The first phase of the program operationalized the mindsets and encouraged students to connect behaviors and metacognition to the two mindsets (i.e. fixed mindset and growth mindset). Students were explicitly taught brain plasticity with the intention of positively impacting students' implicit theories of intelligence (i.e. mindset), one of Dweck's key principles (Dweck, 2016). Students were also taught the importance of goals, resilience, and feedback when facing mathematical challenges, all of which are components of Dweck's mindset theory (Mueller & Dweck, 1998; Yeager & Dweck, 2012). The Mindset Letters and observational data suggest that the Strength Braining Program improved students' mindsets in mathematics. The Mindset Letters implied that students were more likely to apply *positive self-talk*, *effort*, the belief that *intelligence is flexible*, and a *growth mindset* to mathematical challenges. Observational data also supported the effectiveness of the program informed by mindset theory, by documenting changes in behavioral patterns after the implementation of the program. These changes included an increase in *effort*, *positive responses to mistakes and challenges*, positive *attitudes towards mathematics*, and *positive self-talk.*

Research suggests that students with a growth mindset are more likely to show academic achievement (Blackwell et al., 2007; Good et al., 2003; Panuneskuet et al., 2012). However, results from the MGT suggested that the Strength Braining Program did not affect students' academic growth. As mentioned before, the length of the program made it difficult to truly determine the effects of teaching a growth mindset on academic growth.

Relevance of Self-Regulation Theory

Students also demonstrated an increased use of self-regulation strategies after the implementation of the Strength Braining Program. Self-regulation theory also guided the development of the program. Self-regulation theory is the idea that strategies such as self-generated thoughts, feelings, and actions can assist in the attainment of goals (Schunk & Zimmerman, 1989). These self-regulation strategies include *goal-setting*, *self-monitoring*, *seeking help*, and *effort* (Boekaerts & Niemivirta, 2000; Dembo & Eaton, 2000; Sungur, 2007). In the development of the Strength Braining Program, self-regulation strategies were employed to help participants develop a growth mindset by providing them with strategies when facing a challenging mathematics problem. In the second phase of the program, students were explicitly taught these self-regulation strategies and encouraged to apply them in real time during mathematics. The comparison of the pre- and post-Mindset Letters implied that after the program, students were more likely to apply these strategies when facing a challenge in mathematics. Additionally, students were more likely to monitor their use of cognitive strategies in mathematics after the Strength Braining Program. Observational data further supports these conclusions by exposing changes in behavior patterns before the program to after the program. The changes in behavior patterns suggested that students were more likely to self-monitor their progress, use different cognitive strategies, and employ goal-setting after the Strength Braining Program. Although the MSRQ indicated that the Strength Braining Program had no effect on students' uses of self-regulation strategies, the observed changes in behavior patterns align with the findings of existing research studies focused on self-regulation (Blair et al., 2015; Kitsantas et al., 2017; Sungur, 2007).

Summary of influences of theoretical frameworks. Quantitative data suggests the Strength Braining Program did not improve students' understanding of mathematical concepts or use of self-regulation strategies. Additionally, quantitative data suggests that the program may have had a negative effect on students' mindsets. However, qualitative data indicated that the integration of Dweck's (2016) mindset theory and self-regulation theory in the Strength Braining Program helped participants develop a growth mindset and utilize self-regulation strategies in mathematics (Schunk & Zimmerman, 1989).

Recommendations for Practice

In this portion of the chapter, key implications of the study are reviewed for district leaders, professional development coordinators, and teachers. The opportunity to help students develop psychological skills like mindset and metacognitive self-regulation strategies is overlooked in schools today. Many schools are focused on academic achievement putting cognitive skills at the center of learning. Implementing the Strength Braining Program helped students reflect on their learning and shifted the way they saw failure. Participants agreed that the Strength Braining Program helped them develop a growth mindset and use self-regulation strategies as seen on the MSRQ. Participants also indicated that they believed participation in the program helped them in mathematics.

The findings of this action research study encourage me to recommend that professional development coordinators and district leaders facilitate a sustained professional development (PD) opportunity for teachers (Appendix G). This PD should be focused on developing a classroom climate that fosters growth mindsets and develops self-regulation strategies. For this PD to be successful, coordinators and district leaders will have to integrate cognitive and psychological development. In the long run, this focus could possibly result in more effective and efficient development of students' cognitive skills. With my experience of PDs designed for teachers, it is my conclusion that this PD should be over the course of multiple days and throughout the year. This timeline will encourage teachers to continue implementing growth *mindset* and self-regulation strategies in their classrooms throughout the year. Furthermore, this would give teachers the opportunity to apply their learning in phases while also providing them with a platform to problem solve and reflect on their practice with the support of their community (Darling-Hommond, Bullmaster, & Cobb, 1995; Darling-Hammond & Mclaughlin, 2011). The PD should provide explicit teaching strategies and tools for teachers to utilize immediately. However, teachers should have the freedom to take components of the PD to fit their individual classrooms. In other words, the PD should not act as a curriculum that should be followed with fidelity.

Many studies suggest that a growth mindset as well as the use of self-regulations strategies have positive effects on achievement (Aronson et al., 2002; Blackwell et al., 2007; Blaire et al., 2015; Claro et al., 2016; Good et al., 2003; Hong et al., 1999; Kitsantas et al., 2017; Panunesku et al., 2012; Ruff & Boes, 2014). The purpose of this PD would be for teachers to have an opportunity to develop tools and approaches to teaching content in a way that would foster growth mindsets and utilize self-regulation strategies. Darling-Hammond et al. (1995), assert that PD should be a sustained, intensive and ongoing process. For this reason, I recommend that the PD be implemented one academic year and then reinforced for multiple years after. The intention of this PD would be for teachers to disrupt the outcome-focused environment and consequently develop a process-focused environment. It is my belief that kindergarteners who begin their schooling in a growth mindset and self-regulatory environment will be more likely to achieve at higher rates by fifth-grade if these concepts are reinforced throughout their schooling.

Additionally, this research study has implications that are relevant to teachers. Helping students recognize that intelligence is not an innate characteristic that is unchangeable is good for students' motivation and effort. The findings of this research study encourage me to recommend that teachers incorporate materials that communicate brain plasticity in student-friendly terms. Explicitly teaching students how the brain can grow from struggle can help students associate a perceived negative learning experiences with a positive attitude. Furthermore, I recommend that teachers help students develop their metacognitive strategies when they face a challenge. Again, this could be through explicitly teaching students how to utilize and monitor their use of multiple cognitive and self-regulation strategies. From my experience, I believe that co-constructing knowledge and ideas with students not only empowers them to take control of their own learning but also encourages them to reflect on their learning and process. For this reason, I suggest that teachers and students co-construct a list of cognitive and self-regulation strategies for students to reference when they become frustrated or stuck. Reminding students that they are in control of their learning by encouraging them to monitor their use of strategies can motivate students to engage in struggle.

Limitations and Future Research

Engaging in this action research process provided me with the opportunity to be reflective of my practice and my local context. This process allowed me to step into a researcher role while still being an active practitioner in the setting. However, being an active participant in the study is a limitation of this study. I administered the pre- and post-MSRQ as well as collected the Mindset Letters and observations. My involvement in these measures could have affected the outcomes, since students viewed me as a superior in the classroom. Moreover, being an active participant in the classroom could have affected my observational field notes.

Another limitation of this study is that the Strength Braining Program was designed and tailored to my local context making it difficult to generalize results. In addition, this action research cycle was short. It is difficult to assess the effects of the program with only five weeks for students to learn the concepts, apply the concepts and show growth. Furthermore, Dweck's (2016) mindset theory has been more prevalent in my local context over the past couple of years. It is possible that teachers have been utilizing growth mindset approaches in their classrooms, possibly exposing some of the participants to the concepts prior to the Strength Braining Program. These limitations make it difficult to conclude that the Strength Braining Program was the sole cause of the effects seen in the results.

Although employing a control group and experimental group allowed me to compare outcomes of the MGT and MSRQ, both groups had a different mathematics teacher. It is possible that the different approaches to teaching mathematics and helping students navigate challenges could have impacted results. Additionally, Mindset Letters and observational data were not collected from the control group, making it difficult to determine if the noticed changes in the Mindset Letters and observations are due to the implementation of the Strength Braining Program. Other limitations include small sample sizes, and lack of information about the validity and reliability of the measures employed in this study.

Future research cycles should involve a larger sample size with measures that have been tested for validity and reliability. Additionally, to avoid the Dunning-Kruger effect, it may be helpful to pre-teach some of the concepts prior to students taking the pre-MSRQ. This may provide participants with critical background knowledge to self-evaluate their beliefs accurately on the pre-MSRQ. It may also be worthwhile to conduct research in a setting in which the researcher is not a participant. Finally, collecting all forms of pre- and post-data from the control group and experimental group may make it easier to determine the effects of the program.

Conclusion

When I first engaged in this action research cycle, I reflected on my local context and identified a problem of practice that was prevalent in my years of teaching. Fifth-grade students were consistently underachieving in mathematics. As I continued to reflect and read about this problem, two guiding theories seemed to align with the problem I identified: mindset theory and self-regulation theory. After conducting a literature review, I designed the Strength Braining Program to develop students' self-regulation strategies which would improve students' understanding of mathematical concepts. Results of the qualitative data suggested that the program positively affected students' mindsets and use of self-regulation strategies. Quantitative data implied that students saw value in the program. However, results of the quantitative data showed no effect on students' understanding of mathematical concepts or use of self-regulation strategies. Furthermore, the data suggested that the program had a negative effect on students' *mindsets*. The contradictions in the data may be attributed to the Dunning-Kruger effect. In conclusion, it is my hope that the participants of this study enter middle school with a repertoire of self-regulation strategies and a growth mindset in mathematics so that they are prepared to engage in challenging learning experiences.

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APPENDIX A

RECRUITMENT/CONSENT FORM

Dear Parent:

My name is Sarah Manchester and I am a doctoral student in the Mary Lou Fulton Teachers College (MLFTC) at Arizona State University (ASU). I am working under the direction of Dr. Eugene Judson, a faculty member in MLFTC. We are conducting a research study on counteracting fifth-grade underachievement in mathematics.

We are asking for your help, which will involve your child's participation in a small-scale intervention, as well as participation in surveys and classroom observations. The intervention, which will be part of their instructional day, will include learning strategies like goal setting, monitoring how well they are doing, developing a positive attitude for doing math, etc. This intervention will be part of the regular instructional time, so it will not take extra time. Even if you choose not to allow your child to participate in the data collection part of the project, they will still receive the instruction. In the data collection part of the project, a survey will be conducted two times and will take 10-20 minutes each time, for a total of 20-40 minutes. To ensure we can match your child's pre- and post-survey responses to analyze the data, we will ask your child to provide their first and last name, however, their information will be kept confidential. After collecting the survey data, students will be assigned a study ID number that will deidentify survey responses.

In addition to survey responses, we will be collecting student mathematics growth data from students' math academic records, students' written work, and observational data during math instructional time for research purposes. Students will complete a math formative assessment prior to the intervention, and then again after the intervention. Additionally, I will be taking field notes on classroom observations throughout the implementation of the study.

Your child's participation in this study is voluntary. If you choose not to have your child participate or withdraw from the study at any time, there will be no penalty whatsoever. It will not affect your child's grades or their standing at school. Surveys will take place in class. Students not participating in the surveys will be reading.

The benefit of participation is the opportunity for your child to develop some new skills and then reflect on and think more about them. Thus, there is potential to enhance the experiences of students as they learn math. There are no foreseeable risks or discomforts to your child's participation.

Your child's responses will be confidential. Results from this study may be used in reports, presentations, or publications, but your child's name will not be used.

If you have any questions concerning the research study, please contact the research team – Eugene Judson at Eugene.Judson@asu.edu or (480) 727-5216 or Sarah Manchester at sarah.plitt@asu.edu or (480) 586-6877.

Thank you,

Sarah Manchester, Doctoral Student

Eugene Judson, Associate Professor

Please indicate your agreement to allow your child to participate in the survey, intervention and data collection by signing below.

Your Signature	Printed Name	Child's Name	Date

If you have any questions about your or your child's rights as a participant in this research, or if you feel your child has been placed at risk, you can contact Ray Buss at (602) 543-

6343 or the Chair of Human Subjects Institutional Review Board through the ASU Office of Research Integrity and Assurance at (480) 965-6788.

APPENDIX B

STUDENT ASSENT FORM

Learning Math Project

I have been told that my parents (mom or dad) have given permission (said it's okay) for me to take part in a project about learning new strategies to help me learn math.

I will be asked to fill-in a survey that includes approximately 20 items about how I think about and solve math problems. I will be asked to complete the survey two times. It will take about 10-20 minutes each time to do the survey; that means 20-40 minutes in all.

I am taking part because I want to. I know that I can stop at any time if I want to and it will be okay if I want to stop.

_______________________________ _______________________

Sign Your Name Here Print Your Name Here

____

Date

APPENDIX C

MINDSET AND SELF-REGULATION QUESTIONNAIRE

Survey Purpose: The purpose of this survey is to determine what strategies students utilize when solving problems in math and to understand students' beliefs about intelligence in math. The purpose of the last portion of the survey is to determine the effectiveness of the Strength Braining innovation. The last portion will only be administered during the post-test.

Adapted from:

Dweck, C. S. (2016). *Mindset: The new psychology of success*. New York: Random House Incorporated.

Erickson, A. S. & Noonan, P. M. (2018). Self-regulation formative questionnaire. In *The skills that matter: Teaching interpersonal and intrapersonal competencies in any classroom* (pp. 177-178). Thousand Oaks, CA: Corwin.

Demographics **Oral Directions for Survey:** The purpose of this survey is to understand students' beliefs about intelligence and strategies in math. As I read each statement, you will select one of the following categories: strongly agree, agree, slightly agree, slightly disagree, disagree, and strongly disagree. If you need me to clarify any statements, please let me know.	What is your gender? What is your race? Enter the first three letters of your parents' name and the last 4 digits of their phone number.

CONSTRUCT:	Monitor
Self-Regulation Skills: Monitoring Progress **Oral Directions:** The next set of questions are about tracking progress and seeking help in math. Tracking progress means that you are keeping track of your understanding of things in math. Seeking help means that you use resources like notes, teachers or peers to help you when you are stuck. I will read a statement, and you will record your level of agreement with that statement.	1. I keep track of how I am doing in math. 2. I know when I'm behind in math. 3. I track my progress towards my goals in math. 4. I know what my math grade is at any given time. 5. Daily, I identify things I need to get done and track what gets done in math. 6. I have trouble remembering all the things I need to accomplish in math. (N) **Control-Seek Help** 1. I do what it takes to get my math work done on time. 2. I make choices to help me succeed in math, even when they aren't the most fun right now. 3. As soon as I see things aren't going right in math, I ask for help. 4. I keep trying as many different strategies as possible to succeed on a math problem. 5. I have difficulty maintaining my focus on math problems that take a long time to complete. (N) 6. When I get behind on my work in math, I often give up instead of asking for help. (N)

CONSTRUCT: **Self-Regulation Skills: Goal Setting** Goal setting refers to the ability to identify a weak area in math and write a goal that focuses on that area. **Oral Directions:** The next set of questions are about setting goals in math. Goals are statements about what you want to accomplish in math. I will read a statement, and you will record your level of agreement with that statement.	**Reflect-Goal Setting** 1. I think about how well I'm doing on math problems to set goals. 2. I feel a sense of accomplishment when I finish a difficult math problem. 3. I think about how well I've done in the past when I set new goals in math. 4. When I get a math problem wrong, I try to learn from my mistakes. 5. When I keep making the same mistakes over and over again in math, I set a new goal. 6. I have trouble making plans to help me reach my math goals.

Survey items for perceptions of mindset **CONSTRUCT:** **Mindset** Mindset refers to one's implicit theories of intelligence. In other words, mindset refers to whether or not a person believes that intelligence is a fixed asset, or a non-fixed asset. **Oral Directions:** This set of questions involves your beliefs about intelligence. intelligence refers to math abilities. I will read a statement, and you will record your level of agreement with that statement.	1. You have a certain amount of intelligence in math, and you really can't do much to change it. 2. Your intelligence in math is something about you that you can't change very much 3. No matter who you are, you can significantly change your intelligence level in math. 4. To be honest, you can't really change how intelligent you are in math. 5. You can always substantially change how intelligent you are in math. 6. You can learn new things, but you can't really change your basic intelligence in math. 7. No matter how much intelligence you have in math, you can always change it quite a bit. 8. You can change even your basic intelligence level in math considerably.

<u>Survey items for attitudes about innovation (to be given at post-intervention assessment only)</u> **CONSTRUCT:** **Attitudes Towards Innovation (Post-test only)** **Oral Directions:** The next set of questions involve your opinions about the Strength Braining Program. I will read a statement, and you will record your level of agreement with that statement.	1. I believe that the Strength Braining was helpful in math. 2. Strength Braining helped me in math. 3. I liked learning about mindsets. 4. I liked learning to use the self-regulation strategies. 5. Self-regulation strategies were helpful in learning math. 6. By using self-regulation strategies, I learned math better.

Thank you for your participation in this survey.

We appreciate the time and effort you have taken to complete this survey! If you have questions about this research study, please contact the research team: Eugene Judson at Eugene.Judson@asu.edu or Sarah Manchester at Sarah.plitt@asu.edu

APPENDIX D

MINDSET LETTER PROTOCOL

Researcher: Sarah Manchester

Session length: 30 minutes

Location: Classroom

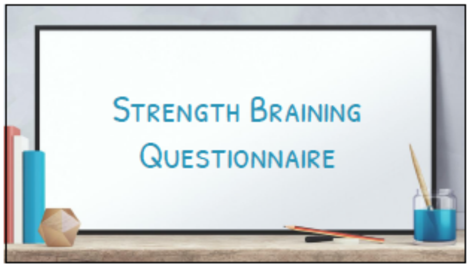
Data storage and collection: Students will submit their letters to Google classroom

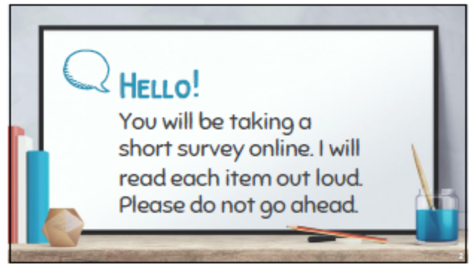
At the conclusion of the Strength Braining sessions, students were given a prompt that described a simulated situation in which to respond. Students will not know that it is a simulated situation. The purpose of this prompt was to understand what students learned from the program and how they would communicate their learnings.

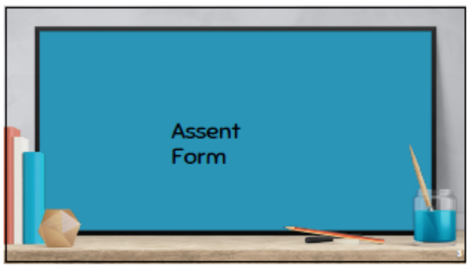
Simulated Prompt: After dismissal yesterday, I had an interesting conversation with a second grader who was crying. When I noticed that she was crying, I asked her what was wrong. She told me that she was going to get in trouble because she had mathematics homework to do for the next day and she didn't understand it at all. "I am stupid… I just don't get it." After having this conversation with her, I wondered if you could write her letters to help encourage her. Think about everything we have learned. What advice would you give her?

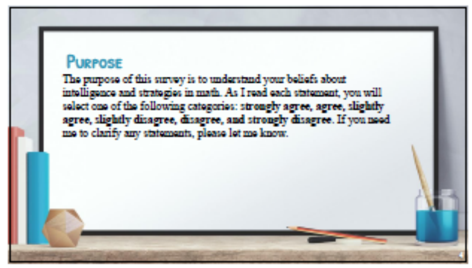
APPENDIX E

STRENGTH BRAINING LESSON MATERIALS

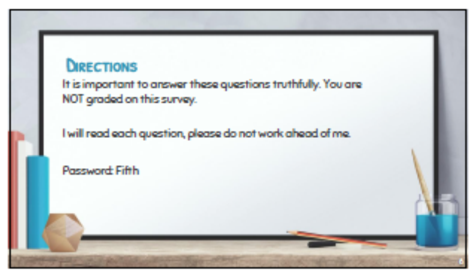

Strength Braining
Questionnaire


Hello!
You will be taking a short survey online. I will read each item out loud. Please do not go ahead.

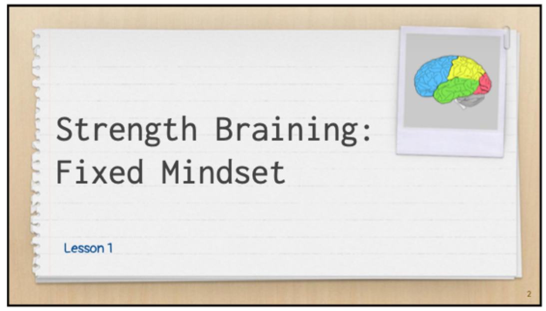

Assent
Form

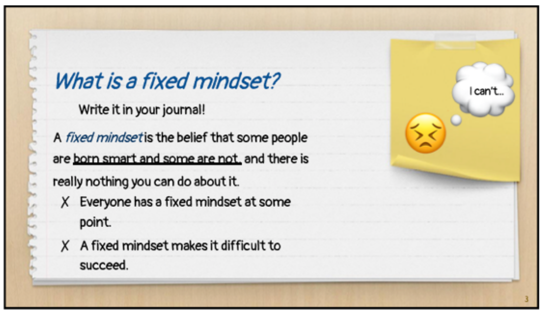

Purpose
The purpose of this survey is to understand your beliefs about intelligence and strategies in math. As I read each statement, you will select one of the following categories: strongly agree, agree, slightly agree, slightly disagree, disagree, and strongly disagree. If you need me to clarify any statements, please let me know.


Directions:
1. Login to your laptop and go to the X-Drive
2. Go to students -> Fifth Grade
3. Manchester or Cotela
4. Questionnaire Links
5. Click "Okay" for read only
6. Click the link
7. Click "Allow"
8. Wait for my directions!

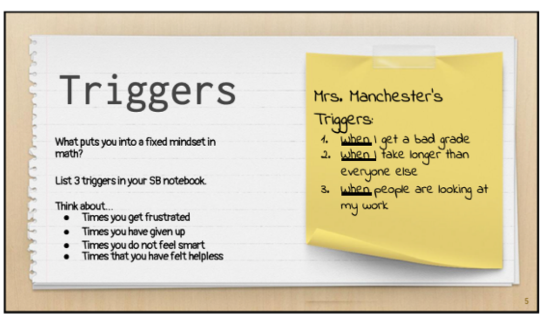

Directions
It is important to answer these questions truthfully. You are NOT graded on this survey.
I will read each question, please do not work ahead of me.
Password: Fifth

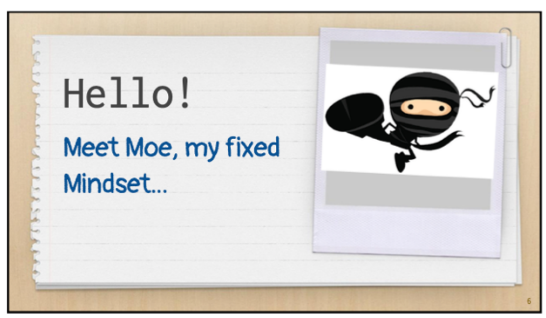

Strength Braining
Purpose
Journals

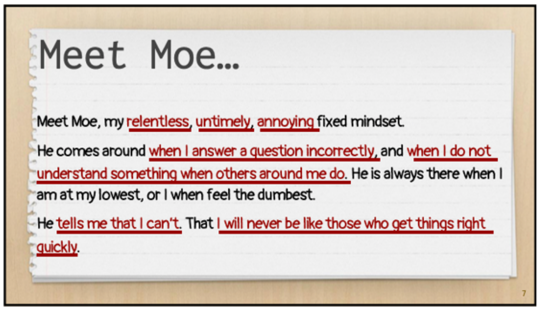

Strength Braining:
Fixed Mindset
Lesson 1


What is a fixed mindset?
Write it in your journal!
A fixed mindset is the belief that some people are born smart and some are not, and there is really nothing you can do about it.
Everyone has a fixed mindset at some point.
A fixed mindset makes it difficult to succeed.
I can't...

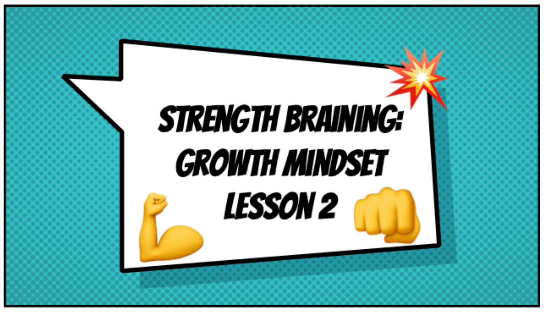

How do you know you are in a fixed mindset?
Negative self-talk
Give up
Afraid to look stupid
Feeling helpless
Mistakes are embarrassing

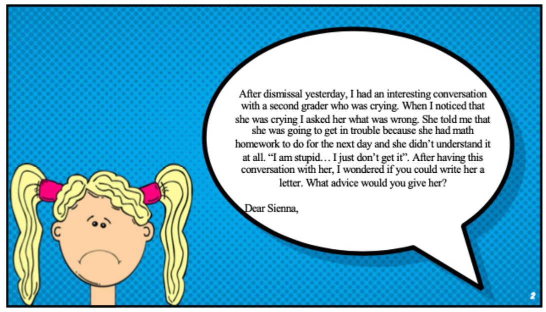

Triggers
What puts you into a fixed mindset in math?
List 3 triggers in your SB notebook.
Think about...
Times you get frustrated
Times you have given up
Times you do not feel smart
Times that you have felt helpless
Mrs. Manchester's Triggers:
1. when I get a bad grade
2. when I take longer than everyone else
3. when people are looking at my work

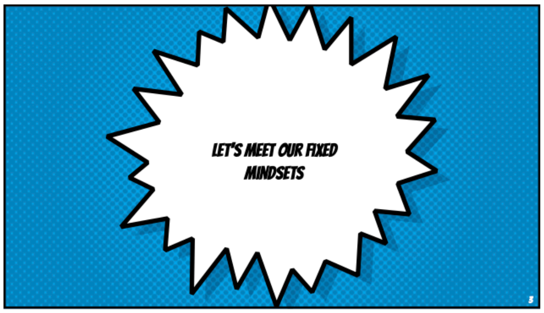

Hello!
Meet Moe, my fixed Mindset...


Meet Moe…
Meet Moe, my relentless, untimely, annoying fixed mindset.
He comes around when I answer a question incorrectly, and when I do not understand something when others around me do. He is always there when I am at my lowest, or I when feel the dumbest.
He tells me that I can't. That I will never be like those who get things right quickly.

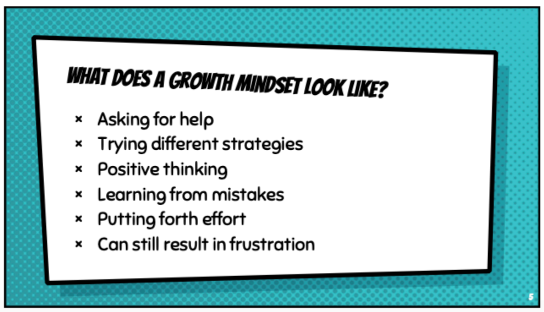

Reflection
Think, Pair, Share…
What is your biggest learning today?

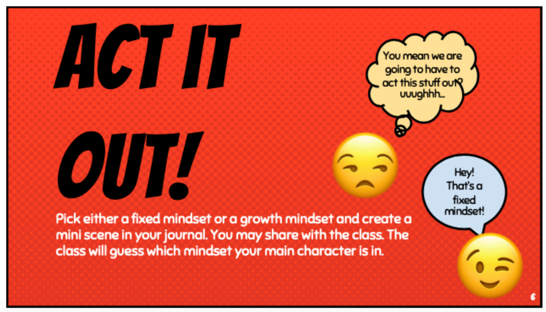

STRENGTH BRAINING: GROWTH MINDSET
LESSON 2

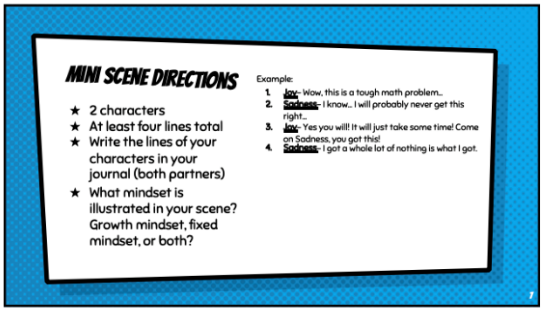

After dismissal yesterday, I had an interesting conversation with a second grader who was crying. When I noticed that she was crying I asked her what was wrong. She told me that she was going to get in trouble because she had math homework to do for the next day and she didn't understand it at all. "I am stupid… I just don't get it". After having this conversation with her, I wondered if you could write her a letter. What advice would you give her?
Dear Sienna,


LET'S MEET OUR FIXED MINDSETS

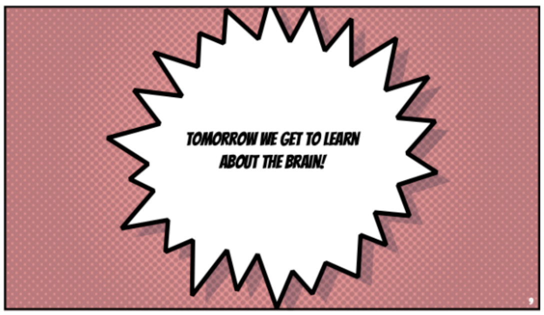

WHAT IS A GROWTH MINDSET?
A growth mindset is the belief that you can grow smartness with effort, strategies, and help from others.
A growth mindset encourages you to keep going when something is hard.

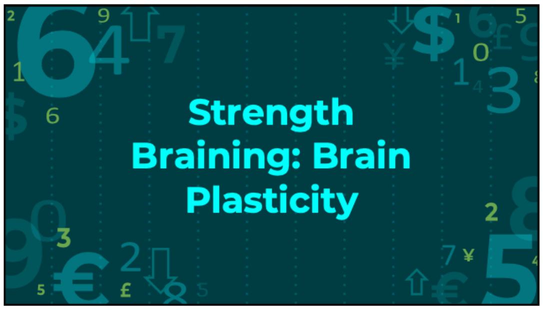

WHAT DOES A GROWTH MINDSET LOOK LIKE?
Asking for help
Trying different strategies
Positive thinking
Learning from mistakes
Putting forth effort
Can still result in frustration

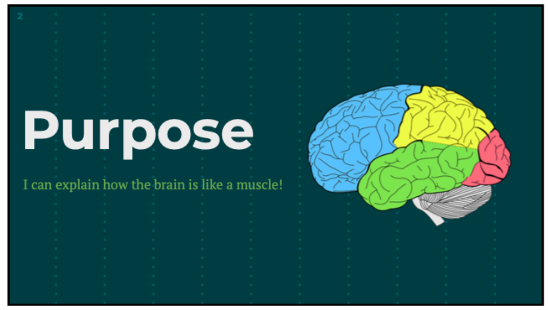

ACT IT OUT!
Pick either a fixed mindset or a growth mindset and create a mini scene in your journal. You may share with the class. The class will guess which mindset your main character is in.
You mean we are going to have to act this stuff out? uuughhh..
Hey! That's a fixed mindset!
6


MINI SCENE DIRECTIONS
★ 2 characters
★ At least four lines total
★ Write the lines of your characters in your journal (both partners)
★ What mindset is illustrated in your scene? Growth mindset, fixed mindset, or both?
Example:
1. Joy- Wow, this is a tough math problem…
2. Sadness- I know… I will probably never get this right…
3. Joy- Yes you will! It will just take some time! Come on Sadness, you got this!
4. Sadness- I got a whole lot of nothing is what I got.
7


DOUBLE BUBBLE
Compare and contrast Growth Mindset and Fixed Mindset in a double bubble map in your journal
8

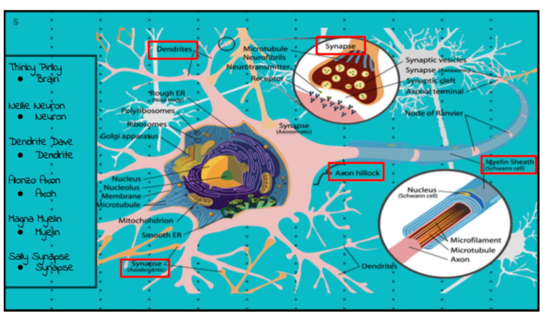

TOMORROW WE GET TO LEARN ABOUT THE BRAIN!
9

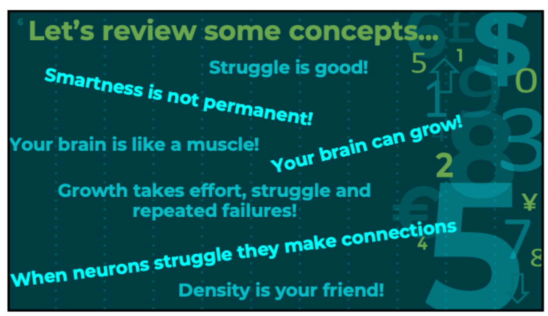

Strength Braining: Brain Plasticity

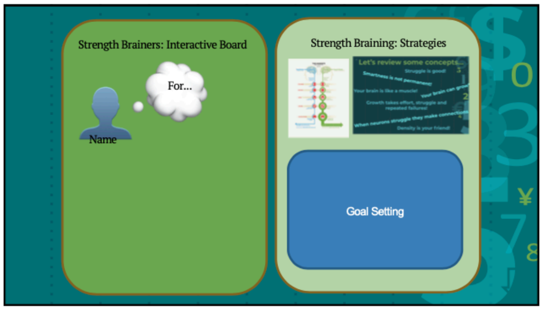

Purpose
I can explain how the brain is like a muscle!


First Viewing
Just sit back and relax!
Second Viewing
Take some notes on the key details of the video!
Third Viewing
Add to your notes and be prepared to share some of your key learnings with a partner! Add anything your partner has to your notes.


Share!
What did you learn?
How does this information make you feel about challenges?


Thinky Pinky
Brain
Nellie Neuron
Neuron
Dendrite Dave
Dendrite
Alonzo Axon
Axon
Magna Myelin
Myelin
Sally Synapse
Synapse
Dendrites
Microtubule
Neurofibrils
Neurotransmitter
Receptor
Synapse
Synaptic vesicles
Synaptic cleft
Axonal terminal
Node of Ranvier
Rough ER
Polyribosomes
Ribosomes
Golgi apparatus
Synapse (Axosomatic)
Myelin Sheath (Schwann cell)
Axon hillock
Nucleus
Nucleolus
Membrane
Microtubule
Mitochondrion
Smooth ER
Nucleus (Schwann cell)
Microfilament
Microtubule
Axon
Synapse (Axodendritic)
Dendrites


Let's review some concepts...
Struggle is good!
Smartness is not permanent!
Your brain is like a muscle!
Your brain can grow!
Growth takes effort, struggle and repeated failures!
When neurons struggle they make connections
Density is your friend!



Strength Brainers: Interactive Board
For...
Name
Strength Braining: Strategies
Let's review some concepts...
Struggle is good!
Smartness is not permanent!
Your brain is like a muscle!
Your brain can grow!
Growth takes effort, struggle and repeated failures!
When neurons struggle they make connections
Density is your friend!
Goal Setting

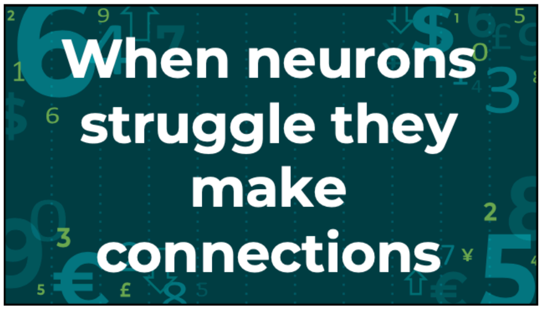
Main Idea
Write the Main idea of today's lesson in your SB Journal.

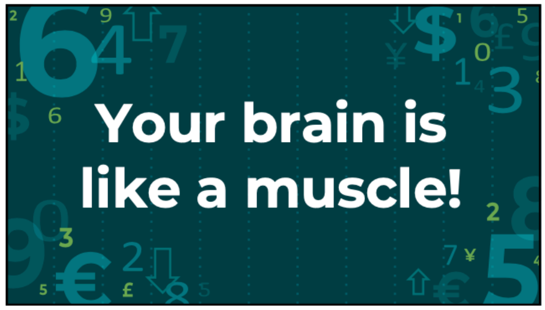
Posters

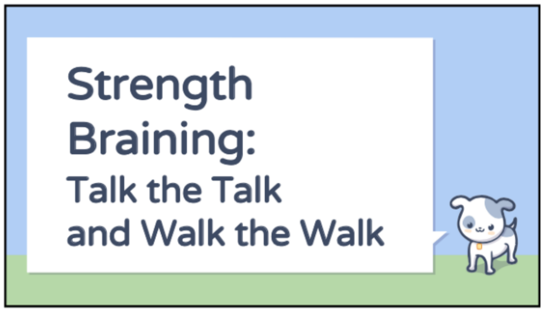
Smartness is not permanent!

Growth takes effort, struggle and repeated failures!

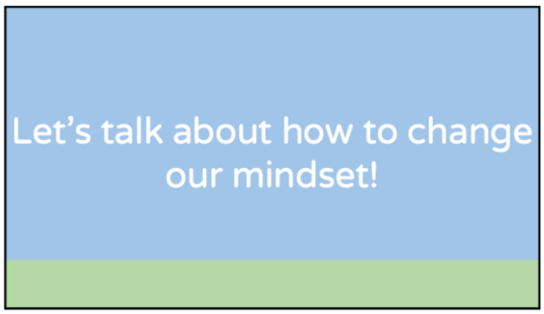
Growth takes effort, struggle and repeated failures!


When neurons struggle they make connections

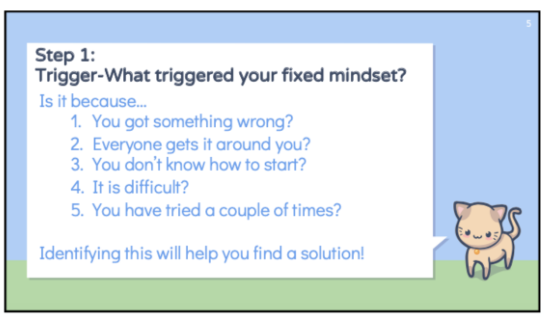

Your brain is like a muscle!

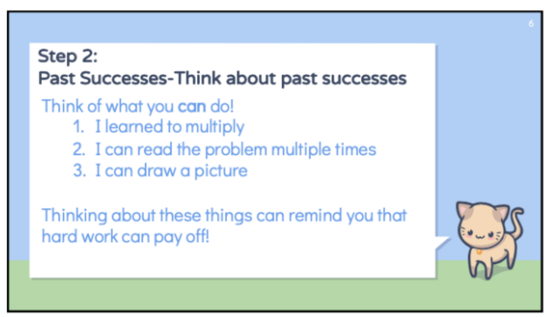

Strength Braining:
Talk the Talk
and Walk the Walk

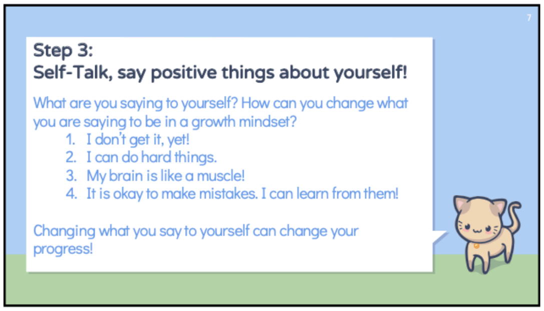

Brainstorm…
How do you know you are in a fixed mindset?
1. What do you say?
2. What do you do?
3. What happens?
How do we get out of this mindset?

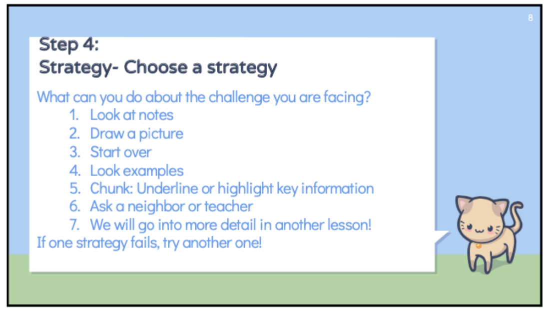

Let's talk about how to change our mindset!

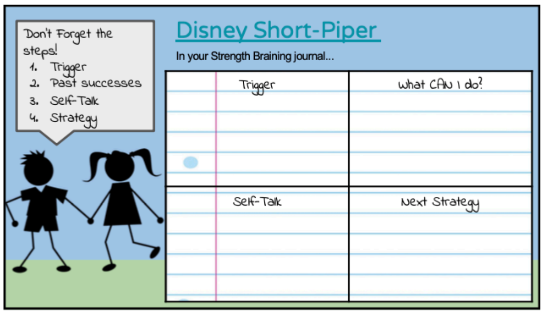

I am in a fixed mindset… What now?
There are steps you can take to get out of a fixed Mindset!
1. Trigger. Think about what triggered your fixed Mindset.
2. Past success. Think about your past successes.
3. Self-Talk, make it positive!
4. Strategy can you use to help?

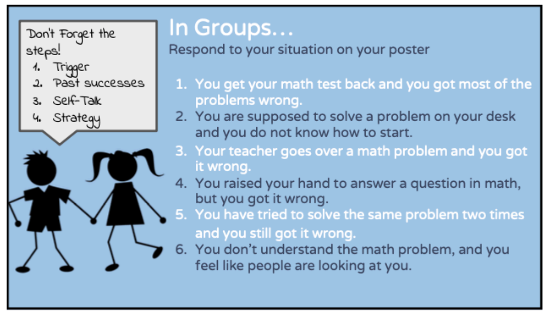

Step 1:
Trigger-What triggered your fixed mindset?
Is it because…
1. You got something wrong?
2. Everyone gets it around you?
3. You don't know how to start?
4. It is difficult?
5. You have tried a couple of times?
Identifying this will help you find a solution!


Step 2:
Past Successes-Think about past successes
Think of what you can do!
1. I learned to multiply
2. I can read the problem multiple times
3. I can draw a picture
Thinking about these things can remind you that hard work can pay off!


Step 3:
Self-Talk, say positive things about yourself!
What are you saying to yourself? How can you change what you are saying to be in a growth mindset?
1. I don't get it, yet!
2. I can do hard things.
3. My brain is like a muscle!
4. It is okay to make mistakes. I can learn from them!
Changing what you say to yourself can change your progress!


Step 4:
Strategy- Choose a strategy
What can you do about the challenge you are facing?
1. Look at notes
2. Draw a picture
3. Start over
4. Look examples
5. Chunk: Underline or highlight key information
6. Ask a neighbor or teacher
7. We will go into more detail in another lesson!
If one strategy fails, try another one!

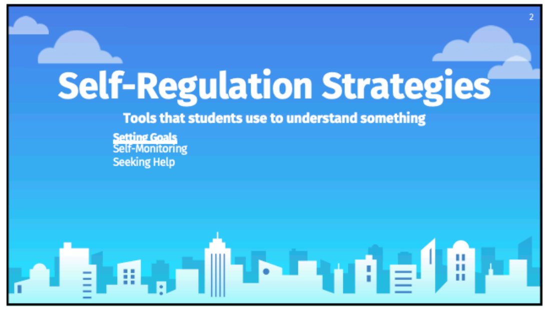

Don't Forget the steps!
1. Trigger
2. Past successes
3. Self-Talk
4. Strategy
Disney Short-Piper
In your Strength Braining journal...
Trigger
What CAN I do?
Self-Talk
Next Strategy

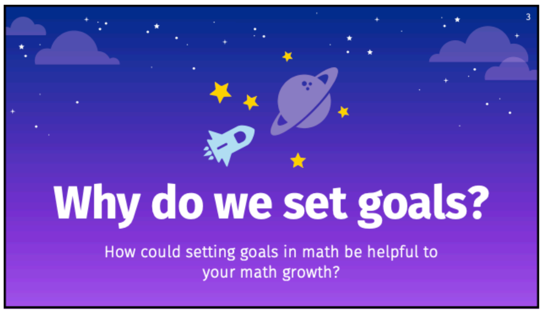

Don't Forget the steps!
1. Trigger
2. Past successes
3. Self-Talk
4. Strategy
In Groups…
Respond to your situation on your poster
1. You get your math test back and you got most of the problems wrong.
2. You are supposed to solve a problem on your desk and you do not know how to start.
3. Your teacher goes over a math problem and you got it wrong.
4. You raised your hand to answer a question in math, but you got it wrong.
5. You have tried to solve the same problem two times and you still got it wrong.
6. You don't understand the math problem, and you feel like people are looking at you.


Mojo-Episode 1
Math gets harder and Mojo tries to quit school

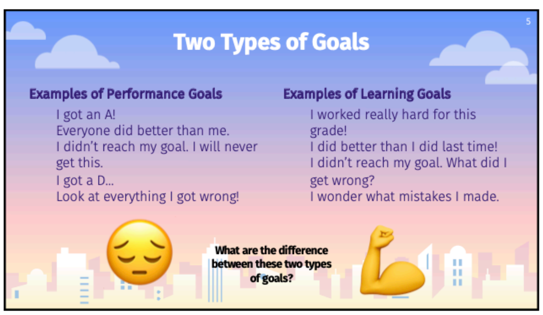

Share!
Which step was the most difficult?

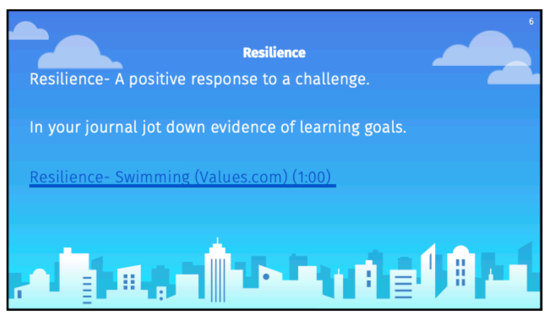

Strength Braining:
Goal Setting

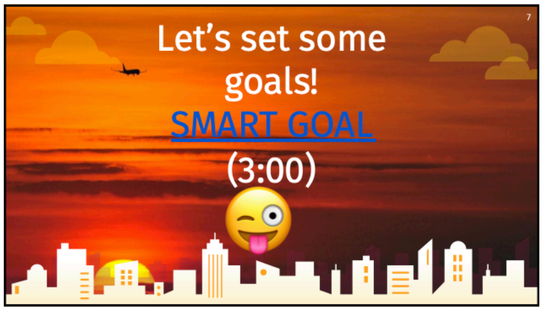

Self-Regulation Strategies
Tools that students use to understand something
Setting Goals
Self-Monitoring
Seeking Help

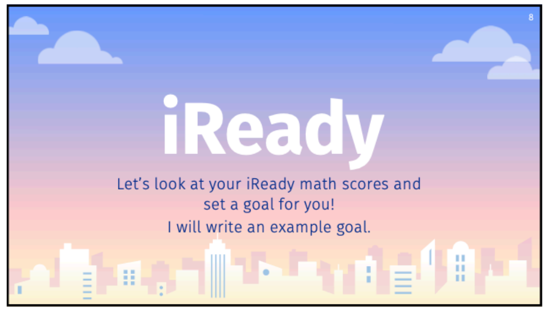

Why do we set goals?
How could setting goals in math be helpful to your math growth?

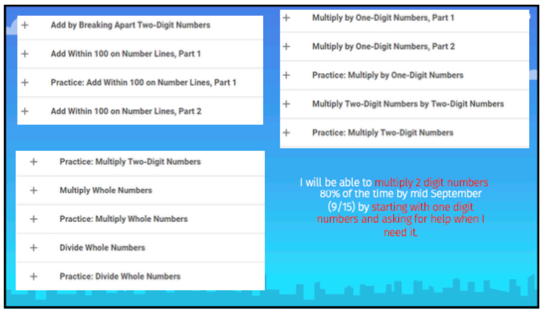

Two Types of Goals
Performance Goals
Focus on ability
Compare ability to others
Focuses on one outcome
Encourages a fixed mindset
Encourages negative self-talk
Learning Goals
Focuses on growth
Focused on improving math skills
Encourages resiliency
Learn from mistakes and failures
Encourages positive self-talk


Two Types of Goals
Examples of Performance Goals
I got an A!
Everyone did better than me.
I didn't reach my goal. I will never get this.
I got a D...
Look at everything I got wrong!
Examples of Learning Goals
I worked really hard for this grade!
I did better than I did last time!
I didn't reach my goal. What did I get wrong?
I wonder what mistakes I made.
What are the difference between these two types of goals?

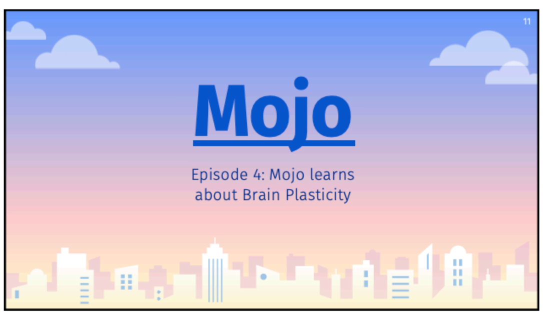

Resilience
Resilience- A positive response to a challenge.
In your journal jot down evidence of learning goals.
Resilience- Swimming (Values.com) (1:00)


7
Let's set some goals!
SMART GOAL
(3:00)


8
iReady
Let's look at your iReady math scores and set a goal for you!
I will write an example goal.


Add by Breaking Apart Two-Digit Numbers
Add Within 100 on Number Lines, Part 1
Practice: Add Within 100 on Number Lines, Part 1
Add Within 100 on Number Lines, Part 2
Multiply by One-Digit Numbers, Part 1
Multiply by One-Digit Numbers, Part 2
Practice: Multiply by One-Digit Numbers
Multiply Two-Digit Numbers by Two-Digit Numbers
Practice: Multiply Two-Digit Numbers
Practice: Multiply Two-Digit Numbers
Multiply Whole Numbers
Practice: Multiply Whole Numbers
Divide Whole Numbers
Practice: Divide Whole Numbers
I will be able to multiply 2 digit numbers 80% of the time by mid September (9/15) by starting with one digit numbers and asking for help when I need it.


10
Goal Sort
Performance Goal
Learning Goal
1. I worked really hard on this test, and it shows!
2. I got an A! What did you get?
3. Everyone did better than me…
4. I am going to ask the teacher why I got this questions wrong.
5. I didn't understand this question, I should ask for help.
6. Ugh… I am stupid.
7. That's okay, I'll just keep working on it.
8. I give up. I keep getting them wrong!

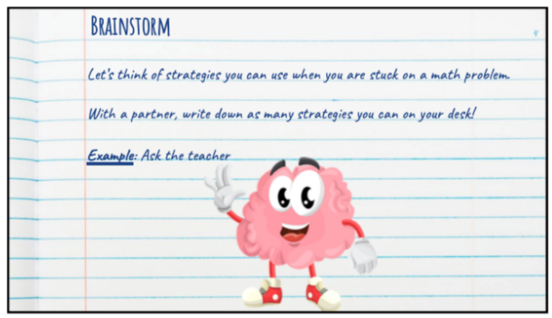

11
Mojo
Episode 4: Mojo learns about Brain Plasticity

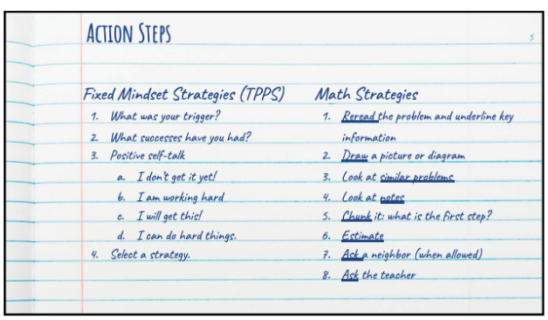

12
Resilience
Resilience- A positive response to a challenge.
Partly Cloudy (6:00)
On your desk jot down evidence of learning goals for either characters (the cloud or the stork).
Pip –Dog Training (5:00)
Resilience-Race (Values.com) (1:00)
Resilience 2- Swimming (Values.com) (1:00)

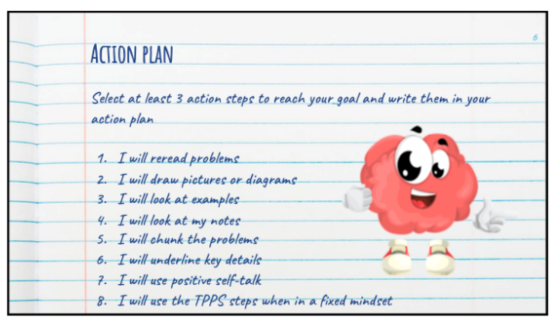

Self-Regulation Strategy
Self-Monitoring
Lesson 6

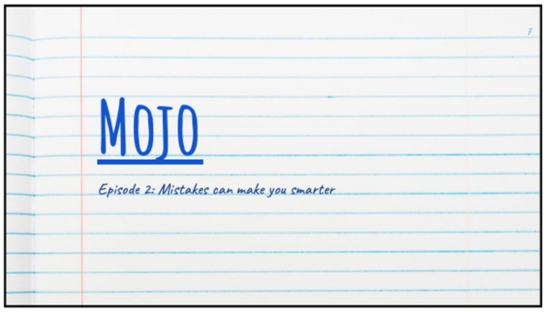

Self-Monitor
The ability of being aware of the learning process and when strategies are not working.
Self-Monitoring thoughts
• Is what I am doing working?
• What strategy can I use to help me?
• How am I progressing towards my goal?
What is my goal again?

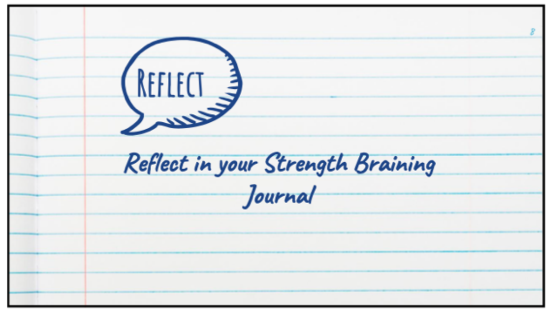

Action Steps
Example goal here
What am I going to do to reach this goal?
My goal is…
Action Steps:
1. What will I do when I get stuck?
2. What will I do when I am in a fixed mindset?
3. What strategies can help me reach my goal?
How are you going to get there?


Brainstorm
Let's think of strategies you can use when you are stuck on a math problem.
With a partner, write down as many strategies you can on your desk!
Example: Ask the teacher


Action Steps
Fixed Mindset Strategies (TPPS)
1. What was your trigger?
2. What successes have you had?
3. Positive self-talk
a. I don't get it yet!
b. I am working hard
c. I will get this!
d. I can do hard things.
4. Select a strategy.
Math Strategies
1. Reread the problem and underline key information
2. Draw a picture or diagram
3. Look at similar problems
4. Look at notes
5. Chunk it: what is the first step?
6. Estimate
7. Ask a neighbor (when allowed)
8. Ask the teacher


Action Plan
Select at least 3 action steps to reach your goal and write them in your action plan
1. I will reread problems
2. I will draw pictures or diagrams
3. I will look at examples
4. I will look at my notes
5. I will chunk the problems
6. I will underline key details
7. I will use positive self-talk
8. I will use the TPPS steps when in a fixed mindset

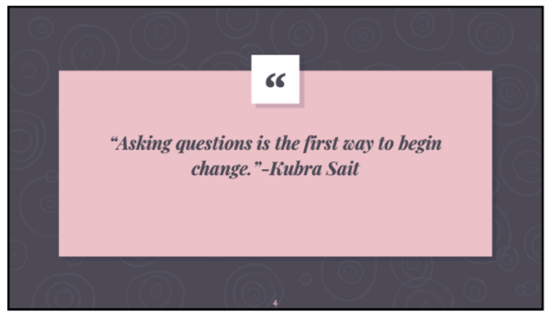

Mojo
Episode 2: Mistakes can make you smarter

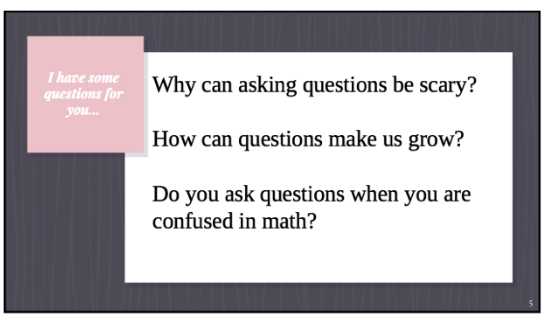

Reflect
Reflect in your Strength Braining Journal


Strength
Braining:
Seeking Help

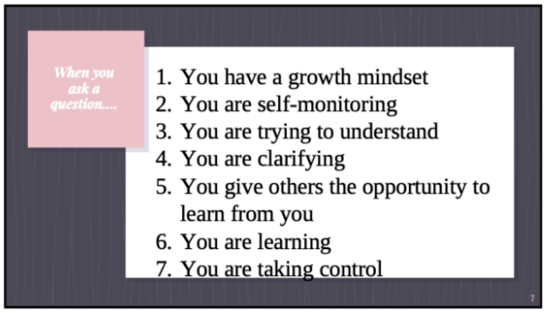

1
Self-Regulation
Strategy: Seeking
Help
Lesson 7

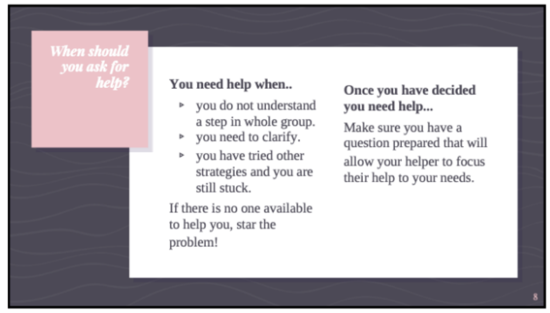

Mojo
Episode 3- Katie does not ask for help.

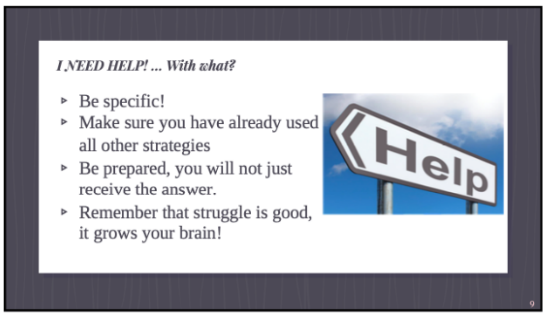

"Asking questions is the first way to begin
change."-Kubra Sait

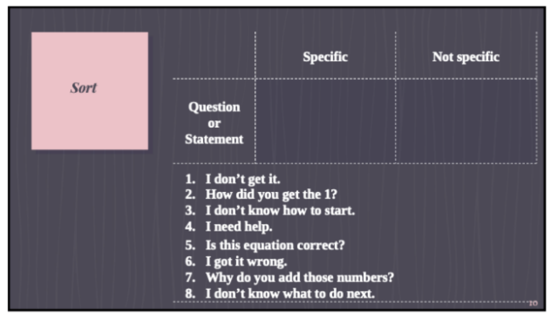

I have some
questions for
you...
Why can asking questions be scary?
How can questions make us grow?
Do you ask questions when you are
confused in math?

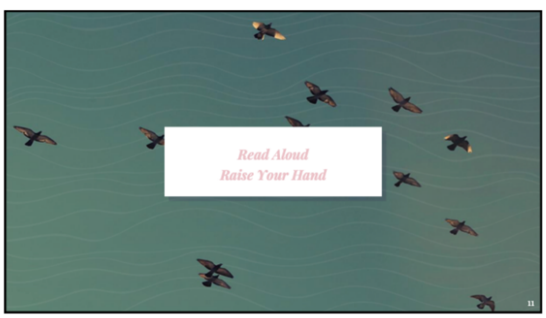

What expectations need to be in place for students to
feel comfortable asking questions?

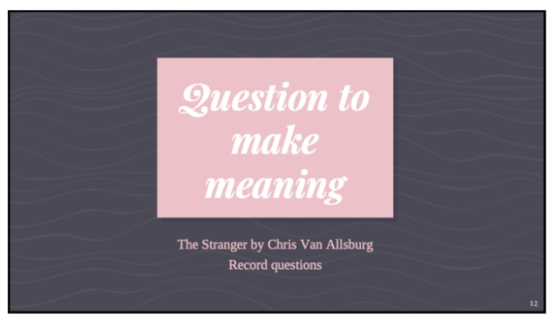

When you ask a question….
1. You have a growth mindset
2. You are self-monitoring
3. You are trying to understand
4. You are clarifying
5. You give others the opportunity to learn from you
6. You are learning
7. You are taking control
7


When should you ask for help?
You need help when..
you do not understand a step in whole group.
you need to clarify.
you have tried other strategies and you are still stuck.
If there is no one available to help you, star the problem!
Once you have decided you need help...
Make sure you have a question prepared that will allow your helper to focus their help to your needs.
8

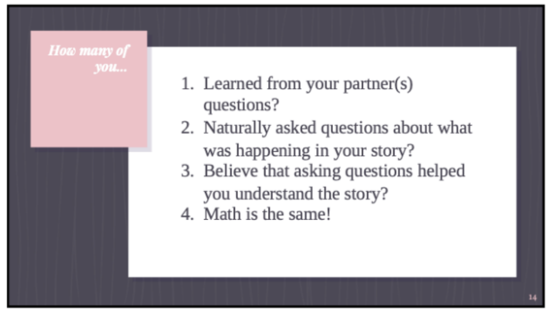

I NEED HELP! ... With what?
Be specific!
Make sure you have already used all other strategies
Be prepared, you will not just receive the answer.
Remember that struggle is good, it grows your brain!
Help
9


Sort
Specific
Not specific
Question or Statement
1. I don't get it.
2. How did you get the 1?
3. I don't know how to start.
4. I need help.
5. Is this equation correct?
6. I got it wrong.
7. Why do you add those numbers?
8. I don't know what to do next.
10


Read Aloud
Raise Your Hand
11


Question to make meaning
The Stranger by Chris Van Allsburg
Record questions
12

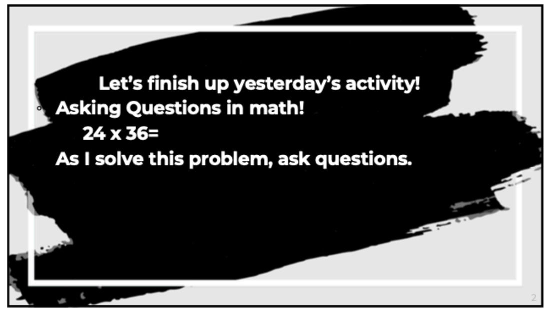

Question to make meaning
Break up into groups
Ask questions as you read your book

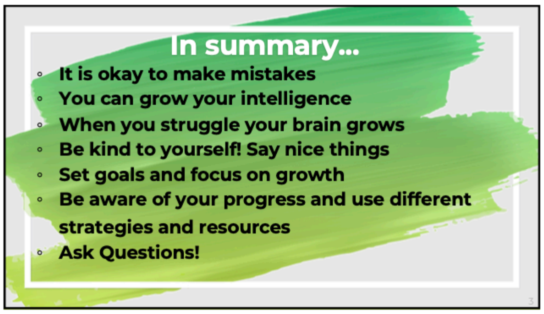

How many of you...
1. Learned from your partner(s) questions?
2. Naturally asked questions about what was happening in your story?
3. Believe that asking questions helped you understand the story?
4. Math is the same!

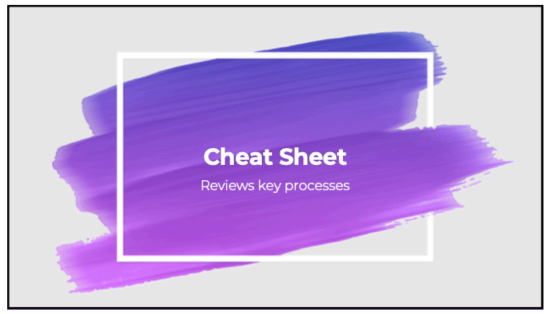

Reflection


Yes,
you can do hard things!


Strength Braining: Putting it all together


Let's finish up yesterday's activity!
Asking Questions in math!
24 x 36=
As I solve this problem, ask questions.


In summary…
It is okay to make mistakes
You can grow your intelligence
When you struggle your brain grows
Be kind to yourself! Say nice things
Set goals and focus on growth
Be aware of your progress and use different strategies and resources
Ask Questions!


Cheat Sheet
Reviews key processes


Mojo- Put it all together Episode 5


"No matter what your ability is, effort is what ignites that ability and turns it into accomplishment."
-Carol S. Dweck


Escape the Room
Let's Make Teams and Team Names

Fixed Mindset Profile

Meet ______________________, my ______________________, and
Name *adjective*

______________________ fixed mindset.
adjective

He/She comes around when…

____
Trigger 1

and when

____
Trigger 2

.

He/She tells me that…

____
First thing your Fixed Mindset tells you

and that

____
Second thing your Fixed Mindset tells you

Illustrate your fixed mindset below:

Name:________________________ Date:___________

Lesson 1: Fixed Mindset

<u>Fixed Mindset</u>: The belief that some people are born smart and some are not, and there really isn't anything that you can do about it.

You are in a fixed mindset when you...

- ☐ Have negative self-talk
- ☐ Give up
- ☐ Are afraid to look stupid
- ☐ Feel helpless
- ☐ Are embarrassed by mistakes

Lesson 2: Growth Mindset

<u>Growth Mindset</u>: The belief that you can grow smartness with effort, strategies, and help from others.

You are in a growth mindset when you...

- ☐ Ask for help
- ☐ Try different strategies
- ☐ Have positive thinking
- ☐ Learn from mistakes
- ☐ Put forth effort

Lesson 3: Brain Plasticity

<u>Brain Plasticity</u>: With effort, repetition and practice the brain can change and grow new neuro pathways and cells, making you smarter.

- ☐ Your brain is like a muscle, it can grow with effort, struggle and challenges
- ☐ Struggle makes your brain grow
- ☐ Brain growth takes effort, struggle and repeated failures
- ☐ Learn from your mistakes, do not be ashamed of them
- ☐ Mistakes are an opportunity and they WILL happen

Lesson 4: Talk the Talk

★ Self-Talk: Self-talk is what you say to yourself and about yourself when you are struggling or challenged. When you find yourself in a fixed mindset, follow the TPSS steps to promote a growth mindset and positive self-talk.

TPSS Steps:

1. Trigger: Think about what triggered your fixed Mindset. (ex: bad grade, don't get it, got a problem wrong)
2. Past Successes: Think about your past successes. These prove that you are not stupid!
   Self-Talk: Use positive self-talk. Only say positive things about yourself.
3. Strategy: Think about what strategies you can use.

Lesson 5: Goal Setting (Self-Regulation Strategy #1)

★ Self-Regulation: The ability to be aware of your academic progress and the ability to change your approach to challenges.

★ Goal: A focused statement of what you would like to accomplish. It should be measurable, specific and attainable.

- ☐ Set a learning goal that focuses on growth not grades!
- ☐ Learn from your mistakes, they are opportunities to learn
- ☐ Be resilient (don't give up) when you face challenges

Lesson 6: Self-Monitoring (Self-Regulation Strategy #2)

★ Self-Monitoring: The ability to monitor the learning process and select strategies and resources that are appropriate.

Use different strategies and resources when you are struggling! Don't give up.

- ☐ Reread the problem and underline key information
- ☐ Draw a picture or diagram
- ☐ Look at similar problems
- ☐ Look at notes
- ☐ Chunk it: what is the first step?
- ☐ Estimate
- ☐ Ask a neighbor (when appropriate)
- ☐ Ask the teacher

Lesson 7: Seeking Help (Self-Regulation Strategy #3)

- ☐ Be respectful of others, there are no stupid questions.
- ☐ It is okay to ask questions, it shows that you are putting in effort to understand a concept!
- ☐ Others can learn from your questions, don't keep them to yourself.
- ☐ Make sure your question is specific (Ex: How did you get that number?)
- ☐ If you ask a teacher, you will not get the answer, but focused direction.
- ☐ Struggle is good! It grows your brain!

Lesson 8: Put it All Together

- ☐ Stay in a growth mindset! If you are not, think TPSS!
- ☐ It is okay to make mistakes
- ☐ You can grow your intelligence
- ☐ When you struggle your brain grows
- ☐ Be kind to yourself! Say nice things
- ☐ Set goals and focus on growth
- ☐ Be aware of your progress and use different strategies and resources
- ☐ Ask Questions!

Name:______________________________ #:_______ Date:__________ Parent Signature:_____________________________________

iReady Math Goal:

____

____

____

iReady Score				
	Monday	**Tuesday**	**Thursday**	**Friday**
Strategies Used	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ TPPS ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ TPPS ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ TPPS ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ TPPS ☐ Other:__________
Mindset	Fixed / Growth	Fixed / Growth	Fixed / Growth	Fixed / Growth

Action Plan: To reach this goal, I will…

1. ____
2. ____
3. ____

Proud Moment:

____

____

____

Growth Opportunity:

____

____

____

Name:________________________________ #:_______ Date:__________ Parent Signature:______________________________________

Personal Goals

Core Math Goal:

____

____

Score 1-4				**Reassess**
	Monday	**Tuesday**	**Thursday**	**Friday**
Strategies Used	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________
Mindset	Fixed / Growth	Fixed / Growth	Fixed / Growth	Fixed / Growth

Core Math Goal:

____

____

Score 1-4				**Reassess**
	Monday	**Tuesday**	**Thursday**	**Friday**
Strategies Used	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________	☐ Reread problem ☐ Draw a picture ☐ Look @ examples ☐ Chunk/underline info ☐ Look @ Notes ☐ Ask friend/teacher ☐ Other:__________
Mindset	Fixed / Growth	Fixed / Growth	Fixed / Growth	Fixed / Growth

APPENDIX F

INSTITUTIONAL REVIEW BOARD APPROVAL

EXEMPTION GRANTED

Eugene Judson
Division of Educational Leadership and Innovation - Polytechnic Campus
480/727-5216
Eugene.Judson@asu.edu

Dear Eugene Judson:

On 2/28/2019 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Strength Braining: An innovation countering Fifth-Grade Underachievement in mathematics Through the Development of a Growth Mindset and Self-Regulation
Investigator:	Eugene Judson
IRB ID:	STUDY00009534
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Recruitment/Consent Letter, Category: Consent Form; • Sarah Manchester Protocol, Category: IRB Protocol; • Survey, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Assent Form, Category: Consent Form; • Innovation Sessions, Category: Other (to reflect anything not captured above); • Kyrene Letter of Approval, Category: Off-site authorizations (school permission, other IRB approvals, Tribal permission etc);

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (1) Educational settings on 2/28/2019.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Sarah Plitt
Eugene Judson
Sarah Plitt

APPENDIX G

STRENGTH BRAINING PROFESSIONAL DEVELOPMENT

Strength Braining Professional Development

Month	Key Concepts	Components	Assessment
August 1.5 hrs	Growth Mindset Fixed Mindset Effects of the mindsets Brain Plasticity	Jigsaw Teachers' Mindsets: "Every Student has Something to Teach Me" article (Dweck, 2014) Review positive effects of a growth mindset environment in the classroom. Define Brain Plasticity. Read article/watch kids friendly videos. What could this look like in your classroom? Have teachers select a subject to observe students' behaviors. How do they react to challenges? How to they respond to mistakes/failures? Are they motivated? Do they put forth effort?	Teacher Survey Observation Reflection
September 1.5 hrs	Operationalize the mindsets Resilience Process Feedback	PLC observation discussion and problem solving Sort Scenarios into the two mindsets Define and make a list of process feedback for each grade level Practice/model offering process feedback to grade level scenarios How to foster resilience with process feedback Teachers reflect/record their use of process feedback in the classroom over the next month.	Observation Reflection and PLC discussion

November 1.5 hrs	Introduce Self-Regulation Strategies Metacognitive Vs. Cognitive	PLC review reflections. Troubleshoot as a team/staff. Define metacognitive strategies Define cognitive strategies Prompt teachers to consider how the types of strategies work in tandem Grade level teams create cognitive and metacognitive strategies for an identified subject. How can you construct a list of strategies with your kids? Reflect in your journal this month.	PLC discussion and reflections.
January 1.5 hrs	Self-Regulation Strategy Goal Setting	PLC review reflections. Troubleshoot as a team/staff. What does goal-setting look like in your room now? Benefits of SMART goals. Set personal SMART goals. As a team discuss a subject in which students could set a SMART goal. What data can you use? How can you track that data? How can students be autonomous in tracking their data? Reflect on goal-setting in your classroom. What is going well? What barriers are you facing? Bring a couple of students' goals to share at the next meeting.	PLC discussion and reflections.
February 1.5 hrs	Self-Regulation	PLC review reflections. Troubleshoot as a team/staff.	PLC discussion

	Strategy: Self-Monitoring	Develop an action plan for teachers' personal goals. What do action steps look like? Look at some students' goals and discuss possible actions steps for that goal. Reflect on any of the concepts in a journal a bring it back.	and reflections.
March 1 hr	Putting it All Together Part 1	Choose 2 Stations: Mindset Station Brain Plasticity station Cognitive/Metacognitive station Goal-Setting station Self-Monitoring station Process Feedback station	PLC discussion and reflections.
April 1 hr	Putting it All Together Part 2	Choose 2 Stations: Mindset Station Brain Plasticity station Cognitive/Metacognitive station Goal-Setting Station Self-Monitoring station Process Feedback station	PLC discussion and reflections.
May 1 hr	Putting it All Together Part 3	Planning for Next Year	