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# Instilling Motivation, Embracing Mistakes, and Fostering Grit: Using The Rubik's Cube in Elementary Classrooms

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# INSTILLING MOTIVATION, EMBRACING MISTAKES, AND FOSTERING GRIT: USING THE RUBIK'S CUBE IN ELEMENTARY CLASSROOMS

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# ABSTRACT

Research into the use of a Rubik's cube in an elementary classroom can provide future implications on fostering grit through a growth mindset. Although previous studies show grit to be a predictor of student success, research surrounding the literature does not address how grit can be taught in the classroom. This mixed methods study explored the missing research by examining the differences between cognitive and non-cognitive skills with the influence of a deliberate practice. The Rubik's cube acted as the instructional tool to foster grit and growth mindset by engaging students in a motivating challenge that builds perseverance and critical thinking skills. The study was conducted using second grade students from a Title I school in the south. The treatment group participate in grit and growth mindset discussions, as well as Rubik's cube instruction. The control group also participated in grit and growth mindset discussions using motivational PowerPoints and videos, but did not receive any type of Rubik's cube instruction. Pre-tests and post-tests were used to analyze reading and mathematics change scores, along with grit and growth mindset levels. In addition, the researcher reflected in a teacher journal, collected student responses from writing prompts, as well as conducted teacher interviews to conclude the study.

# DEDICATION

To my memaw,
For showing me what it means to have grit

To my parents,
For teaching me the meaning of hard work

To my husband,
For cheering me on and being my biggest fan

To my twins,
For kicking me to the finish line

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# CHAPTER I

## INTRODUCTION

*It's not that I'm so smart, it's just that I stay with problems longer.*
-Albert Einstein

Walt Disney was fired for not being creative enough, and J.K. Rowling's first draft of Harry Potter was rejected twelve times before finally getting published by Bloomsbury London publishers (Great Performers, 2021). Simone Biles grew up in foster care and learned how to do backflips off of her neighbor's mailbox, and Michael Oher jumped from home to home while struggling in school with a reading comprehension level equivalent to a second grader (Carr, 2016; Zakarin, 2021).When taking on a challenge, failure is inevitable. However, people are curious to see what it takes to reach a desired goal. After tasting success, the bar is raised even higher to find out if a more efficient approach can result in a faster, better, or stronger outcome (Ericsson & Pool, 2016). What makes some people successful? Why do some people persist and strive to be the best? Is it the effort used to achieve the goal, or is it the talent brought to the table? Perhaps people with a go-get-it attitude were exposed to rich experiences from an early age that fueled the connection of pathways in the brain resulting in a positive learning cycle (Zull, 2011).

Dweck (2006) and Duckworth (2016) suggested that successful people work towards a goal and persevere through adversity using a positive mindset. Although success looks different for everyone, Duckworth (2016) proposed that success refers to meeting a desired outcome. The described icons are known for their extraordinary talent and creativity, but their setbacks reveal

that success requires more than ability. Duckworth (2016) stated, “Consistency of effort over the long run is everything” (p. 50). Everyone has potential to reach a new goal, but unexpected detours will always be ahead that require additional determination to reach the finish line (Ericsson & Pool, 2016). In order to accomplish the objective, one must put forth effort, persist in adversity, and maintain consistency (Duckworth, 2016). Therefore, how does society teach children to instill motivation, embrace mistakes, and foster grit?

Duckworth (2016), a psychology professor at the University of Pennsylvania, is known for research in grit. Duckworth coined and defined grit as “passion and perseverance for long-term goals” and supported the theory by creating and implementing the Grit Scale (Duckworth, 2016, p. 12; Peck, 2018). Studies using the Grit Scale have been conducted on cadets at West Point, first year teachers in Chicago, and National Spelling Bee contestants. In each of the studies, findings revealed grit to be a predictor of success. Duckworth (2021) has described various ways grit is developed, such as recognizing self-control and acknowledging mistakes, but is unsure if grit is grown, learned, or possibly cultivated.

**Background of the Study**

Data suggest that standardized tests can predict future success by measuring knowledge and acquired skills, but studies also indicate that an increase in test scores does not necessarily influence abstract thinking and one’s ability to problem solve (Eng, 2015). Students can be proficient in mathematics and reading skills, but still struggle at being successful with challenging tasks (Tough, 2016). Trafton (2013) evaluated 1,400 eighth graders in Boston public schools who had an increase in state test scores. The study found that cognitive gains did not improve student performance when working with abstract problems, such as identifying missing

puzzle pieces. Trafton suggested that student achievement involves more than solely focusing on test scores. Duckworth (2009) indicated that the challenge now rests in identifying what personal characteristics predict success outside of standardized achievement levels.

Hochanadel and Finamore (2015) proposed that grit could be cultivated by having a growth mindset. Growth mindset, a concept developed by Carol Dweck (2015), suggests that student perceptions on intelligence can be developed through accepting setbacks and identifying areas of growth. Findings have shown a correlation between grit and growth mindset, but little evidence exists on how character education can impact academic achievement. In addition, learning strategies that foster grit and growth mindset are described in current research but lack explicit techniques and practices for classroom implication (Laursen, 2015; McKibben, 2018). Bashant (2014) suggested that grit and growth mindset could be taught to students when using the right strategies. Recommendations for encouraging the two concepts include discussion of attitude, communication with classmates, and repetition with a deliberate practice.

Deliberate practice is described as purposefully working towards a goal while being pushed beyond the expected limit by using repetition and reflection (Ericsson, Krampe, & Tesch-Romer, 1993). Duckworth and Dweck created a theoretical framework that suggested the level of grit can change after teaching students to embrace a growth mindset by implementing a deliberate practice in the classroom (Perkins-Gough, 2013). Ericsson and Pool (2016) recommended that educators teach children how to plan realistic goals with specific steps as a way to encourage deliberate practice. Instead of mindless repetition, instruction should focus on meaningful practice that builds potential. A clear goal with an intentional plan teaches adolescents to monitor progress and develop habits for maintaining motivation. Students learn to

embrace the idea that trying harder is not always the answer, but instead, trying differently may be the key to improvement. Working towards a goal with purposeful action cultivates a growth mindset and teaches children that moving past hardships require grit and determination (Ericsson & Pool, 2016).

With the help of new technology, neuroscientists found that the brain physically grows during a deliberate practice that is repetitive, challenging, and moves the individual out of the comfort zone (Zull, 2004). When using a deliberate practice to learn a new skill, neurons fire repeatedly and send signals to other connecting neurons. The signaling connections are the synapses, which holds the job of transforming isolated neurons into an active system of talking neurons. In order to create the buzzing neurons, the brain must respond to emotional chemicals, such as adrenalin, dopamine, or serotonin. Once emotion is a factor in the firing of the neurons, the synapse is altered and the reaction of neurons can change, which results in learning. In order for meaningful learning to take shape, tasks should be geared toward activating all areas of the brain (Zull, 2004). Hohen and Murphy (2016) encouraged adults to expose children to challenging tasks that present opportunities for success. As research in neuroscience continues to emerge, researchers and educators can use the scientific findings to inform educational practice and maximize learning in the classroom.

**Statement of the Problem**

Concerned Americans have questioned if the public school system is adequately preparing the future generation to compete in the working world (Levin, 2015). Curriculum and high-stakes testing place singular focus on cognitive achievement. By ignoring the value in non-cognitive skills, the role of character development is often left out in instructional practices

(Levin, 2012). Noddings (2013) emphasized the contradiction between the prescriptive curriculum and testing measures with the political push for embracing student creativity, diverse interests, and personal goals. Employee surveys revealed that non-cognitive qualifications are held at a higher priority than academic achievement when looking at potential job applications (Levin, 2012). Moore (2015) indicated that employers seek employees that are "passionate, empathetic, preserving communicators, collaborators, and creative and critical thinkers" (p. 40).

In addition to the discussion surrounding real world preparation, The National Assessment of Educational Progress (NAEP) found that only 35% of fourth grade students scored at or above proficient in reading during the 2019 school year. Students who score at a proficient level can demonstrate mastery in grade appropriate subject matter. In the same year, 41% of our country's students scored at or above proficient in mathematics (The Nation's Report Card, 2019). Since 1992, the national public average score in fourth grade reading has only increased by four points, and only twelve states scored at or above proficient in reading during the 2019 school year (The Nation's Report Card, 2019). With an alarming percentage of the country's students not reading proficiently, states continue to put forth high-quality instructional materials and effective training for teachers. However, despite the K-12 reforms, academic performance scores have shown little progress, and data suggests that something is still missing from America's public school systems (Cranston, 2016; New Accountability, 2014). Table 1 provides a progression of achievement levels for reading and mathematics over the past decade.

Table 1

*Grade 4 Reading and Mathematics Percentages At or Above Proficient Achievement Level*

| Year | Reading | Math |
|---|---|---|
| 2019 | 35% | 41% |
| 2017 | 37% | 40% |
| 2015 | 36% | 40% |
| 2013 | 35% | 42% |
| 2011 | 34% | 40% |
| 2009 | 33% | 39% |

*Note.* Adapted from "The NAEP Report Card: Reading" and "The NAEP Report Card: Math," by The Nation's Report Card, 2019, *National Assessment of Educational Progress*. Retrieved from https://www.nationsreportcard.gov/

Duckworth and Seligman (2005) proposed that the greatest obstacle dominating the American education system rests in the need to find a balance between cognitive and non-cognitive skills. Standardized tests are limited in identifying social traits needed to be successful in the working world. In addition, the literature surrounding the connection between non-cognitive skills and student success fails to provide explicit instructional strategies that aim at teaching life traits, such as grit and growth mindset. By using a deliberate practice, the researcher sought practical solutions to foster grit and a growth mindset in an elementary setting without interrupting daily instruction. In addition, the researcher examined if the firing of neurons from learning a new skill transferred to gains in mathematics and reading scores.

**Purpose of the Study**

The purpose of this mixed methods study was to seek the extent of differences between cognitive and non-cognitive skills with the influence of a deliberate practice. In a Title I school in Mississippi, the lead investigator taught one-second grade class how to persist in the challenge of learning to solve a Rubik's cube. The Rubik's cube acted as the instructional tool used to

implement a deliberate practice. The students experienced more failure than success by being pushed out of their comfort zone when learning how to solve the cube. Since the cube is a challenge in the form of play, each child engaged in a motivating problem-solving task that builds a grit mindset. By implementing a deliberate practice for nine weeks, the researcher hypothesized the firing of neurons with learning a new skill would result in an increased grit and growth mindset, which would carry over into reading and mathematics gains.

Rohrig (2010) identified several benefits of using the Rubik's cube as a deliberate practice by expressing how the puzzle increases confidence, provides a problem-solving framework, promotes cooperative learning, strengthens spatial reasoning, and helps grow the brain. In addition, the Rubik's cube models the progression of learning and illustrates the importance of intentional practice (Rohrig, 2010). Since the birth of the Rubik's cube in 1974, many similar cubes have been produced and many methods for solving the cube have been developed. Most solutions for restoring the cube to solid colors on all six sides uses the following five-step process: cross (four top edges), top layer (four top corners), middle layer (four middle edges), bottom layer (four bottom corners), and cube master (four bottom edges) (Rohrig, 2010; You Can Do the Rubik's Cube, 2019).

The object is to take a cube that has the colors of the dies mixed up in random order and to rotate the sides of the cube, thus manipulating the dies that eventually restore the cube to its original solid colors. Even though the purpose of the cube is to successfully place each die in a desired spot, the goal of this current study does not focus on shuffling the randomized colored dies back into its primary state. Instead, the goal is to provide a rich experience using a deliberate practice that results in increased learning outcomes.

## Research Questions

The idea of using neuroscience to help reshape education and teach a grit mindset raises a new perspective for educators. The following research questions guided the development of the study:

1. What is the extent of differences among a deliberate practice and learning outcomes in reading, mathematics, grit, and growth mindset scores?
2. What are student perceptions and experiences of grit and growth mindset instruction?
3. How does a teacher's orientation to grit and growth mindset instruction influence student experience?

## Limitations and Delimitations

This current study has unavoidable limitations. Since the results are based on a Title I school in Mississippi, the findings may not be generalizable to other districts and states. In addition, extending the findings using relevant demographic variables developed a more robust model. Another limitation considers that the sample sizes for the control and treatment groups are not guaranteed to be equal in regards to classroom size. Given the nature of the public school setting, maintaining equal sample sizes throughout an academic year is challenging in a rural area due to lack of parental involvement, family moves, and changes made in the school district. In addition, the unexpected nature of COVID-19 poses a limitation in this study. School procedures and state guidelines change daily with emerging research. Due to policies in place by the school district, the study was conducted in a virtual setting. The online format brought new challenges for implementing instruction, such as technology issues, difficulty with engagement, lack of personal connection, reduced learning time, hesitation to communicate, and

unaccustomed distractions (Garcia & Weiss, 2020; Middleton, 2020). Along with the virtual factors, participants could potentially be exposed to COVID-19, which would result in a two week quarantine period regardless of positive or negative test results. Other limitations include personal bias, convenience sampling, small sample size, maturation of students over a nine-week period, and self-examining surveys.

The results of this study will be further unyielding if students in the treatment group are matched to students in the control group according to beginning of the year scores. The quantitative testing measure employed in this study is a between subjects design, which raises concern for threats to internal validity (Balkin & Kleist, 2017). Since there is no random assignment in a quasi-experimental design, the researcher ensured equivalence. To control the internal validity threat, a matched pairs design was implemented to match each participant in the treatment group to a participant in the control group across grade, age, ethnicity, and sex. Beginning of the year average grade equivalency from the Standardized Test for the Assessment of Reading (STAR) was used to match the treatment class across the control class (Renaissance Learning, 2013). When equivalence is demonstrated in the design, the results of the study will be further unyielding by looking at the effects of the independent variable (Balkin & Kleist, 2017).

**Significance of the Study**

Using a student-centered approach, the researcher encouraged students to construct meaning and knowledge through a deliberate practice using a Rubik's cube (Krahenbuhl, 2016). The researcher identified the effectiveness of using the Rubik's cube as an instructional tool during two separate pilot studies. The first study was conducted during the 2017-2018 school year to understand the extent by which mathematics change scores were influenced by cube

groups and gender. As evidence in Table 2, the total mean for cube instruction was greater than no cube instruction. The relationship between cube instruction and change in mathematics scores accounted for 17% of the variance for the model. During the 2018-2019 school year, the second pilot study aimed to understand the extent by which mathematics and reading change scores were influenced by cube instruction. As evidence in Table 3, the total mean for cube instruction was again proven to be greater than no cube instruction. Both pilot studies were conducted over an academic school year in a small, rural town in Mississippi. Other than the lead investigators involvement, the treatment class was conducted as usual without any modification in the curriculum or with the methodology.

Table 2

*Descriptive Statistics for Pilot Study One*

| Group | Gender | Mean | N | SD |
|---|---|---|---|---|
| No Cube Instruction | Male | 1.08 | 8 | 0.51 |
| | Female | 1.36 | 10 | 0.84 |
| | Total | 1.23 | 18 | 0.71 |
| Cube Instruction | Male | 1.78 | 12 | 0.96 |
| | Female | 1.96 | 9 | 0.50 |
| | Total | 1.86 | 21 | 0.78 |
| Total | Male | 1.49 | 20 | 0.87 |
| | Female | 1.65 | 19 | 0.74 |
| | Total | 1.57 | 39 | 0.80 |

Table 3

*Descriptive Statistics for Pilot Study Two*

| Dependent Variable | Group | Mean | SD | N |
|---|---|---|---|---|
| Reading Change Score | Cube Instruction | 1.17 | .65 | 91 |
| | No Cube Instruction | 1.06 | .55 | 91 |
| Mathematics Change Score | Cube Instruction | 1.25 | .58 | 91 |
| | No Cube Instruction | 1.07 | .56 | 91 |

**Pilot study one.** The two participating second grade classrooms were randomly assigned to a treatment or control group. The treatment group received cube instruction, whereas the control group did not receive any type of cube instruction. Twenty-one students enrolled in a second grade class in a rural school district in the South participated in the treatment group. Nineteen students from the same school district participated in the control group. The two teachers selected for the study shared the same assistant teacher, demonstrated similar pedagogy, and taught the same mathematics curriculum using the same pacing guide. The makeup of the classroom in regards to beginning of the year mathematics scores, gender, and sex were also comparable across the two classrooms.

***Procedures.*** The lead investigator presented a total estimate of 50 sessions on Mondays and Wednesdays that lasted an average of 15 minutes. The study started on October 2, 2017 and concluded on May 17, 2018. Each session was completed within the first hour of the school day, typically from 8:00 am until 8:20 am. This time slot was selected based on teacher preference and class schedule. The sessions were designed to be both instructional and motivational to

promote excitement in the children. A sample lesson can be found in Appendix A. In addition to the 15-minute presentations, the researcher conducted individual teaching sessions lasting approximately 20 minutes. The individualized instruction was based on student readiness. If a student was on the verge of mastering a particular step of the Rubik's cube, the researcher would pull the student into the teacher workroom, which was across from the treatment classroom, to scaffold instruction. The researcher documented the individualized instruction by recording student names with a corresponding description of instruction. Each student received an average of 12 individual sessions during the study. Appendix B includes a sample note-taking guide with student pseudonyms to show the format of instruction in the one-on-one setting. On the days the researcher was not present, the teacher allowed students to continue practicing the Rubik's cube for 15 minutes in the morning during the assigned instructional time. The researcher and teacher placed students with cube partners to enhance collaboration, promote communication, and provide encouragement. Cube partners were based on student personality and student mastery of steps. By the end of the study, 10 students had successfully mastered the cube. The remaining 14 students finished at the following steps: one student at step four, five students at step three, and eight students at step two. Even though not all students reached step five, no one in the treatment class gave up at any point during the study.

***Data analysis.*** The study consisted of two discrete variables and one continuous variable. During the data analysis, the students' gender and assigned cube group were examined across the dependent variable to determine if statistically significant differences existed between the effects. The dependent variable in this study was change in mathematics scores. In order to compute the mathematics change scores, students were administered the Renaissance STAR Mathematics test

in August before the cube instruction started in the treatment classroom (Renaissance Star Mathematics, 2020). The same test was administered at the end of the year as a posttest to track student growth over the nine-month academic school year. The difference was found between the students' pretest and posttest mathematics scores using the STAR assessment. The STAR assessment is widely known in Mississippi as a progress-monitoring tool. It meets the guidelines for valid testing with reliable, standardized protocol (Renaissance Learning, 2013). Table 4 provides the average mathematics change score based on grade equivalency from the groups. This research study was designed to examine if there was a difference in mathematics change score based on cube instruction and gender. Given the nature of the research, a factorial ANOVA was used to conduct the analysis.

Table 4

*Average Mathematics Change Scores*

| | Pretest | Posttest | Mathematics Change Score |
|---|---|---|---|
| Treatment Group | 2.4 | 4.1 | 1.7 |
| Control Group | 2.0 | 3.3 | 1.3 |

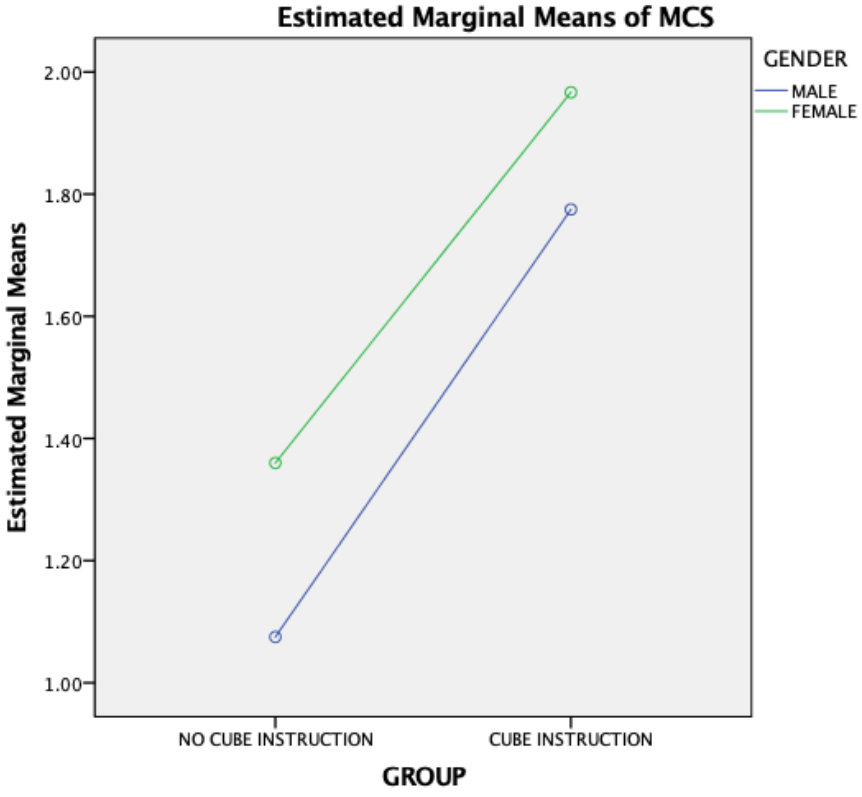
***Results.*** A factorial ANOVA was conducted on mathematics change scores with respect to differences in cube instruction and gender. An alpha level of .05 was utilized for this study. Groups were normally distributed for students who received cube instruction and the students who did not receive cube instruction. Gender was also normally distributed. Variances were homogenous, $F_{Levene}$ (3, 35) = 2.468, $p$ = .078.

There was not a statistically significant interaction between groups and gender $F(3, 35)$ = .036, $p$ = .851 (see Figure 1). Statistically significant differences were not found in mathematics

change scores and gender $F(1, 35) = .940$, $p = .339$. A small effect size was evident, $\eta^2 = .026$ indicating a weak relevance to the dependent variable. Statistically significant differences were found in mathematics change scores between groups, $F(1, 35) = 7.066$, $p = .012$. A medium effect size was noted $\eta^2 = .168$ indicating a moderate degree of practical significance. Given the sample size n = 40, statistical significance would be detected at large effect sizes, $\eta^2 = .25$. Both statistical significance and practical significance provide evidence to the effectiveness of the cube instruction.

Figure 1

*Interaction between Cube Groups and Gender*




**Pilot study two**. The second study aimed at working with a larger sample size in the same school district as the previous pilot study. Instead of two classrooms, eight participating

second grade classrooms were randomly assigned to a treatment or control group. The treatment group received cube instruction, whereas the control group did not receive any type of cube instruction. Ninety-one students enrolled in four second grade classes participated in the treatment group, and ninety-one students participated in the control group. The eight teachers selected for the study shared the same planning team, demonstrated similar pedagogy, and taught the same reading and mathematics curriculum using a pacing guide. The makeup of the classroom in regards to beginning of the year mathematics and reading scores, gender, and sex were also comparable across the eight classrooms.

***Procedures.*** The lead investigator presented a total estimate of 90 sessions on Mondays, Wednesdays, and Fridays that lasted an average of 15 minutes. The study started on September 14, 2018 and concluded on May 7, 2019. Each session for the four classrooms was completed within the first hour of the school day. This time slot was selected based on teacher preference and class schedule. A schedule with a general lesson plan can be found in Appendix C. The sessions were designed to be both instructional and motivational to promote excitement in the children. The lead researcher used various teaching strategies during the second pilot study, such as discussions, songs, and power points. A sample power point can be found in Appendix D. In addition to the 15-minute presentations, the researcher conducted individual and small group teaching sessions lasting approximately 10 to 15 minutes. The individual and small group instruction was based on student readiness. The goal was to provide additional instruction to help the students reach the next step. Following the same format from the first pilot study, the investigator documented the individualized and small group instruction by recording student names with a corresponding description of instruction. Each student received an average of eight

individual and/or small group sessions during the study. On the days the researcher was not present, the teachers allowed students to continue practicing the Rubik's cube during various times throughout the day.

The teachers represented in the treatment classes had different perceptions for implementing the Rubik's cube. Two teachers showed interest in the cube and promoted the challenging task by allowing students to keep the cubes in their desk to work with as an early finisher task. In addition, students were able to work with partners and practice the cube at home. Within these two classrooms, a total of 30 students were able to successfully solve the Rubik's cube by the end of the study. Five students reached step two, and nine students reached step three. The remaining two teachers were not as involved with their students when learning the Rubik's cube. The classroom culture did not appear as encouraging or welcoming compared to the other two groups. Both classes lacked consistency, and as a result, students appeared to struggle with confidence in understanding procedures and routines. No students in these two classrooms were able to move past step three in solving the Rubik's cube. However, just like the findings from pilot study one, no one in any of the treatment classes gave up at any point during the study.

***Data analysis.*** The study consisted of one discrete variable and two continuous variables. During the data analysis, the students' assigned cube group was examined across the dependent variables to determine if statistically significant differences existed between the effects. The dependent variables in this study were change in mathematics scores and change in reading scores. In order to compute the mathematics and reading change scores, students were administered the Renaissance STAR Mathematics and Reading test in August before the cube

instruction started in the treatment classroom (Renaissance Star Mathematics, 2020; Renaissance Star Reading, 2020). The same test was administered at the end of the year as a posttest to track student growth over the nine-month academic school year. The difference was found between the students' pretest and posttest scores using the STAR assessment. This research study was designed to examine if there was a difference in mathematics and reading change scores based on cube instruction.

***Results.*** A one-way MANOVA was conducted to determine the effect of grit instruction (Rubik's cube instruction and no Rubik's cube instruction) on two learning outcomes (reading and mathematics scores). An alpha level of .05 was utilized. Descriptive statistics for the dependent variables across program groups are in Table 2. Assumptions for normality (box plots) and homogeneity of covariances (Box's $M = 7.13$, $p = .07$) were met. No statistically significant effect was identified between cube instruction and the two dependent variables, Wilks' $\lambda = .971$, $F\ (2, 179) = 2.72$, $p = .07$. Approximately 3% of the variance in the model was accounted for in the combined dependent variables across program groups, yielding a small effect. An *a priori* power analysis yielded a total sample size of 68 to find statistical significance with a moderate effect size ($f^2 = .15$).

**Discussion.** The two pilot studies resulted in mixed findings. The first pilot study concluded that cube instruction in the treatment classroom contributed to a change in mathematics scores. One explanation for this finding is brain growth through the firing of neurons (Zull, 2011). By instructing students to learn an engaging new skill, the brain grew with the firing of neurons through a deliberate task (Bashant, 2014; Ericsson & Pool, 2016; Zull, 2011). Since the results proved to be significant, the researcher proposed that the gritty attitudes

then transferred to the mathematics content taught during the academic school year, which resulted in a successful learning experience. The cube provided an opportunity to play. Play precedes perseverance. Through perseverance, value in work was found.

Cube instruction with the treatment classrooms in the second pilot study did not contribute to a significant change in mathematics and reading scores. The testing measures administered during the 2018-2019 school year not only identified mathematics change scores, but also examined reading change scores as an additional dependent variable. When considering the contradicting findings from the two studies, one plausible explanation could be due to the differing variables and testing measures. Another condition to consider is that the cube instruction resulted in growing the brain through knowledge of a new skill, but the portion of the brain affected by the cube was not related to the cognitive reading skills used in the students' STAR Assessment (Zull, 2004).

It is possible that students learned grit by using a growth mindset during the deliberate practice. The cube instruction possibly helped students foster grit by cultivating a mindset when persevering through the challenging task, but due to the nature of standardized testing, grit and growth mindset levels are not accounted for when analyzing student results (Bashant, 2014; Hochanadel & Finamore, 2015; Ericsson & Pool, 2016).

Since it is difficult to determine which, or if any, of the above reasons explain the non-significant and significant findings of cube instruction and change scores, the public education system should acknowledge the difference and consider how to implement rich learning experiences that promote critical thinking in the classroom. As a result, the relationships examined in this study merits further consideration.

To continue investigating the impact of cube instruction on student success, the researcher used a variety of flexible approaches to gain a better understanding of student motivation and perseverance when working with a deliberate practice. By using a mixed methods design, the researcher analyzed data from different angles rather than focusing on one isolated approach. The goal was to identify practical, effective strategies to help students increase motivation when faced with challenging tasks. The qualitative and quantitative data provided a deeper understanding of the research surrounding student motivation and perseverance (Creswell & Creswell, 2018).

**Summary**

Teaching the Rubik's cube is a practical way to teach a grit mindset by instilling the motivation to stay in the game, which in turn can carry into other games. The impact of COVID-19 has heightened the importance of fostering grit and a growth mindset. Cutolo (2020) expressed that now more than ever, mindset is crucial as unpredictable challenges continue to surface. Cultivating grit and growth mindset does not remove the stress surrounding COVID-19, but learning resilience when faced with adversity will equip students with stamina to tackle future challenges. The nation's recovery path will require resilience, patience, and hard work (Cutolo, 2020). By exposing students to a rich experience, neuron pathways continued to fire and grow, and students learned to approach failure and frustration as a chance to grow the brain. The purpose of this study is to promote grit and the belief in oneself to be successful in the face of adversity, which, in turn, leads to the ultimate goal of education – learning.

# CHAPTER II

# REVIEW OF LITERATURE

*If you are curious, you'll find the puzzles around you. If you are determined, you will solve them.*
-Erno Rubik

The purpose of the literature review is to gain information on the existing research surrounding grit and growth mindset, along with current neuroscience findings that can influence classroom instruction. The chapter opens with a list of important terms surrounding the literature. Next, standardized tests and educational reforms are reviewed by looking at the history of public schools. Following the history behind state mandated tests, the chapter examines 21st century skills used to increase economic growth and future opportunities. Previous research conducted on non-cognitive skills is also examined in relation to student success. The next section of the chapter is organized to provide content regarding grit and growth mindset, and the importance of each concept in respect to academic achievement. The two concepts are discussed, prior research is reported, and findings are evaluated in relation to student achievement. Limitations and differing views of grit and growth mindset are also reviewed in the literature. The final section presents research regarding brain development, along with integrating practical classroom implications to promote learning. This chapter concludes with a description explaining the connection between grit, growth mindset, and neuroscience.

## Definition of Terms

The following terms are referenced in the literature review:

21st century skills: "A broad set of knowledge, skills, work habits, and character traits" needed to be successful in today's advanced technological world (Lapek, 2017, p. 25).

Cognitive: "Shorthand for cognitive ability and knowledge, constructs validly measured by high-stakes tests" (Duckworth, 2009, p. 279).

Non-cognitive: Skills that "embraces personality and temperament traits, interests, values, and goals" (Duckworth, 2009, p. 279).

Grit: A combination of passion and perseverance in regards to long-term goals (Duckworth, 2016).

Growth mindset: Abilities and intelligence can be developed with hard work (Dweck, 2015).

Plasticity: Ability to shape and grow (Zull, 2004).

Neuron: A nerve cell (Zull, 2004).

Synapse: Signaling connections that transform isolated neurons to pass through other neurons (Zull, 2004).

Deliberate practice: Purposefully working towards a goal while being pushed beyond the expected limit by using repetition and reflection (Ericsson, Krampe, & Tesch-Romer, 1993).

Productive struggle: Engaging students with challenging problems to problem solving strategies (Livy, Muir, & Sullivan, 2018).

**Educational Reforms**

The concern for teacher accountability on student performance was brought to attention in the 1983 report, *A Nation at Risk.* The report addressed issues in the quality of education provided by public schools across the United States. The discussion of global competitors with innovative ideas alarmed the population as the lack of rigor in America's education system was

brought to light (National Commission on Excellence in Education, 1983). Policy makers have since focused attention on student performance scores for the promotion of career readiness success. State mandated standardized tests skyrocketed after the No Child Left Behind Act (NCLB) came into effect during the Bush administration in 2001. The NCLB created an accountability system for teachers to measure student success, but the outcome resulted in teaching towards the test rather than promoting active student learning (Croft, Roberts, & Stenhouse 2016; Laursen, 2015). Standardized testing introduced an educational reform that has continued to evolve America's education system.

Following the NCLB, the Race to the Top initiative went into effect under the Obama administration in 2008. The reform was designed to place focus on revamping charter schools and teacher evaluations, as well as distribute more federal funding (McQuinn, 2015). To maximize student success, the Common Core State Standards were launched in 2010 in hopes of establishing rigorous curriculum and nationwide content standards. Schools around the country have restructured practices in curriculum, assessment, and accountability in order to achieve student reading and mathematics proficiency (McQuinn, 2015).

**21st Century Skills**

The United States has continued to focus on creating globally competitive students to increase economic growth and future opportunities using the standardized testing accountability movement (Croft, Roberts, & Stenhouse, 2016). Watagodakumbura (2013) expressed that authentic education aims to improve personal development through sparking curiosity and engagement by integrating deep learning into the curriculum. Laursen (2015) stated, "Education experts agree that the single-minded focus on academic competencies is insufficient to prepare

learners for success in an increasingly complex world" (p. 20). Rote knowledge and memorization techniques have continued to decline as general skills have risen since the start of the 21st century (Grieff & Kyllonen, 2016). Since the publication of a *Nation at Risk*, educators have questioned the existing approach used in schools as the focus has remained on competency rather than innovation (Eng, 2015). Lapek (2017) shared, "It is no longer enough for students to be proficient in mathematics, reading, and writing; today's students need to have more tools at the ready. These tools generally come in the form of 21st century skills" (p. 25). The term 21st century skills is defined as "a broad set of knowledge, skills, work habits, and character traits" needed to be successful in today's advanced technological world (Lapek, 2017, p. 25). Moore (2015) suggested that teachers place emphasis on the willingness to take risks and experience failure, rather than recognizing facts and reciting definitions. In addition, studies have identified key characteristics employers seek in employees, such as flexibility, passion, perseverance, and communication (Moore, 2015). Noddings (2013) added that cooperation, critical thinking, and creativity are also important skills education needs to aim for outside of the standardized curriculum.

In order to foster the mentioned 21st century traits, traditional teaching lectures need to be restructured to center instruction on student problem-solving strategies (Lapek, 2017). Instead of focusing on standardization, Zhao (2015) proposed that public schools should center attention on the development of individual differences. Eng (2015) shared his opinion on 21st century skills by stating, "They allow achievers to persist in learning a difficult language, persuade clients on a new idea, and follow through on a commitment" (p. 239). Researchers suggest that non-cognitive traits separate successful people from the rest of the population (Eng, 2015).

**Non-Cognitive Skills**

Duckworth (2009) defined cognitive as "shorthand for cognitive ability and knowledge, constructs validly measured by high-stakes tests" (p. 279). The term non-cognitive or non-academic "embraces personality and temperament traits, interests, values, and goals" (Duckworth, 2009, p. 279). Standardized testing has proven to predict cognitive abilities, but researchers are now curious about how to identify and measure non-cognitive skills (Duckworth, 2009). Recent research suggested intelligence as being malleable instead of a fixed trait. As a result, studies are now investigating the impact of non-cognitive, non-academic skills on student achievement (Duckworth, 2009).

To investigate non-cognitive skills on student success, Duckworth and Seligman conducted a study on 198 eighth graders in 2004. Results revealed that highly self-disciplined students outperformed peers who showed less control in overcoming feelings and temptations. Moreover, the non-cognitive trait of self-discipline was a better predictor of academic performance than student IQ and GPA (Duckworth & Seligman, 2005). Duckworth and Seligman (2005) suggested that the reason for students falling short of reaching full potential is due to an instantaneous world. Students struggle making decisions that delay gratification for a long-term goal.

Similar results were found in a study conducted with early elementary students in 1983 by Mischel and colleagues. The same students were revisited 10 years later, and the results showed the children with a greater ability to delay gratification proved to have higher academic success (Mischel & Mischel, 1983). This research was supported by the longitudinal results of a study conducted in the 1990's known as the marshmallow experiment. The study looked into

children's level of self-regulation. Participants were tempted with a choice of eating a marshmallow or waiting for the return of an adult to receive an additional marshmallow. Findings revealed that some children valued self-regulation and the delay of gratification, whereas other children were quick to give into the temptation. The same students were revisited four years later. Participants who showed a higher level of self-regulation were statistically more successful than peers who lacked an equal degree of self-control (Shoda, Mischel, & Peake, 1990).

Black (2007) shared a heightened concern for teaching self-discipline in order to delay gratification. Perseverance and self-discipline, when experiencing failure, teaches students the difference between instant gratification and long-term gains. Perseverance is the "ability to keep doing something," and self-discipline is the "ability to refrain from doing something" (Black, 2007, p. 54). Acknowledging the relationship between perseverance and self-discipline teaches students the value in long-term gains (Black, 2007). In addition, a deliberate practice that delays gratification can help develop perseverance (Duckworth, 2016).

Fink (2013) offered practical tips to help foster resilience and perseverance in the classroom. Since the average population is motivated by personal interest, educators are encouraged to integrate student interest and passion into classroom assignments while building on student strengths, incorporating challenging tasks, and identifying motivating factors. Fink highlighted learning as a process filled with both setbacks and mastery. The aftermath of failure determines true character development, and teachers should model positive reactions to mistakes made in the classroom (Fink, 2013).

Opposing views on today's non-cognitive skills, such as grit and growth mindset, have pushed researchers to extend on previous studies, as well as investigate new theories and concepts. Synder (2014) argued that character growth goes against the overall goal of education and proposed that research lacks specific strategies on how to teach and measure non-cognitive skills. Critics have indicated that the focus for character education is only a trend, and student disposition will continue to follow academic skills (Ducker, 2017).

Ducker (2017) questioned the reliability and validity of assessing social-emotional factors by sharing that the main focus for educators is the daily teaching and learning in the classroom. The argument was grounded using the Assessment Triangle, which is "a framework for understanding the connections among what students know, how we might observe their performance, and how we can know if they've acquired knowledge and skills in a meaningful way" (Ducker, 2017, p. 62). The Assessment Triangle was derived from the Standards for Educational Psychological Testing guidelines to ensure fairness and logic when measuring student knowledge. Three principles emerged from the Assessment Triangle: cognition, observation, and interpretation. Ducker (2017) argued the difficulty in measuring student dispositions using the three principles, along with how to monitor progress as students acquire and demonstrate the trait being taught. When assessing student disposition, self-report surveys could potentially create inconsistency represented by student answers.

Duckworth and Yeager (2015) defended non-cognitive measurements by stating, "self-report questionnaires are arguably better suited than any other measure for assessing internal psychological states" (p. 240). Literature has indicated that people are generally comfortable in sharing true opinions on questionnaire items (Duckworth & Yeager, 2015; West, 2016). A

performance task, which is usually presented as a unit project where students demonstrate mastery of a skill, is an alternative to self-report surveys for elementary students. In addition, performance tasks allow teachers to monitor progress as students continue to make improvements using feedback and learned experiences. Duckworth and Yeager (2015) recommended using several measures when identifying non-cognitive traits in students in order to optimize findings and reduce misinterpretations.

Duckworth (2016) challenged the opposing opinions by encouraging parents and educators to teach children self-control strategies by planning and implementing attainable steps to reach a goal using a Character Growth Card. KIPP, a charter school located in Harlem, has integrated character education into the curriculum by implementing Duckworth's Character Growth Card. Students receive feedback on character strengths, along with identified areas of growth, by addressing an assigned frustration and diligence task (McKibben, 2018; Willey, 2014). Willey (2014), a teacher from KIPP, stated, "By nurturing students' character strengths, we are dramatically expanding their opportunities for life after high school" (para. 9). In addition, Willey (2014) added that KIPP does not look at character development in isolation, but rather as an integrated component of the entire learning process.

The current pandemic has resulted in an estimated 55 million students out of school over the past year (Hippel, 2020). Mosanya (2020) proposed that character education, such as grit and growth mindset, can "be regarded as a protective shield from the adverse impact of COVID-19 pandemic on students" (p. 10). Regardless of different views, a growing body of literature has indicated the importance of promoting non-academic skills for student success (Ducker, 2017; West, 2016). Bridgeland, Bruce, and Hariharan (2013) stated, "Year after year, test after test,

students and their teachers focus on the cognitive elements of education, while other life skills are often absent from the in-school experience" (p. 3). By implementing programs that target grit and growth mindset, students are provided an opportunity to enhance resilience and heighten achievement in the face of adversity and inevitable distractions (Mosanya, 2020).

**Grit**

Duckworth (2016) has supported her Grit theory by creating and implementing the Grit Scale in diverse settings to determine grit levels within individuals. The Grit Scale measures passion and perseverance using a trait-level questionnaire. Limitations include a self-report questionnaire, individual reflection of character, and the lack of knowledge on grit relating to other achievement predictor variables (Duckworth & Quinn, 2009). The purpose of the Grit Scale is to determine if grit plays a role in success using the goal at hand. Duckworth identified findings from cadets at West Point, first year teachers in Chicago, and National Spelling Bee contestants. In each of the studies, findings revealed grit to be a predictor of success (Duckworth, 2016). In an interview with Deborah Perkins-Gough (2013), Duckworth stated, "Grit predicts success over and beyond talent. When you consider individuals of equal talent, the grittier ones do better" (p. 16).

Duckworth, Peterson, Matthews, and Kelly (2007) conducted a study to test the construct of the grit scale. The original Grit-O scale consisted of twelve items. To test the validity of the self-reported questionnaire, data were collected from 1,545 participants over the age of 25. Results showed that the participants with a higher degree of education held a higher grit score. Duckworth and colleagues also found that older individuals appeared to have more grit than participants of younger age. This finding suggested that life experiences contribute to one's grit

level (Duckworth et al., 2007). In 2009, Duckworth and Quinn shortened the original grit scale to eight items due to the predictive validity of the questions. The updated short Grit-S scale was used in a study conducted at West Point. The findings revealed grit to be a better predictor of completion of the rigorous program than the Whole Candidate Score (WCS), which is used in the admission process at West Point (Duckworth & Quinn, 2009). Similar findings were found in 2014 with military candidates. The study showed that participants high in grit were more likely to complete the Army Special Operations Forces training (Eskreis-Winkler, Shulman, Beal, & Duckworth 2014).

In regards to grit in education, Duckworth et al. (2007) measured grit using spelling bee finalists. Verbal IQ and self-control were used as predictor variables. Results showed that students with more grit spent more hours studying and had a stronger level of self-control than peers. Additionally, Cross (2014) identified a statistically significant relationship between grit and the amount of time spent studying in doctoral students.

The debate on why some individuals achieve more than competitors with equal aptitude remains a validated research question (Duckworth et al., 2007). In 2018, Duckworth developed the Character Growth Card used to evaluate student character by using a frustration task, as well as an academic diligence task. The measurement proposed a more accurate way of assessing student character than the original Grit Scale with the self-report questionnaire. Since students have to complete a task, the evaluation results are more credible in response to students' grit level (McKibben, 2018).

Even with Duckworth's research revealing grit to be a predictor of success, studies lack information explaining if grit levels can increase or even be taught to students. Findings have

shown a correlation between grit and student success, but how performance traits can assist student learning is still undetermined in current research (McKibben, 2018). Pappano (2013) examined several classroom teachers who shined light on character education. The practitioners used problem solving techniques that supported a productive struggle as students uncovered the underlying meaning or solution to the task. Pappano (2013) emphasized the commonalities between the teachers who promoted the concept of grit. The participants centered instruction on thought provoking questions that led to quality interactions. The teachers shared the opinion that challenging tasks sparked student curiosity, boosted self-esteem, and promoted intrinsic motivation (Pappano, 2013).

Hoerr (2017) discussed how to establish a school wide environment built on a grit mindset by suggesting the following six steps for teaching grit: establish the environment, set the expectations, teach the vocabulary, create frustration, closely monitor, and reflect. Rich communication is also needed as students respond to frustration and dig deep to find solutions (Hoerr, 2016). When investigating techniques used to promote and encourage grit, Bashant (2014) found commonalities between discussing attitude and persistence, turning assignments into games, breaking problems into achievable steps, placing students in collaborating communities, creating relevance to the assignment, and delaying gratification.

**Opposing Views of Grit**

Although research regarding grit as a predictor of success has increased within the last decade, little quantitative data exist within the context of education. Studies have noted that grit is not an adequate predictor of success (McClendon, Neugebauer, & King, 2017). Dumfart and Neubauer (2016) conducted a study with 8th-grade students to see if noncognitive traits were as

important as cognitive skills. Grit did not prove to be the most important factor. Additionally, Bazelais, Lemay, and Dolect (2016) found similar results with college freshmen when examining a physics course. The study concluded that grit was not a predictor of course grade or success in the class (Bazelais, Lemay, & Dolect, 2016).

Mixed reviews surround grit as a reliable predictor of student success due to the majority of quantitative studies being in the military field. Critics argue that grit ignores the existence of white privilege and suggests that students of color should work harder to achieve goals (Cranston, 2016). Denby (2016) adds to the argument by expressing the influence of family income, culture, and economy on individual success when landing the perfect opportunity. Grit critics state that by romanticizing hardships, systemic barriers in race and poverty continue to be ignored as students are told to work harder and persevere through uncontrollable circumstances (Strauss, 2016; Young, 2018).

**Growth Mindset**

In an interview with Perkins-Gough (2013), Duckworth indicated a correlation between being gritty and having a growth mindset. Growth Mindset, a concept developed by Carol Dweck, suggests that abilities and intelligence can be developed with hard work (Dweck, 2015). The bridge connecting the two terms is a deliberate, purposeful practice that fosters perseverance and drives motivation (Perkins-Gough, 2013). Ericsson, Krampe, and Tesch-Romer (1993) coined deliberate practice and described the term as purposefully working towards a goal while being pushed beyond the expected limit by using repetition and reflection. Duckworth and Dweck are currently in the process of developing an intervention that focuses on a deliberate practice that improves skills using scientific evidence of the brain. The two researchers have a

theory that the level of grit can change after altering a student's thinking and growth mindset (Perkins-Gough, 2013).

Students who portray a growth mindset believe intelligence can be developed with positive thinking and hard work (Dweck, 2015). Research findings indicate that students with a growth mindset outperform students with a fixed mindset, as well as use motivation as an influencer in achievement (Hwang, Reyes, & Eccles, 2013). Dweck suggested that this finding is due to students focusing on the process of learning rather than the product or outcome (Dweck, 2015). Students with a growth mindset understand progress is developed through sustained effort and dedication by viewing the challenge as energizing instead of threatening (Dweck, 2007; Laursen, 2015). Dweck (2015) suggested that if a student is struggling with a task, the teacher is expected to help the student face the challenge and learn from the setback. Students with a fixed mindset eventually reach a barrier when learning is no longer easy and more effort is needed in order to move forward. Instead of seeing the task as a way to improve and grow, students view the opportunity as a challenge, which results in an ego threat causing a decline in confidence and motivation (Dweck, 2007). Dweck (2015) reported that a number of strategies and approaches are necessary in order for students to achieve goals and experience real success with a growth mindset.

Students do not automatically take the same mindset as their parents or teachers (Haimovitz & Dweck, 2017). Literature surrounding the influence of a child's perception of achievement supports the claim that student's thinking about intelligence, or metacognition, can assist in determining a future path. Haimovitz and Dweck (2017) suggested that explicit interventions and challenging tasks help students grow a mindset that leads to motivation and

achievement. The way adults respond to student success can also impact a child's mindset by placing emphasis on praising the process instead of the product (Haimovitz & Dweck, 2017). A study conducted by Ricci (2013) found that 100% of kindergarten students believed in a growth mindset and expressed confidence in learning new material. The number declined to 58% by the time students reached 4th-grade. Students' positive mindset continuously decreased through the progression of lower elementary grades. The findings from this study suggest that as students get older curiosity and creativity slowly disintegrates from the learning environment (Ricci, 2013). Adults play a large responsibility in paving a meaningful route for children to become lifelong learners that persist in challenging problems with support and guidance (Laursen, 2015).

A research study conducted by White and McCoy (2019) looked at 24 fifth-grade students in a southeastern public school. Game-based learning was integrated into the classroom by playing *Battleship* to reinforce coordinate planes and ordered pairs while exploring complex problems. By viewing classroom assignments as a puzzle or game instead of a rigid task, students approached the activities with an open mindset (White & McCoy, 2019). Student interviews uncovered an increase in growth mindset, problem solving skills, and engagement of learning after implementing the approach in the classroom. Qualitative findings also found that students were more open and resilient to developing new skills when using game-based learning (White & McCoy, 2019).

The literature surrounding growth mindset tends to take place in a mathematical setting. Hwang, Reyes, and Eccles (2013) conducted a two-year study with 10th-grade students. Mathematics test scores acted as a control variable, and mathematics scores collected at the end of the study represented the outcome variable. Students who measured a fixed mindset were used

to see if the consequence of holding a fixed mindset affected long-term achievement levels. The researchers measured students' fixed mindset by using a survey that assessed students' feelings towards mathematics performance. The results showed that students who were high achieving in mathematics were just as likely to hold a fixed mindset as students who were low achieving in mathematics. The study also concluded that having a fixed mindset does not predict lower mathematics achievement levels. The researchers suggested using growth mindset interventions to increase later achievement when facing adversity (Hwang, Reyes, & Eccles, 2013).

Sparks (2015) shared a related study conducted by neuroscientists at Stanford University, but the results revealed contrasting findings compared to Hwang, Reyes, and Eccles' research. The study looked at brain activity in students with a positive mathematics mindset. The findings suggested that positive mindset levels in mathematics act as a predictor for later student success. The neuroscientists also noted that brain activity was higher during mathematics tasks associated with word problems (Sparks, 2015).

Similar findings were found in a study conducted by Daly, Bourgaize, and Vernitski (2019). The authors explored the theory of mathematical mindset being influenced by the type of problem presented to students. Daly, Bourgaize, and Vernitski (2019) discussed the idea of increased neural activity when the brain is introduced to an extended workload. Participants were asked to report motivation levels after being presented with either a standard mathematics problem or a mathematical mindset type problem. The participants' neural activity was examined through electroencephalogram (EEG) images. Findings indicated a statistically significant difference between neural activities and problem type. Even though the problem type yielded significant results, the reported effect size indicated a small degree for practical use. However,

the authors noted an increasing trend in brain activity that aligned with open-ended problems used to increase motivation and engagement (Daly, Bourgaize, & Vernitski, 2019).

**Opposing Views of Growth Mindset**

The literature includes mixed evidence regarding growth mindset as a predictor of later success (Aditomo, 2015). Romero, Master, Paunesku, Dweck, and Gross (2014) found that growth mindset highly correlated with intelligence in mathematics. In contrast, Shively and Ryan (2013) conducted a study that found no relationship between mindset and academic achievement. However, research does encourage teachers to facilitate challenging tasks, structure problems with multiple entry points, and monitor student discussion while fostering quality conversation (Livy, Muir, & Sullivan, 2018). In addition, Admitomo (2015) reported that the studies that found growth mindset to be a predictor of achievement resulted in a small effect size. As a result, the current findings on growth mindset as a predictor of success lack practical significance but merits further research when considering qualitative data (Aditomo, 2015).

Growth mindset critics also argue that teaching students to adopt an optimistic approach to hard tasks and setbacks only takes emphasis away from the real root of classroom problems. Instead of focusing on student attitude, opponents claim the attention should be placed on the quality of the curriculum and pedagogical approaches (Kohn, 2015). In regards to life after grade school, advocates for a growth mindset believe students should learn to confront challenges without being intimidated in order to recognize errors and mistakes in the workplace. According to Dweck (2007), “A fixed mindset can similarly hamper communication and progress in the workplace by leading managers and employees to discourage or ignore constructive criticism and

advice" (p. 81). Students who enter professions with a fixed mindset are more likely to ignore feedback and avoid personal reflection (Dweck, 2007).

**Grit and Growth Mindset with a Deliberate Practice**

In order to have a high degree of grit, students must believe that any goal is attainable by acquiring a growth mindset (Duckworth, 2016). Pueschel and Tucker (2018) described an experiential learning unit aimed at teaching grit through growth mindset. The students participated in a learning module that focused on grit, growth mindset, and perseverance. The participants completed the grit assessment and watched videos featuring Carol Dweck. No quantitative support was collected to evaluate the success of the learning module, but student response encouraged and supported the goal of fostering grit by enhancing a growth mindset (Pueschel & Tucker, 2018). Even though the researchers and teachers claimed positive results, research lacks specific strategies on promoting grit and growth mindset other than through discussions and videos.

With the concept of grit and growth mindset, commitment towards a goal is broken into attainable steps through the use of a deliberate practice. In addition, positive thoughts are encouraged and awareness of adversity is understood when working towards a challenge using grit and growth mindset (Duckworth, 2016; Dweck, 2015). Deliberate practice strategies are designed to explicitly help improve a skill by embracing multiple attempts to succeed at the problem, fostering an openness to try an unfamiliar task, and reflecting on the process to reach the goal (McClendon, Neugebauer, & King, 2017). Ericsson and Pool (2016) described deliberate practice as purposeful and focused with set goals. The key to a successful deliberate practice includes a clear plan on how to reach the desired goals while monitoring progress and

maintaining motivation. Ericsson and Pool (2016) also suggested that mindset matters by stating, "Doing the same thinking over and over again in exactly the same way is not a recipe for improvement; it is a recipe for stagnation and gradual decline" (p. 121). A deliberate practice encourages individuals to find the right approach in order to improve a skill and maximize full potential. Students need mental representations to imagine success, along with practice to show the grit needed to reach the end goal (Ericsson & Pool, 2016).

Duckworth suggested that people who are grittier spend more time working with a deliberate practice by looking at specific target goals rather than passively practicing a routine for basic mastery (Fink, 2013). Ericsson (2016) provided a deeper understanding of the term by explaining that the practice techniques must be effective with feedback and repetition. Duckworth, Kirby, Tsukayama, Bernstein, and Ericsson (2011) conducted a study with 190 participants from the 2006 Scripps National Spelling Bee. The study examined the likeliness of grittier spellers engaging in a deliberate practice when preparing for the spelling bee. Results showed participants who prepared using a deliberate practice were grittier than the participants who engaged in passive reading and spelling quizzes (Duckworth et al., 2011).

Malcolm Gladwell (2008) suggested that anyone could become an expert in a given field after practicing for 10,000 hours. However, Miller (2018) debunked this rule by arguing that quality matters when practicing a particular skill. In order to really improve at a task, time and attention should focus on addressing weaknesses and identifying steps for improvement. Macnamara, Hambrick, and Oswald (2014) conducted a meta-analysis with 11,135 participants. The study found that "high levels of deliberate practice were associated with high levels of performance" (p. 1615). Findings revealed that using a deliberate practice predicted 26% of the

variance in games, such as chess, 21% of the variance in music, and 18% of the variance in sports. The study indicated that deliberate practice is a statistically significant factor when looking at acquired skills in various performance areas (Macnamara, Hambrick, & Oswald, 2014).

For students to foster grit and embrace mistakes, opportunities to fail should be viewed as a growth experience rather than a disappointment (Duckworth, 2016). Hoerr (2017) expressed that failure is the key to success. The perspective is justified by explaining how students need to be taught to view frustration as an opportunity to learn (Hoerr, 2017). Problem-solving techniques that support a deliberate practice build grit and self-discipline (Pappano, 2013). The focus of grit is to establish perseverance by digging deep to find the root of the problem and then address the gaps that will lead to the solution or goal (McKibben, 2018). Duckworth (2016) stated, "To be gritty is to invest, day after week after year, in challenging practice. To be gritty is to fall down seven times, and rise eight" (p. 275).

Research suggests that teachers should aim to plan engaging activities that push students out of comfort zones in order to help boost determination and perseverance (Hoerr, 2016). In addition, recent brain research suggests that learning should activate all major regions of the brain, and teachers should focus on the process rather than the product by promoting problem solving strategies during a deliberate practice (Zull, 2004).

**Neuroscience**

Learning occurs when neurons in the brain connect and create pathways. In order for the pathways to link, children need to be exposed to challenging tasks that present opportunities for success (Hohnen & Murphy, 2016). Within the last decade, new technology has allowed

scientists to look at brain growth in children. Studies have found that the brain can physically alter when learning a new idea. Boaler and Dweck (2016) stated that when students genuinely learn, structural pathways are created from synaptic activity, which encourages brain plasticity (Zull, 2004). Zull (2004) compared the term brain plasticity to silly putty. Just as silly putty can mold and change shape with outside forces, the brain can also change and grow due to life experiences from birth into adulthood (Zull, 2004). Research suggests that in order for the brain to grow, rich experiences are needed to activate the firing of neurons. According to Zull (2011), "Rich experiences are those that engage many different areas of the brain" (p. 174).

When practicing a new skill, neurons fire repeatedly and send signals to other connecting neurons. The signaling connections are the synapses. The synapse holds the job of transforming isolated neurons into an active system of talking neurons. According to Morris (2016), the synapse connection becomes more constant each time the activation is ignited between the neurons. Understanding this connection indicates the importance of practice and repetition when learning new skills in order to strengthen the networks (Morris, 2016). Willis (2010) explained, "Neuroplasticity changes neural networks by adding or pruning synapses and dendrites and producing layers of insulating myelin around axons" (p. 58). Just as muscles gain strength with consistent exercise, the brain improves memory with repetitive activation of neural networks (Willis, 2010).

With the activation of neural networks, individuals engage in practice and emotion. Emotion is the center of feeling, acting, and thinking (Rager, 2009). If a student is experiencing an intense emotional state, the process of comprehending can be delayed due to heightened anxiety or stress (Gnezda, 2011). The impact of COVID related stressors on student learning

have recently created cognitive interference (Terada, 2020). If neurons are not talking and firing, learning is infringed and student progress is interrupted. In addition, special populations, along with the mental health of students, pose an obstacle in regards to accommodations and support. Cantor (2020) suggested that students' academic achievement is linked to mental health and intense feelings of stress. A study conducted by Cook and Wellman (2004) found that chronic stress in mice can lead to the shrinking of brain cells, which results in cognitive discrepancies. Terada (2020) stated, "Chronic stress changes the chemical and physical structure of the brain, impairing cognitive skills like attention, concentration, memory and creativity" (para. 16). Statistics also show that students living in poverty have a harder time adapting to the toxic stress that is stemmed from the current pandemic. Social isolation is a major concern for the 57% of America's students who receive mental health services from public schools (Goblerstein, Wen, & Miller, 2020; Terada, 2020). In addition, Terada (2020) reported that 25% of minority students do not have access to reliable Internet access. As the country begins to recover from the pandemic, social isolation, trauma, and anxiety create a heightened concern in the development of students. In order to help students process their emotions, teachers must advocate for students' well-being, eliminate unnecessary stress, and prioritize relationships (Cantor, 2020).

When experiencing an intense emotional state, chemicals are released activating the synapse and increasing motor cell firing (Zull, 2011). The memories that stick produce the most emotion and leave a lasting impression, whereas other experiences are vague and distant. The more emotion connected to a memory, the longer one will recall the experience. Not only do memories produce emotion, but memories also guide people to make decisions. Reflecting on the emotional state felt from previous outcomes directs people to making the next choice (Zull,

2011). For instance, if accomplishing a goal leaves a satisfying mindset, the memory leaves a positive impression on the brain that will further motivate the next decision (Zull, 2004). When students experience a delicate emotional state, new emotions are aroused through hard work and frustration. If the goal is met, the negative feelings fade resulting in gained experiences (Gnezda, 2011). Once emotion is a factor in the firing of the neurons, the synapse is altered and the reaction of neurons can change, which results in learning (Zull, 2004).

When creating the buzzing neurons, the brain must also respond to emotional chemicals, such as adrenalin, dopamine, or serotonin. Dopamine takes the job of transferring information across synapses. Curriculum that activates the release of the hormone promotes perseverance and progress towards a goal. When students feel success with an incremental goal, dopamine is released due to the correct response or decision. As a result, the students are intrinsically motivated to face greater challenges (O'Doherty, 2004). If students have experienced success, the end product and the feeling of fulfillment can trigger motivation to complete the task at hand. Therefore, teachers should focus on finding innovative and creative methods to make learning intrinsically gratifying. Assignments should encourage progress that work towards a goal of mastery and success, as well as student interest. In order for meaningful learning to take shape, activities should be geared to activating all areas of the brain (Zull, 2004).

A study conducted in London looked at 35 healthy males who had passed "The Knowledge" training test. The test requires drivers to recall thousands of streets and landmarks after several years of studying to be black-cab drivers (Magurie, Woollett, and Spiers, 2006). Scientists studied the brains of each participant before and after the training process. With the intense spatial training, the black-cab drivers all sustained a significant amount of growth in the

hippocampus, which is the region in the brain associated with memory and learning. The scans of the posterior hippocampus showed that the brain could reshape to match a learned task or skill (Maguire, Woollett, and Spiers, 2006). The same participants were revisited after retirement for a follow-up scan. Scientists found that the hippocampus had shrunk to the original size. Without repeated practice of driving, the black-cab drivers lost the growth from the learned skill (Boaler, n.d.). The study provided further evidence supporting the brain's plasticity and the impact on rewiring of neurons (Maguire, Woollett, and Spiers, 2006).

In 2004, a similar study described a change in brain plasticity generated by learning a new skill. The experiment focused on learning how to juggle. An MRI was conducted on the participants before and after the study to show the effects of the brain after learning a new skill. The results showed that the visual part of the brain changed after purposeful, deliberate practice with continuous mistakes being made in the learning process (Draganski, Gaser, Busch, Schuierer, Bogdahn, & May, 2004). Zull (2006) connected the research to practical use in the classroom setting by stating, "The chemicals of emotion act by modifying the strength and contribution of each part of the learning cycle. Their impact is directly on the signaling systems in each affected neuron" (p. 4). Since changes occur when neurons are immersed in emotion, new experiences and challenging skill practice results in more complex neuron branching. In addition, multisensory learning heightens network connections due to each sense having a distinct region in the brain. When student activities involve multisensory learning, more connections between dendrites are fired forming additional networks, along with improved memory retrieval (Wagner et al., 1998). Zull (2004) stated, "When our students find the right connections, they will learn. They won't be able to help themselves" (p. 72).

**Practical Neuroscience Implications for Today's Learners**

Brain research suggests practical implications for the classroom by focusing on instruction, curriculum, and assessment. According to Reigeluth and Schwartz (1989), small achievable challenges that are developmentally appropriate help motivate students to persist in mastery of a skill. For example, the nature of computer and video games provide students with differentiated instruction within the zone of proximal development. Students are captivated by the challenge and succeed at incremental levels that support a long-term goal (Reigeluth & Schwartz, 1989). According to Willis (2010), "This is the power of achievable challenges: opportunities for students to see their effort-related improvement along the way to an ultimate goal, instead of having only the feedback of a final test or other end-point assessment" (p. 49). Educators can encourage powerful brain responses by recognizing student effort, along with providing opportunities for short-term goals that lead to a higher level of accomplishment (Willis, 2010).

In addition, Willis (2010) encouraged educators to provide frequent formative assessments. By providing students with immediate constructive feedback, the brain alters the misconception with the correct information while fostering long-term memory skills. A specific example Willis (2010) suggested includes regular informal checks. By scanning the classroom and responding to students' needs, teachers can halt frustration by providing opportunities for further explanations and new challenges. Immediate feedback prevents decreased confidence levels in struggling students, as well as boredom with students who experience mastery with the focused skill. With differentiated instruction procedures in place for assessment techniques, dopamine levels increase while intrinsic motivation and learning are promoted through

instructional strategies. Classroom teachers can prompt students in understanding how practice and persistence with a grit mindset can change the brain by enhancing memory and transferring knowledge to other settings and situations (Willis, 2010).

**Conclusion**

Hoerr (2017) indicated that the overall goal for educators and parents is to build a culture that focuses on persistence and learning through mistakes while promoting intrinsic motivation. With the focus shifting from testing scores to lifelong success, emerging research on non-cognitive skills in education suggests that schools could improve the overall climate in classrooms (Cranston, 2016). A common theme surfacing from the literature surrounding character education urges the need for ownership. The motivation to learn starts within the individual. Intrinsic motivation is "essential when cultivating innovators and change agents" (Eng, 2015, p. 239). Zhao (2015) stated, "Start empowering children by liberating their potentials, capitalizing on their passion, and supporting their pursuits. Start giving the ownership of learning to the children" (p. 134). Kohn (2009) explained that the primary reason for students to attend school is to learn skills that will maximize potential and help grow the economy. With the obsessive concern of test scores, students lack ownership in curriculum and appear disengaged with interpersonal goals (Levin, 2015).

Zull (2006) warned readers that the impact of testing could have negative effects on students if the focus solely relies on the proficiency outcome rather than student growth. The fundamental concepts of learning should focus on gathering, reflecting, and creating. Zull (2006) also suggested practical classroom implications that promote a balance of cognitive and non-cognitive skills, such as problem solving strategies that activate the emotional chemicals in the

brain. John Dewey once stated, “It is impossible to foretell definitely just what civilization will be twenty years from now. Hence, it is impossible to prepare the child for any precise set of conditions. To prepare them for the future means to give them command of [themselves]” (as cited in Gomez & Albrecht, 2014, p. 15). In summary, Lapek (2017) urged educators to equip students with a balance of academic content and general skills necessary to thrive in an uncertain, modern future by integrating current brain research with the concepts of grit and growth mindset.

# CHAPTER III

# METHODOLOGY

*I have not failed. I've just found 10,000 ways that won't work.*
-Thomas A. Edison

The purpose of this mixed methods study was to seek the extent of differences between grit, growth mindset, reading change scores, and mathematics change scores with the influence of a deliberate practice. To get second graders to participate in a deliberate practice that instills motivation and embraces mistakes, students were taught how to solve a Rubik's Cube. In addition, the researcher investigated student perceptions and experiences of grit and growth mindset, along with teacher orientation surrounding grit and growth mindset instruction.

## Research Design

This current study used a mixed methods approach. Burke-Johnson, Onwuegbuzie, and Turner (2007) stated, "Mixed methods research is an intellectual and practical synthesis based on qualitative and quantitative research" (p. 129). Since the participants were selected out of convenience, the nature of this project was quasi-experimental. The participating classrooms were randomly assigned to a control or treatment group. A matched pairs design was implemented to match each participant in the treatment group to a participant in the control group across grade, age, ethnicity, and sex. The study aimed to collect both qualitative and quantitative data to establish a more meaningful understanding of the findings. Creswell and Creswell (2018) stated, "The core assumption of this form of inquiry is that the integration of qualitative and quantitative data yields additional insight beyond the information provided by

either the quantitative and qualitative data alone" (p. 4). Data collection included self-report surveys, standardized tests, teacher interviews, student writing prompts, and a researcher reflection journal.

**Purpose of the Research**

This study sought to understand the extent of differences between cognitive and non-cognitive skills with the influence of a deliberate practice using a Rubik's cube. A second grade class was taught how to persist in a challenge while learning to solve a Rubik's cube used to foster grit and a growth mindset. The cube was selected as the instructional tool due to the nature of the three-dimensional puzzle. Students were captivated by the colorful squares, interested in the small, hands-on design, and attracted to the mysterious toy. The students experienced more failure than success by being pushed out of their comfort zones when learning how to solve the Rubik's cube. Since the cube was a challenge in the form of play, each child was engaged in a motivating problem-solving task while building a grit mindset. By implementing a deliberate practice for nine weeks, the researcher believed the firing of neurons with learning a new skill would result in an increased grit and growth mindset, which would carry over into reading and mathematics gains.

**Research Questions**

The idea of using neuroscience to help reshape education and teach a grit mindset raised a new perspective for educators. The following research questions were used to guide the development of the study:

1. What is the extent of differences among a deliberate practice and learning outcomes in reading, mathematics, grit, and growth mindset scores?

2. What are student perceptions and experiences of grit and growth mindset instruction?
3. How does a teacher's orientation to grit and growth mindset instruction influence student experience?

**Population and Sampling**

The design of this study had to meet the nature of the educational setting, as well as voluntary participation from the superintendent, principal, teachers, and students. Participants in the study were from a rural, Title I school district in the South. The selected public school included grades two through three with an estimated population of 600 students and 26 classroom teachers. Based on principal discretion, teacher willingness, and COVID-19 procedures, two-second grade classrooms were selected for the study and randomly assigned to a treatment or control group. The 20 students in the treatment group received grit, growth mindset, and Rubik's cube instruction, whereas the 19 students in the control group only received grit and growth mindset instruction. Students who opted for virtual learning were excluded from the study findings. Two students were enrolled in virtual learning from the treatment classroom, and four students from the control classroom. The two teachers selected for the study shared the same planning team, demonstrated similar pedagogy, and taught the same reading and mathematics curriculum using a pacing guide. The treatment class teacher has taught in an elementary setting for five years, and the control class teacher has taught for 14 years. The makeup of the classroom in regards to beginning of the year mathematics and reading scores, gender, and sex were also comparable across the two classrooms.

The population was selected due to the high-stakes testing procedures that start in third grade (Hernandez, 2011; Hill, 2017). Although students are assessed in reading and mathematics

starting in Kindergarten, Mississippi does not begin measuring student knowledge through standardized state assessments until the third grade. In order for students to get promoted to the fourth grade, all third graders must pass the Mississippi Academic Assessment Program (MAAP) in English Language Arts. In addition, students in third grade are also administered the MAAP Mathematics assessment (Mississippi Department of Education, 2020). Research has indicated that 88% of high school dropouts are non-proficient readers in third grade (Hernandez, 2011; Hill, 2017; The Nation's Report Card, 2019). By conducting the study with second graders, the researcher believed that the grit and growth mindset instruction would carry into third grade and provide students with the motivation and perseverance necessary to reach proficient levels in mathematics and reading as students transition from learning-to-read to reading-to-learn (Hanford, 2019).

**Instrumentation**

The quantitative instruments for the study included the STAR reading and mathematics test (Renaissance Star Mathematics, 2020; Renaissance Star Reading 2020), the Grit-S (Duckworth & Quinn, 2009), and a growth mindset survey (Dweck, 2006; Hall, Hume, & Tazzyman, 2016). For qualitative data, a researcher reflection journal was implemented to collect, organize, and analyze useful data obtained during each session (Cochran-Smith & Lytle, 1993). In addition, teacher interviews were conducted at the end of the study to gain insight on how teacher orientation influences student experience with grit and growth mindset instruction, along with student writing prompt responses (Creswell, 2013).

**Quantitative instruments.** In order to compute the mathematics and reading change scores, the Renaissance STAR Mathematics and Reading test was administered to students in

August and May to track student growth over the academic school year. The difference was found between the students' pretest and posttest scores using the STAR assessment. The STAR assessment is widely known in Mississippi as a progress-monitoring tool (Renaissance Learning, 2013). The mathematics and reading STAR tests were administered using classroom computers and could easily accommodate all learning environments. Students logged in to the Renaissance STAR site using a predetermined username and password indicated by the classroom teacher. Since this study started at the end of the school year, students were already familiar with the site features and felt comfortable navigating through the reading and mathematics tests.

The reading STAR test takes an average of 19 minutes to complete (Renaissance Star Reading, 2020). The questions are designed to gain insight on student understandings of grade level reading standards. Since the test is comprehensive, teachers use the data to plan day-to-day instruction. The mathematics STAR test takes a similar approach but has an average time of 24 minutes to complete. Teachers are able to see what mathematics standards students have mastered and plan intervention and enrichment activities to address the identified gaps in instruction (Renaissance Star Mathematics, 2020). The STAR assessments meet the guidelines for valid testing with reliable, standardized protocol (Renaissance Learning, 2013).

The third quantitative instrument was a growth mindset survey (see Appendix E). The survey used a Five Degrees of Happiness Smiley Face Likert scale to measure student mindset before and after the treatment and control instruction. The Likert-type scale used five smiley face images that ranged in degrees of happiness. To provide children with an effective portrayal of emotions, Hall, Hume, and Tazzyman (2016) conducted a study to evaluate student questionnaires. The study consisted of over 330 students ranging from 9-11 years old. The results

found that the most effective approach for students to communicate personal feelings was when the Likert scale represented a range of five positive responses (see Figure 2) (Hall, Hume, & Tazzyman, 2016). For students to adequately measure and judge the experience being explored, quantitative questions included effective rating scales with appropriate differentiation for children (Hall, Hume, & Tazzyman, 2016). The questions presented on the survey were adapted from Carol Dweck's mindset survey. The survey was designed to be developmentally appropriate for students starting at age 10 (Dweck, 2006). Since the students in this study ranged from ages seven to nine, the vocabulary was adapted to meet grade level standards and expectations. The survey was administered using paper and pencil but changes could be made to accommodate hybrid and online learning environments.

Figure 2

*The 5 Degrees of Happiness Smiley Face Likert*

The final quantitative instrument was the Grit-S, which was developed by Duckworth and Quinn (2009) as a measure for perseverance and passion. The survey can be found in Appendix F. Similar to the growth mindset survey, the grit instrument was provided to students in a hard copy form, but the researcher could make necessary adjustments based on teacher discretion. Using six different studies, the Grit-S was determined to be a valid and reliable survey. Medium-to-large correlations were found between grit scores indicating the reliability of

grit being a self-assessment measure (Duckworth & Quinn, 2009). To maintain consistency with the growth mindset survey, the Grit-S was adapted using the Five Degrees of Happiness Smiley Face Likert scale to measure student grit before and after the treatment and control instruction (Hall, Hume, & Tazzyman, 2016).

Participants in the treatment and control group completed the Grit-S and the growth mindset survey at the beginning and end of the study. The purpose was to determine if students had a high pre-grit and growth mindset score before being presented with the treatment and control instruction. Following the same format of the STAR assessments, the change scores were used to analyze the data.

**Qualitative instruments.** For qualitative data, a researcher reflection journal was used to capture each session (Cochran-Smith & Lytle, 1993). Immediately following each session, the researcher wrote an informal, open reflection paragraph to record the daily happenings, observations, and discoveries experienced during the instruction. After organizing and reviewing the daily events using the open reflection, the researcher wrote a formal, post-reflection paragraph using the researcher reflection journal to document student and teacher interactions, insightful quotes and questions, an overview of the session, and any concerning information. By adapting Cochran-Smith & Lytle's (1999) Teacher Learning Conceptual Framework, a structured guide for recording session reflections was implemented in the study. The framework can be found in Appendix G and the adapted protocol in Appendix H. In addition to the researcher reflection journal, writing prompts were given to students at the end of the study to obtain student perceptions and experiences of grit and growth mindset instruction. Individual student interviews and student focus groups were not conducted due to the online setting, along

with teacher requests to avoid additional interruptions. As an alternative measure, students reflected on the nine weeks by responding to the writing prompts during the last week of instructional time. The writing prompts can be found in Appendix I and Appendix J.

To examine the third research question, teacher interviews were conducted over Zoom at the end of the study to analyze teacher orientation to grit and growth mindset instruction (Creswell, 2013). Five elementary classroom teachers outside of the present study reviewed the interview questions, which can be found in Appendix K. In addition, committee members were able to suggest changes and provide feedback to confirm the overall appropriateness of the interview questions and researcher reflection journal.

**Ethical Considerations**

Due to conflicting findings from the pilot studies, along with the literature surrounding the impact of non-cognitive skills on student success, the control and treatment groups received the same grit and growth mindset instruction. Furthermore, the project did not alter the designated reading and mathematics curriculum. The difference between the two groups was the implementation of a deliberate practice. The treatment group worked with the Rubik's cube to see if a deliberate practice enhanced growth in the four independent variables. Balancing instruction in a fair and equal manner helped strengthen the findings and ensured appropriate ethical standards.

In addition, parental consent forms were required for students to participate in this study. Students and teachers were continuously reminded to share concerns, ideas, and feedback throughout the nine week study. Parents and teachers remained informed on student progress with the Rubik's cube in the treatment classroom. Teachers and parents were also given the

option to withdraw from the study at any point in the semester. All data remained confidential, and student names were scrubbed from forms and documents.

**Procedures**

The study began during the fourth nine-weeks of the academic school year (March 16, 2021) and concluded during the last week of the semester (May 20, 2021). The 20 sessions occurred virtually on Zoom every Tuesday and Thursday. The researcher met with the treatment group from 12:30 p.m. until 12:50 p.m., and the control group sessions were from 1:45 p.m. until 2:00 p.m. The time slots were based on teacher preference and class schedule. Since the district was offering a hybrid format for students, Wednesdays were half-days to allow teachers to meet with their online students. As a result, the researcher was only allowed to meet with each group twice a week rather than three times a week, which was outlined in the pilot studies. A pacing guide can be found in Appendix L to provide a detailed overview of each session, along with the daily PowerPoint link.

Prior to the study, the lead investigator met in a face-to-face setting with the treatment and control group teacher. The meeting was held on March 14, 2021 after the school day. During this time, the researcher discussed the pacing guide for the study and answered questions from the two teachers. In addition, the researcher provided hard copies of the grit and growth mindset surveys and explained the directions (see Appendix E and F). Teachers were instructed to read the directions out loud to the students in a whole group setting, along with each question from both surveys. The purpose of reading the questions was to avoid any unclear responses due to student reading difficulties. Teachers were also instructed to give the surveys on separate days to avoid confusion between grit and growth mindset understandings. After seeking amendment

approval from the Institutional Review Board (IRB), teachers were given permission slips to send home with detailed information regarding the study (see Appendix M). In addition, student mathematics and reading scores from the beginning of the year STAR assessments were collected from the participating teachers during the meeting.

All students in the treatment classroom were given two Rubik's cubes, along with a cube manual that was used throughout the study. The purpose of two cubes was to prepare for any unexpected quarantine periods. Students kept one cube in the classroom and one cube at home. An online version of the cube was also offered if a student could not locate their Rubik's cube. In addition, various handouts were distributed to assist in mastery of the cube steps (see Appendix N). Laminated solving cards were also given to the students as an additional learning tool. Students were encouraged to keep the manuals and various handouts in the classroom.

All data from the study were stored electronically using Sandbox. Identifiable student information from STAR tests, grit and growth mindset surveys, interviews, student writing samples, and the researcher reflection journal was scrubbed from the data before presenting any findings. At the start of the study, the researcher requested beginning of the year STAR mathematics and reading scores. In addition, students completed the grit and growth mindset survey. At the end of the semester, the principal shared end of the year STAR mathematics and reading scores, and students were re-administered the grit and growth mindset surveys. Teacher interviews were also conducted during the final week of the spring semester. A timeline and summary of the study's procedures can be found in Table 5.

Table 5

*Study Procedures Timeline*

| Date | Procedure |
|---|---|
| March 14, 2021 | Meeting with teachers |
| March 16, 2021 | Sent home notes and permission slips |
| March 16, 2021 | Administered grit and growth mindset surveys |
| May 18, 2021 | Re-administered grit surveys |
| May 18, 2021 | Shared writing prompts with students |
| May 18, 2021 | Conducted teacher interview for Treatment Class |
| May 20, 2021 | Re-administered growth mindset surveys |
| May 20, 2021 | Conducted teacher interview for Control Class |
| May 20, 2021 | Collected student writing prompt responses |

**Treatment condition.** During the study, children were exposed to the cube in two different formats. Two times a week students would participate in a whole group session taught by the researcher during the daily routine. During the whole group instruction, the researcher presented the cube instruction using an interactive PowerPoint designed to be instructional and motivational for students. An example of the whole group instruction can be found in Appendix O. Instruction started with a grit and growth mindset discussion using videos and read alouds. After the opening, the researcher shared strategies and techniques on how to solve the identified step of the cube. Students were then given a few minutes to practice with neighboring peers. The second exposure to the cube was at various times throughout the school day. The classroom

teacher encouraged students to practice problem-solving skills by using the cube as an early finisher, brain booster, and morning opener.

**Control Condition.** The control group was also presented with an interactive PowerPoint designed to be motivational for students. The instruction included grit and growth mindset videos and read alouds. The control group participated in ongoing student-led discussions that focused on persevering through challenging tasks, along with strategies to promote problem solving and critical thinking skills. Students were simply encouraged to participate in the discussions and engage in the PowerPoint. The PowerPoint was the same for both control and treatment groups, but no Rubik's cube instruction was given to the students in the control group (see Appendix O).

**Quantitative Data Analysis**

This current study consisted of one discrete variable and four continuous variables. During the data analysis, the students' assigned group was examined across the dependent variables to determine if statistically significant differences existed between the effects. The dependent variables in this study were change in mathematics scores, change in reading scores, change in grit scores, and change in growth mindset scores. This research study was designed to examine if a difference existed in cognitive and non-cognitive change scores based on the influence of a deliberate practice using a Rubik's cube.

Four separate one-way analysis of variance (ANOVA) was conducted using Statistical Package for the Social Sciences (SPSS) to determine the effect of a deliberate practice (Rubik's cube instruction and no Rubik's cube instruction) on two cognitive outcomes (reading and mathematics change scores) and two non-cognitive outcomes (grit and growth mindset change

scores). An alpha level of .05 was utilized, and descriptive statistics for the dependent variables across program groups was presented in the data analysis. Assumptions for normality, which refers to the distribution of the groups being compared, was considered using box plots due to a sample size greater than thirty. Homogeneity of variance, the estimation of within group differences, was also determined before moving forward with the test (Dimitrov, 2008). When reporting quantitative data, statistical and practical significance was identified between groups and the four dependent variables. The percentage of the variance in the model was also reported, along with the effect size (Dimitrov, 2008).

**Qualitative Data Analysis**

The central strand of data used in this study was the researcher reflection journal, which was adapted from the Teacher Learning Conceptual Framework (Cochran-Smith & Lytle, 1993). The post-session reflection notes proved to be an accurate representation of what occurred during the Zoom instruction. Teacher interviews and student writing prompts were also used to further investigate the findings found in the researcher reflection journal. In addition, the teacher interviews and student writing prompts helped supplement observations, as well as corroborate any observational findings from the three different perspectives. The researcher reflection journal was the starting point for analyzing the data. After completing the first cycle of coding in the researcher reflection journal, the teacher interviews and student writing prompts were coded in order to combine the data collection. The teacher interviews and student writing prompts were merged into the researcher reflection journal after the first cycle of coding.

**Analysis of researcher reflection journal.** Due to the quantity of data that was collected over the eight week study, qualitative findings were coded using an excel spreadsheet in

Sandbox. Color codes were used in the excel spreadsheet to document the transition from raw data to reportable findings using several coding cycles (Saldaña, 2016).

***1 cycle.*** The first cycle method, which is the initial coding of data, is used to explore the data before refining the codes (Saldaña, 2016). Provisional coding (Saldaña, 2016) was used during the first cycle, with the codes based on the Teacher Learning Conceptual Framework (Cochran-Smith & Lytle, 1993).

***After 1 cycle.*** Since the data collection included the researcher reflection journal, teacher interviews, and student writing prompts, the transitional method (Saldaña, 2016) was used to split the data to help answer the two qualitative research questions guiding the study. After exploring the researcher reflection journal through provisional coding, the codes were lumped into three larger categories based on teacher images, researcher images, and student images. The teacher images would later be added to the teacher interview codes, and the student images merged into the student writing prompt codes.

**Analysis of teacher interviews and student writing prompts.** Following the same procedures as the researcher reflection journal, teacher interviews and student writing prompts were coded using an excel spreadsheet in Sandbox. Color codes were assigned during each coding cycle to organize the data. The same coding cycles and procedures were executed for teacher interviews and student writing prompts.

***0 cycle.*** In order to shake hands with the data, a zero cycle of coding was executed using both sets of data. The purpose of this initial cycle was to become familiar with the teacher and student responses. By engaging in the data with an open mind, I was able to read each student and teacher response from a researcher's point of view and gather a conceptual understanding of

the findings. During the zero cycle, two codes were created to help establish a general view of the data. The two codes examined each participant's response by identifying great and interesting quotes mentioned throughout the teacher interviews and student writing prompt responses.

***1 cycle.*** After the zero coding cycle, Process Coding (Saldaña, 2016) was used to describe the participant's action in hopes of detecting a pattern from the data. Process Codes are labeled with gerunds and help the researcher stimulate a connection between the participants. By assigning a code to a participant's action rather than summarizing the participant's general perspective, I gained insight on each participant's experience and noticed potential relationships between the codes, as well as relationships between the teacher and student perceptions and experiences with the grit and growth mindset instruction.

***After 1 cycle.*** After executing the first round of coding, I engaged in a transitional cycle by implementing a tabletop approach to narrow the focus of my coding. The tabletop method "involves the literal spatial arrangement on a table of coded and categorized data" (Saldaña, 2016, p. 230). Using my Process Codes identified in the first coding cycle, I created a hard copy of the coded data and lumped the codes into categories. The categories helped establish a relationship between the codes. By physically manipulating the coded categories, I was able to organize my Process Codes and arrange the data in a structure that represented a relationship between the participant actions (Saldaña, 2016).

**Merging the analysis.** To narrow down the data collection and help provide precise themes for the research questions, the student image codes from the researcher reflection journal were added into the student writing prompt codes. In addition, the teacher image codes from the researcher reflection journal were added into the teacher interview codes. The merging of the

data occurred after the first cycle of coding and was added during the tabletop transitional round. At this point in the data analysis, the teacher codes and student codes were separated to provide a more detailed exploration of the two qualitative research questions.

***2 cycle.*** The goal of the second cycle was to refine and reorganize the data to show a link between the codes. Saldaña (2016) explained the second coding cycle by stating, "Basically, your first cycle codes (and their associated coded data) are reorganized and reconfigured to eventually develop a smaller and more select list of broader categories, themes, concepts, and/or assertions" (p. 234). To refine the codes created in the previous cycles, Axial Coding was used to determine the best representation of actions. The Axial Coding approach sparked the removal of redundant labels, lumping of similar codes into a broader category, and identifying an emerging link between participant perceptions and experiences (Saldaña, 2016).

***After 2 cycle.*** After conducting the second cycle of coding, the refined codes were then clumped into categories, which led to themes presented in the researcher reflection journal, student writing prompts, and teacher interviews. Member checking (Saldaña, 2016) was also used to clarify accuracy and the credibility of the codes. The control and treatment teacher considered the researcher's interpretation of the data in order to ensure reliability with the emerged themes. Themes developed from the researcher reflection journal, along with the teacher interviews and student writing prompts, are discussed and described in detail in Chapter IV. In addition, quotes from participants are used in the report to substantiate the researcher's conclusions.

**Scope and Limitations**

This current study had unavoidable limitations. Since the results were based on a Title I school in Mississippi, the findings may not be generalizable to other districts and states. In addition, the sample sizes for the control and treatment groups were not guaranteed to be equal in regards to classroom size. Given the nature of the public school setting, maintaining equal sample sizes throughout an academic year was challenging in a rural area due to lack of parental involvement, family moves, and changes made in the school district. Other limitations included personal bias, convenience sampling, small sample size, maturation of students over an academic year, and self-examining surveys.

The current pandemic also added inescapable limitations. Due to the fluid nature of the virus, school procedures and state guidelines changed daily with emerging research. The fluctuating protocol resulted in flexible decision-making. Participating students and teachers faced additional stress with the changing routines and learning platforms (Cantor, 2020). With the added mental strain, instructional time was interrupted at times due to lack of concentration and focus. COVID-19 brought a magnitude of concern for the academic and mental well-being of students. The limitations surrounding the impact of the virus were ultimately unpredictable, but the main challenges related to student stress, learning interruptions, and changing guidelines.

**Summary**

The pragmatic paradigm focuses on what applications work by identifying and providing solutions to problems. Saunders, Lewis, and Thornhill (2009) stated, “For a pragmatist, research starts with a problem, and aims to contribute practical solutions that inform future practice” (p. 143). By using a mixed methods approach, the researcher aimed to gain a better understanding of how to teach grit through a growth mindset by examining student scores and perceptions, along

with teacher orientation. The findings of this study will contribute to the existing body of research regarding grit and growth mindset. Chapter IV provides a close analysis of the quantitative and qualitative findings.

# CHAPTER IV

# RESULTS

*Without ambition one starts nothing. Without work one finishes nothing. The prize will not be sent to you. You have to win it.*
-Ralph Waldo Emerson

This mixed methods study sought to understand the extent of differences between cognitive and non-cognitive skills with the influence of a deliberate practice using a Rubik's cube. In addition, student perceptions and teacher orientation surrounding grit and growth mindset were explored within the study. The treatment class participated in grit and growth mindset instruction, along with learning the steps of the Rubik's cube. The control class engaged in grit and growth mindset instruction but did not receive any direction on learning how to solve the Rubik's cube. The following research questions directed this study:

1. What is the extent of differences among a deliberate practice and learning outcomes in reading, mathematics, grit, and growth mindset scores?
2. What are student perceptions and experiences of grit and growth mindset instruction?
3. How does a teacher's orientation to grit and growth mindset instruction influence student experience?

This chapter includes a detailed description of the findings. The data are organized by quantitative and qualitative findings and includes a detailed analysis of the results. In addition, Table 6 is presented to share and organize the research questions, data collection, and data analysis.

Table 6

*Overview of Research Questions, Data Collection, and Data Analysis*

| Research Question | Data Collection | Analysis |
|---|---|---|
| What is the extent of differences among a deliberate practice and learning outcomes in reading, mathematics, grit, and growth mindset scores? | STAR Reading Test<br>STAR Mathematics Test<br>Growth Mindset Survey<br>Grit-S Survey | 4 separate ANOVAs using SPSS |
| What are student perceptions and experiences of grit and growth mindset instruction? | Researcher Reflection Journal<br>Student Writing Prompts | Qualitative Coding |
| How does a teacher's orientation to grit and growth mindset instruction influence student experience? | Researcher Reflection Journal<br>Teacher Interviews | Qualitative Coding |

**Quantitative Results**

The quantitative instruments for the study included the STAR reading and mathematics test (Renaissance Star Mathematics, 2020; Renaissance Star Reading 2020), the Grit-S (Duckworth & Quinn, 2009), and a growth mindset survey (Dweck, 2006; Hall, Hume, & Tazzyman, 2016). During the data analysis, the students' assigned group was examined across the four dependent variables to determine if statistically significant differences existed between the effects. Four separate one-way analysis of variance (ANOVA) was conducted using Statistical Package for the Social Sciences (SPSS). In addition, an a priori analysis was conducted to determine an appropriate sample size. With a moderate effect size, a sample size of 129 participants would be necessary in order to achieve adequate power at .80 (Dimitrov, 2008). Therefore, this study was underpowered with a sample size of 39.

**Reading results.** A one-way ANOVA was conducted to explore group differences based on reading change score. An alpha level of .05 was utilized. Descriptive statistics are provided in Table 7. All groups were normally distributed. Variances were homogeneous, $F(1, 37) = 1.479$, $p = .232$. Statistically significant differences were not evident among the groups, $F(1, 37) = 2.69$, $p = .109$. A medium effect size was noted, $n^2 = .068$, indicative of a moderate degree of practical significance. Given the sample size of $n = 39$, statistical significance would be detected for only large effect sizes, $n^2 > .18$. Though the results were underpowered resulting in no statistical significance, the 6.8% of the variance accounted for in the model does indicate some evidence of differences between groups. The moderate degree of practical significance provides evidence to the effectiveness of the Rubik's cube instruction and suggests that the difference is meaningful to the field of education.

Table 7

*Descriptive Statistics for Reading Change Score*

| Group | *n* | Mean | SD |
|---|---|---|---|
| 1 | 20 | 0.96 | 0.84 |
| 2 | 19 | 0.4 | 1.26 |
| Total | 39 | 0.69 | 1.09 |

**Mathematics results.** A one-way ANOVA was conducted to explore group differences based on mathematics change score. An alpha level of .05 was utilized. Descriptive statistics are provided in Table 8. All groups were normally distributed. Variances were homogeneous, $F(1, 37) = 1.746$, $p = .195$. Statistically significant differences were not evident among the groups, $F(1, 37) = .04$, $p = .837$. A negligible effect size was noted, $n^2 = .001$, indicative of a very limited

degree of practical significance. Given the sample size of $n = 39$, statistical significance would be detected for only large effect sizes, $n^2 > .18$.

Table 8

*Descriptive Statistics for Mathematics Change Score*

| Group | *n* | Mean | SD |
|---|---|---|---|
| 1 | 20 | 1.00 | .55 |
| 2 | 19 | 0.95 | .86 |
| Total | 39 | 0.98 | .71 |

**Growth mindset results.** A one-way ANOVA was conducted to explore group differences based on growth mindset change score. An alpha level of .05 was utilized. Descriptive statistics are provided in Table 9. All groups were normally distributed. Variances were homogeneous, $F(1, 37) = .022$, $p = .884$. Statistically significant differences were not evident among the groups, $F(1, 37) = .068$, $p = .796$. A negligible effect size was noted, $n^2 = .002$, indicative of a very limited degree of practical significance. Given the sample size of $n = 39$, statistical significance would be detected for only large effect sizes, $n^2 > .18$.

Table 9

*Descriptive Statistics for Growth Mindset Change Score*

| Group | *n* | Mean | SD |
|---|---|---|---|
| 1 | 20 | 3.55 | 3.44 |
| 2 | 19 | 3.84 | 3.55 |
| Total | 39 | 3.69 | 3.45 |

**Grit results.** A one-way ANOVA was conducted to explore group differences based on grit change score. An alpha level of .05 was utilized. Descriptive statistics are provided in Table 10. All groups were normally distributed. Variances were homogeneous, $F(1, 37) = 1.700$, $p = .200$. Statistically significant differences were not evident among the groups, $F(1, 37) = .215$, $p = .646$. A negligible effect size was noted, $n^2 = .006$, indicative of a very limited degree of practical significance. Given the sample size of $n = 39$, statistical significance would be detected for only large effect sizes, $n^2 > .18$.

Table 10

*Descriptive Statistics for Grit Change Score*

| Group | *n* | Mean | SD |
|---|---|---|---|
| 1 | 20 | .91 | .77 |
| 2 | 19 | .80 | .64 |
| Total | 39 | .86 | .70 |

**Qualitative Findings**

For qualitative data, a researcher reflection journal was implemented to collect, organize, and analyze useful data obtained during each session (Cochran-Smith & Lytle, 1993). In addition, teacher interviews were conducted at the end of the study to gain insight on how teacher orientation influences student experience with grit and growth mindset instruction (Creswell, 2013). Student writing prompt responses were also collected to examine student perceptions and experiences surrounding grit and growth mindset. Several rounds of coding cycles were executed to refine categories and expose two sets of reportable themes developed from the data collection (Saldaña, 2016).

**Student perceptions and experiences.** The qualitative data analysis revolved around three forms of data collection. To answer the second research question employed in this study, the researcher reflection journal and student writing prompt responses were merged together to create a more accurate representation of the data. After the second cycle of coding, the connected relationships exposed three themes relating to student perceptions and experiences of grit and growth mindset instruction. The following themes emerged from the data collection: (a) connect neurons by working out the brain, (b) overcome challenges by persevering, and (c) experience growth by reflecting.

***Connect neurons by working out the brain.*** During the second cycle of coding, the "talking" and "growing" Process Codes were lumped together to form a broader category titled "growing the brain." The codes were connected into one category based on student perceptions of how to grow the brain by getting neurons to talk through challenging tasks. Observations from the researcher reflection journal, along with the writing prompt responses, revealed that students had a concrete understanding of how to promote brain growth by connecting neurons. The following quotes from students support the emerged theme:

James: *We work our brains out and get our neurons talking by doing hard things, like learning to ride a bike.*

Haley: *I have made my neurons talk by doing hard stuff like iReady.*

Ben: *You might not know it yet, but you can know it. When your neurons connect, you grow your brain and can do hard things.*

Finley: *The harder the challenge the more neurons start talking.*

Grace: *I got my neurons talking by practicing the Rubik's cube this weekend and thinking really hard.*

Sandra: *To get smarter our brain has to get bigger like a muscle.*

Ricky: *We can do hard stuff and our brains will grow.*

Rich: *I made my neurons talk by doing the cube.*

The student findings corroborated with the researcher observations. In the researcher reflection journal, the researcher made note of student conversations during the Zoom sessions to capture images of student knowledge, discussion, and collaboration. When conversations were started regarding how students can partake in brain workouts, comments such as, "our brain is a muscle," "do hard things," and "get your neurons talking," were common answers over the course of the study. In addition, the researcher observed table conversations with students during the treatment classroom sessions. At the end of each session, the treatment class teacher allowed students to practice the Rubik's cube until recess. During that time, the researcher was able to observe and make note of student knowledge and discussion. At least four different times in the study, a student came to the Smart Board to show their Rubik's cube and say they got their neurons talking by solving a difficult step. One student was quoted in the researcher reflection journal stating, "Do challenging things and don't give up so our brains will get bigger and stronger. You have to think harder to get your neurons talking."

***Overcome challenges by persevering.*** During the second cycle of coding, the "overcoming," "challenging," "controlling," and "persevering" Process Codes were lumped together into one category titled "overcoming hard challenges." The codes were connected into one broader category based on student understanding of how to conquer challenging tasks. The

data collection revealed the relationship between the lumped codes, which led to the development of the second theme. The following quotes from students support how to overcome challenges by persevering:

Katie: *Learning to solve the cube is challenging. It is real hard and you get real tired and you might want to take a nap. When you get frustrated you just wanna quit because you are tired but you can't quit.*

Jane: *Go step by step and take one step at a time to help you move forward.*

Alison: *I challenged myself by learning how to do the pogo stick. It took me a couple of times. I fell down but I got back up.*

Abbie: *If you keep working on it, you'll get it.*

Elizabeth: *Be positive, confident, and unstoppable.*

Taylor: *Never say you are going to give up.*

Jordan: *Never give up like the power of yet. We couldn't do the cross on the cube last week, but now we can.*

The student findings corroborated with the researcher reflection journal. During the Zoom sessions, the researcher made note of student conversations to capture images of student knowledge, discussion, and collaboration. When discussing grit and growth mindset after viewing the instructional videos, comments such as, "you have to have a hard working attitude," "you have to have a growth mindset," and "you have to act like Mojo when he comes to a challenge," were common responses documented over the course of the study. In addition, the researcher observed conversations with students during the treatment classroom sessions. During one particular session, the researcher observed a student saying to a friend, "The Rubik's cube is

hard but fun. It's a challenge but you'll keep doing it, doing it, doing it, and keep trying." In addition, one student was quoted in the researcher reflection journal stating, "Learning how to solve the Rubik's cube is as hard as drawing an elephant, but stick to it like MoJo." Both the treatment and control classroom connected how to overcome challenges with MoJo's experiences in the instructional videos. The majority of conversations observed during the sessions related back to MoJo and his friend Katie's challenging tasks and problem solving skills. For example, one student in the control classroom stated, "Try to conquer our fears by never giving up and using the staircase strategy like MoJo did when jumping off the diving board." The instructional powerpoints and Classroom MoJo video series allowed students to relate to MoJo's challenges and see what grit and growth mindset looks like in action.

***Experience growth by reflecting.*** During the second cycle of coding, the "reflecting," "practicing," and "problem solving" Process Codes were lumped together into a larger category titled "learning from experience." The codes were connected into one broader category based on student experience. Students expressed understanding the importance of practice and problem solving in order to grow and learn. After watching a short video clip from Toy Story during session eighteen, one student described what happened to the toys by stating, "They had to problem solve and didn't give up. They persevered. They took small steps to solve the problem. They never gave up and they did it. They were able to escape by working together." The following student quotes also support the emerged theme:

Ashleigh: *Reflect and think about your mistakes to correct what you did wrong.*

Caitlin: *You can probably do the hard thing later if you keep trying and maybe try a different way.*

Jon: *It's okay to not be the best, it is just important to keep getting better.*

Bradley: *Reflect and think about your mistakes to correct what you did wrong.*

Trey: *You might not be able to do something now, but you just probably need to ask for help and more practice.*

Lanier: *Learning from mistakes can make your brain smarter if you don't give up.*

The student findings corroborated with the researcher's observations. In the researcher reflection journal, the researcher made note of student conversations during the Zoom sessions to capture images of student knowledge and discussion. When conversations were started regarding how students can grow from challenging tasks or by learning from mistakes, comments such as, "learn from your mistakes and keep trying," "you have to problem solve and work together," and "think really hard about how to learn from your mistakes," were common responses captured over the course of the study. In addition, the researcher observed many conversations in the treatment classroom when students were practicing the Rubik's cube. One student remarked, "If we have never done something we are scared and frustrated because it is new. We grow by reflecting on what we learned with the Rubik's cube." In addition, many students in both the treatment and control classroom connected growth to problem solving and reflecting by recalling the instructional videos. For example, after watching a short video clip on YouTube from the movie, Inside Out, one student responded to the character's growth by stating, "He got out of the wagon because it had too much weight and he wanted his friend to make it up the cliff." By problem solving and reflecting on past failures, the character was able to help a friend, and the students were able to understand the moral of the video clip. The video clips throughout each

session gave students the opportunity to make connections with what it means to experience growth through reflecting on past experiences.

**Teacher orientation.** To answer the third research question presented in the study, the researcher reflection journal and teacher interviews were merged together to create a more accurate representation of how teacher orientation to grit and growth mindset instruction influences student experience. By reorganizing the categories, the following three themes emerged from the data: (a) set high expectations, (b) support challenging instruction, and (c) celebrate student determination.

***Set high expectations***. During the second coding cycle, the following Process Codes were lumped together: persevering, hoping, and benefiting. The three Process Codes shared a relationship that was summed into an Axial Code titled "expectations." Based on the researcher reflection journal and the teacher interviews, both participating teachers set high expectations for all students. The following quotes support the emerged theme:

Treatment Teacher: *I hope my students have learned that we must work as a team in order to be successful, to help each other to reach that success goal, and to not give up when things get tough.*

Control Teacher: *When we did STEM activities, I made sure to remind students that the task would be a challenge and that I expected to see teamwork, perseverance, and problem solving in order to be successful.*

The researcher was also able to capture images of teacher knowledge during the sessions using the researcher reflection journal. Throughout the journal, the words "success" and "community" were used multiple times to portray the teachers end goal for students. Both

teachers demonstrated a strong desire for students to reach mastery at grade level, as well as value and grasp the concept of grit and growth mindset.

***Support challenging instruction***. "Practicing," "reminding," and "challenging" were three Process Codes that developed during the first round of coding. During the second coding cycle, the three codes were combined under the "instruction" Axial Code. The codes in this category captured how teachers supported grit and growth mindset instruction during the scheduled sessions, as well as during instructional time. Both teachers encouraged students to persevere during challenging tasks and reminded students of grit and growth mindset lessons. After the twenty sessions, one teacher stated, "They seemed to have a stronger desire to try their best on their work in class." The following additional quotes also support the emerged theme:

Treatment Teacher: *I repeatedly reminded the students of how their brains could grow and grow if they challenged themselves as well as the step by step strategy when they were working out a problem or task.*

Control Teacher: *I constantly try to walk around the room, reiterate grit and growth mindset statements, ask questions, and call on students to answer open-ended questions that promote higher order thinking skills.*

The researcher journal also captured teacher involvement during the sessions. Both teachers encouraged students to be respectful, to remain on task, and to respond to questions. The researcher also noted that the treatment and control teacher would share what students had worked on during the week that connected to the grit and growth mindset instruction. For example, one week the teachers selected a reading comprehension passage that focused on brain growth through challenging tasks.

***Celebrate student determination***. The third theme emerged from the "reflection" Axial Code during the second cycle. The codes represented in this category all shared a positive response to the grit and growth mindset instruction. Both teachers reflected on the experience by explaining how the overall attitude of students improved after participating in the grit and growth mindset discussions. One teacher responded to the instruction by stating, "I feel as though this can really help them tackle hard things that are sure to come their way, such as state testing and higher level material." In addition, the teachers shared positive experiences of seeing students encourage one another while remaining determined with the task at hand. The following quotes provide additional support for the developed theme:

Treatment Teacher: *Prior to the instruction, the students were quick to say they couldn't do something and would immediately ask for help before even giving the problem or task a try. Since the instruction, I've noticed them persevering and actually trying by themselves before asking for assistance.*

Control Teacher: *It was great seeing my students encourage each other when they could tell others were getting frustrated-just like the Mojo video clips. I saw students push forward with any and all tasks performed in the classroom, even outside the cube.*

The teacher findings corroborated with the researcher's observations in the reflection journal. The researcher captured that both teachers believed in the grit and growth mindset instruction and strongly encouraged students to persevere during challenging tasks. In addition, the observations noted that the teachers also prompted students to praise one another for small victories in order to encourage a sense of community within the classroom.

**Summary**

This chapter provided the findings of the mixed methods study. The three research questions guiding the study were explored and results were discussed in detail. In response to question one, the quantitative results did not prove to be significant; however, when combined with the developed themes from the qualitative findings, the study shows a promising relationship between student success and grit and growth mindset instruction. Chapter V will share a detailed discussion of the research findings, along with recommendations for the future.

# CHAPTER V

# DISCUSSION

*Energy and persistence conquer all things.*
-Benjamin Franklin

This study investigated the implementation of a deliberate practice in an elementary classroom and aimed to target grit and growth mindset instruction while teaching the importance of persevering through challenging tasks. This chapter will provide an interpretation of the findings, as well as relate the findings to the literature. The findings will be discussed in regards to each research question, and the emerged themes related to the literature review will also be examined in this chapter. In addition, this chapter will discuss how the findings contribute to the field of education while providing future research recommendations.

## Interpretation of Results

Research lacks specific strategies on how to teach and measure non-cognitive skills, such as grit and growth mindset (Synder, 2014). However, the idea of using neuroscience to help reshape education and teach a grit mindset raises a new perspective for educators. This study revealed a discrepancy in the findings between the quantitative and qualitative research. The Rubik's cube was used as an intervention that focused on a deliberate practice to improve skills using evidence from the brain (Perkins-Gough, 2013). The Rubik's cube allowed students to apply the grit and growth mindset instruction in an encouraging environment. Although quantitative results revealed no statistical significance, qualitative findings support that utilizing a deliberate practice in the classroom builds student grit and growth mindset.

**Research question one.** The Rubik's cube instruction in the treatment classroom did not contribute to a significant change in reading, mathematics, grit, or growth mindset scores. The literature surrounding grit and growth mindset as a predictor of student success includes mixed findings (Bazelais, Lemay, & Dolect, 2016; Dumfart & Neubauer, 2016; McClendon, Neugebauer, & King, 2017; Shively & Ryan, 2013). When considering the contradicting findings from the pilot studies and this current study, one plausible explanation could be due to the differing variables and testing measures. Another condition to consider is that the cube instruction resulted in growing the brain through knowledge of a new skill, but the portion of the brain affected by the deliberate practice was not implemented long enough to show any significance with student survey and test results (Zull, 2004). In addition, the research surrounding a deliberate practice in the classroom setting is very limited in today's literature. The studies that have been conducted on a deliberate practice mostly pertain to sports and music (Ericsson, 2016; Macnamara, Hambrick, & Oswald, 2014).

However, at no point in this study did any participant decline in confidence or motivation. In addition, no student experienced a regression with the grit and growth mindset pre and post-test surveys. Three students showed no change in the grit survey, whereas seven students showed no change in the growth mindset survey. By the end of the study, the students in the treatment classroom finished at the following Rubik's cube steps: 19 students mastered the white cross; 19 students mastered the yellow sunflower; 19 students mastered orienting the yellow sunflower; 14 students mastered the top layer; 10 students mastered orienting the top layer, and two students mastered the middle layer. Even though no student mastered the entire cube, no one in the treatment class gave up at any point during the nine-week study. When

considering the impact of the study on student motivation and perseverance, the results prove to be promising in regards to student dedication.

The reading test scores did not prove to be significant, but the results did show a moderate degree of practical significance. This provides evidence to the effectiveness of the Rubik's cube instruction and suggests that the difference is meaningful to the field of education. The reading results contradict previous research conducted by Admitomo (2015) who looked into studies that indicated grit and growth mindset as predictors of achievement. Admitomo (2015) found that the studies' results lacked practical significance and reported small effect sizes. One plausible explanation to the moderate degree of practical significance in reading could be attributed to the intentional reading structure for lower elementary classrooms (Getting Smart Staff, 2018). Teachers report having an uninterrupted 90-minute reading block compared to a 60 minute math block in lower elementary classrooms (Underwood, 2018).

**Research question two.** Evidence was gathered through the researcher reflection journal and student writing prompts to support the second research question being explored in this study. The researcher observed students having a positive attitude while remaining engaged during the grit and growth mindset instruction. This finding supports the literature surrounding grit and growth mindset. Pueschel and Tucker (2018) conducted a qualitative study that found student response in support of fostering grit by enhancing a growth mindset. In addition, White and McCoy (2019) conducted a study with 24 fifth grade students. The student interviews uncovered an increase in growth mindset, problem solving skills, and engagement of learning in the classroom. The findings revealed that students were more open and resilient to developing new skills (White & McCoy, 2019).

Based on observations, students in the treatment classroom had more effective conversations surrounding grit and growth mindset compared to the control class. The treatment students had a better understanding of what grit and growth mindset meant through working with the deliberate practice. Following the grit and growth mindset instruction, the treatment class was able to put the instruction into practice whereas the control class could only participate in discussion. As a result, students in the treatment class exhibited a greater connection with grit and growth mindset. When asked to define grit and growth mindset, the students in the treatment classroom had an overall stronger understanding than students in the control classroom. For example, students in the control group defined grit as "thinking hard," "you can't do it yet," and "trying harder." The majority of students in the treatment class defined grit as "not giving up," "persevering through hard stuff," and "taking small steps to reach your goal." Similar responses were found when students were asked to define growth mindset. Students in the treatment class demonstrated a better understanding of the concept by writing, "growth mindset means that you can grow your brain," "growth mindset means you can learn new things," and "growth mindset means you can challenge yourself." On the other hand, students in the control group described growth mindset as "not giving up." Although not giving up is a factor of growth mindset, the goal of grit and growth mindset is to recognize that the brain can grow during challenging tasks by preserving and learning from mistakes.

Students in the treatment classroom demonstrated a greater connection to the grit and growth mindset instruction. When asked what the biggest challenge was in solving the Rubik's cube, almost every student responded with learning to solve the middle layer. This response supports student understanding of grit and growth mindset. Students were faced with new

challenges when learning each step of the Rubik's cube but continued to engage in the task until each small step was met. For example, one student stated, "At first we couldn't do the white cross and now we can and it's easy!" With the deliberate practice, students were able to grasp the idea that all things are possible with practice and perseverance. In addition, when students were asked if they liked the Rubik's cube, no student responded with a negative answer. For example, students responded with "yes because it is a challenge," yes because it is fun and like a game," yes because it is a challenge and helps me have a growth mindset," "I like the Rubik's cube because it can grow my brain," "yes because the Rubik's cube has made me smarter," and "yes because it makes my neurons talk."

Overall, both classrooms exhibited a positive attitude when considering student perceptions and experiences of grit and growth mindset instruction. Even though the control classroom did not have the deliberate practice, students were still able to articulate the importance of working out the brain. When asked what gets neurons talking, students responded with, "helping my dad train his dog," "beating Minecraft by taking it one level at a time," "putting together my cat puzzle with the help of my friend," and "helping my dad fix my dirt bike." The grit and growth mindset instruction proved to be successful in both classrooms, and all students remained engaged, focused, and excited during the duration of the study.

**Research question three.** Consistent patterns between teacher and student experience emerged from the data collection. Both teachers and students portrayed positive attitudes toward grit and growth mindset instruction. In addition, all participants expressed the importance of persevering through challenging tasks while learning from mistakes. Evidence was gathered through the researcher reflection journal and teacher interviews to support the third research

question being explored in this study. The findings support the literature and reveal that teacher orientation to grit and growth mindset influences student experience. Lauresen (2015) expressed that adults play a large responsibility in paving a meaningful path for children to become lifelong learners that persevere in challenging tasks. Dweck (2015) suggested that if a student is struggling with a task, the teacher should help the student face the challenge and learn from the setback. In addition, Haimovitz and Dweck (2017) conducted a study that found the way adults respond to student success can impact a child's mindset.

Because both teachers had high expectations, participants were actively engaged during discussions and remained interested during the duration of the study. Through observations, the treatment and control teacher both shared a common attitude of supporting instruction while encouraging students. The researcher reflection journal noted that both teachers were strong role models for students. In addition, both teachers remained in constant communication with the researcher, encouraged student response, and prompted students to reflect on the grit and growth mindset instruction. Classroom management was exceptional in both classrooms, and students showed respect towards the teacher, as well as towards peers. The treatment teacher also had strict procedures in place for managing the Rubik's cubes and materials.

Just as findings revealed with the second research question, the treatment teacher expressed a stronger connection with the grit and growth mindset instruction using a deliberate practice. The treatment teacher stated, "I have noticed a difference in my students after working with the Rubik's cube. They seem to have a stronger desire to learn and actually try by themselves before asking for assistance." In addition, the teacher expressed the effectiveness of students engaging in a focused practice after the grit and growth mindset instruction. By working

towards a new goal each session, students were able to continue exercising their brains in a safe environment with quality feedback from the treatment teacher.

Both teachers expressed gratitude for being part of the study. The control teacher stated, "My class and I really enjoyed this instructional content, and the overall attitude of my students was great." The grit and growth mindset instruction proved to be successful, and both teachers expressed the effectiveness of the instruction.

**Implications of the Study**

The literature surrounding grit reveals that the non-cognitive trait is a predictor of success. However, studies lack information explaining how grit can be taught to students, along with how character education can enhance student cognitive development (McKibben, 2018). This study aimed to target how grit and growth mindset can enhance student perseverance when working with a deliberate practice. Hoerr (2017) suggested that schools should be built on a grit mindset by establishing a positive environment, setting high expectations, creating frustration, and promoting student reflection. In addition, Bashant (2014) encouraged teachers to break challenges into small tasks, delay gratification, and encourage collaboration. Qualitative data found that students were more open and resilient after participating in the grit and growth mindset instruction. In addition, students in the treatment classroom connected growing the brain to challenging tasks, such as solving the Rubik's cube. Treatment students were able to experience frustration with a deliberate practice while taking on the challenge of solving the Rubik's cube. The Rubik's cube captivated all students while exercising the brain and tapping into their potential.

The goal was to identify practical, effective strategies to help students increase motivation when faced with challenging tasks. The qualitative and quantitative data provide a deeper understanding of the research surrounding student motivation (Creswell & Creswell, 2018). As a result, the study revealed significant improvement in student attitude and perseverance.

**Limitations of the Study**

The mixed findings can be attributed to the small sample size, short time frame, and online learning environment. The Rubik's cube sessions in the pilot studies lasted approximately 20 minutes in a face-to-face environment. In addition, students received individualized instruction based on student readiness in a one on one and small group setting. Due to the nature of COVID-19, students did not receive any isolated instructional time on solving the Rubik's cube. During both pilot studies, students were placed with cube partners based on personality and mastery of steps. The COVID-19 setting also hindered any type of close proximity amongst the students. Additionally, students missed the opportunity to receive quality feedback to help improve their identified areas of weakness in regards to solving the Rubik's cube. One explanation for the study not proving to be statistically significant in regards to the quantitative results could possibly be due to the COVID-19 protocols and lack of student and researcher interaction.

**Recommendations for Future Research**

Due to the small sample size, this current study must be replicated in order to provide confidence and greater validity in the results. Recommendations for future research include how to extend grit and growth mindset instruction based on the quantitative and qualitative findings.

When comparing the two pilot studies with this current study, the researcher believes that a face-to-face setting is best for implementing a deliberate practice in the classroom. Miller (2018) argued that quality matters when practicing a particular skill. Time and attention should focus on identifying areas of improvement. Additionally, the researcher suggests working with a higher grade level if the study is replicated in the future. Since third graders in the state of Mississippi are administered the MAPP assessment, the study would best fit a third grade classroom (Mississippi Department of Education, 2020). Findings in previous studies show that grit increases with age based on life experiences (Duckworth et al., 2007). Not only would students be more mature in regards to life experiences when facing adversity, but the grit and growth mindset instruction would better prepare students for the motivation and perseverance necessary to reach proficiency on the reading and mathematics MAPP assessments. Another recommendation would be to work with a larger sample size, along with a wider geographical reach across the state.

Additionally, the researcher hopes to make more of a connection with the Rubik's cube instruction and school curriculum. Instead of seeing the Rubik's cube as a separate subject or task, the goal would be to integrate the instruction with the existing curriculum. For example, after learning about historical figures or particular animals, students would use problem-solving strategies to create mosaics with the Rubik's cubes that represent the learning objectives. Many mathematics standards can also be integrated with Rubik's cube instruction. In addition, the researcher would integrate music and movement with the Rubik's cube instruction, as well as expand on current neuroscience findings. Hardiman (2010) highlighted the importance of a motivating classroom environment that is conducive to physical activity. By integrating music

and movement into a positive emotional climate, student learning would be enhanced through creativity and symbolic understanding while releasing dopamine. With the influence of dopamine, educators could enhance student motivation, memory, and focus (Hardiman, 2010; Zull 2004).

**Conclusion**

The goal of this study was to promote grit and growth mindset and the belief in oneself to be successful in the face of adversity. By looking at the comprehensive findings of this study, the researcher believes the goal was successful. Character education, such as grit and growth mindset, should be an integrated component of the entire learning process (Wiley, 2014). By infusing a deliberate practice with a grit mindset, students are encouraged to develop an attitude that targets success in a rapidly changing world. The public education system should consider how to implement rich learning experiences that promote critical thinking in the classroom. The researcher will continue to explore the benefits of grit and growth mindset while teaching a deliberate practice using a Rubik's cube.

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## LIST OF APPENDICES

APPENDIX A

SAMPLE LESSON PLAN

**10/2/17 (20 minutes)**
24-second grade children seated at desks with chairs in a horseshoe formation

1. Handed out cubes
2. Mixed up the dies
3. Looked at page 1 of the manual
4. Played Simon Says by labeling the sides of the cube (front, bottom, posterior, left side, right side, and top)
5. Looked at page 2 of the manual
   Identified the Top Layer, Middle Layer, and Bottom Layer by referencing a Hamburger
6. Pointed to layers and center of cube
7. Discussed keeping the white center die on the top layer
8. Showed anchor chart on poster board
9. Allowed students to practice with peers

Charles asked, “How can you turn the sides, and they don’t fall apart?”

APPENDIX B

NOTE TAKING GUIDE FOR INDIVIDUALIZED INSTRUCTION

**1/30/18**
Individual conferences:

- Ben and Denson- met with them separately and then met with them together
  Ben-help Denson with solving the cross on Tuesday and Thursdays. He will record how many times he solves the white cross using stickers on his manual pages
- Brad- master of step 4. Ready for next step instruction. Solved steps 1, 2, 3, and 4 for me 4 times before I called him a master
- Jacob-master of step 3. Ready for next step instruction. Solved step 1, 2, and 3 for me 3 times before I called him a master
- Katie-also master of step 3. Ready for next step instruction. Solved step 1, 2, and 3 for me 3 times before I called her a master.
  Maybe place Jacob and Katie as partners for next week to learn step 4.

APPENDIX C

INSTRUCTIONAL SCHEDULE AND LESSON PLAN

4/29/19

| **Class:** | **Time:** | **Instruction:** |
|---|---|---|
| Jackson | 8:00-8:15 | -Whole group instruction-Middle Layer practice<br>-Caleb solved middle layer with my help in class<br>-Pulled Noah for one-on-one work; he solved middle layer with my help<br>-Gave Terry and Jane middle layer cards |
| Smith | 8:15-8:30 | -Whole group instruction-Middle Layer practice<br>-Cam, Brayden, Kaitlyn, and Warren solved the middle layer in class<br>-Pulled Maggie for one-on-one work; she was given middle layer card<br>-Pulled Jayden for one-on-one work; still working on mastering the middle layer |
| Howell | 8:45-9:10 | -Whole group instruction-Four Corner practice<br>-Pulled Carly, Kendal, Taylor, and Justin for middle layer practice |
| Walton | 9:10-<br>10:30 | -Whole group instruction-Four Corner practice<br>-Pulled Tristan and Jayden; worked on middle layer<br>-Pulled Eli and Miles; worked on solving the entire cube (ahead)<br>-Pulled Cadi and Bobby worked on solving the entire cube (ahead) |

APPENDIX D

INSTRUCTIONAL POWERPOINT

# Rubik's Cube

Mastering Step 2: The Top Layer
Total time: 15 minutes

## Learning the Directions
## Simon Says

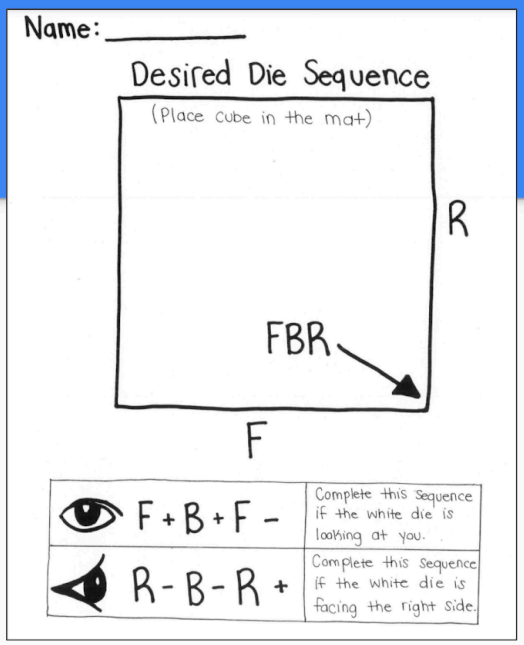
1. F + (Clockwise)
2. F - (Counter clockwise)
3. B + (Clockwise)
4. B - (Counter clockwise)
5. R + (Clockwise)
6. R - (Counter clockwise)


**When you are rotating the front, it is like driving a car.**

## Manual

Let's look at our top layer mat handout

WATCH & LEARN




## Let's practice:

1. I want you to get your cube, find your cube partner, and get into your cube location.
2. We will practice with our cube partner until the timer goes off.
3. Work hard and stay on task!

## Small Group Work

1. I will now call 4 to 5 students to come work with me
2. We will work on mastering the top layer in groups

APPENDIX E

GROWTH MINDSET SURVEY

1. You cannot change how smart you are no matter how hard you try.

2. You can always change how smart you are if you try hard.

3. You have to be born good at sports.

4. The harder you work at something, the better you will be at it.

5. I sometimes get angry when I get feedback on my performance in school.

6. I like when parents, coaches, and teachers give me feedback to help me.

7. Really smart people do not have to try hard.

8. You can always learn more.

9. You can’t really change the way you are right now.

10. An important reason why I do my school work is that I enjoy learning new things.

**Score Chart**

5 4 3 2 1

50 - 38 = Strong growth mindset

37 - 25 = Growth with some fixed ideas

24 - 12 = fixed with some growth ideas

12 - 0 = Strong fixed mindset

*Adapted from:*

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House Inc.

Hall, L., Hume, C., & Tazzyman, S. (2016). Five degrees of happiness: Effective smiley Likert scale for evaluating with children. Interaction and Design and Children: *Proceedings of the 15th International Conference on Interaction Design and Children*, 311-321. doi:org.umiss.idm.oclc.org/10.1145/2930674.2930719

APPENDIX F

8-ITEM GRIT SCALE FOR CHILDREN

1. New ideas and projects sometimes distract me from previous ones.

2. Setbacks don't discourage me.

3. I have been obsessed with a certain idea or project for a short time but later lost interest.

4. I am a hard worker.

5. I often set a goal but later choose to go for a different one.

6. I have difficulty maintaining my focus on projects that take a long time to complete.

7. I finish whatever I begin.

8. I am diligent. (You care a lot about your work)

**Score Chart**

5 4 3 2 1

**Scoring Directions**

1. For questions 2, 4, 7 and 8 assign the following points:
   5 = Very much like me
   4 = Mostly like me
   3 = Somewhat like me
   2 = Not much like me
   1 = Not like me at all

2. For questions 1, 3, 5 and 6 assign the following points:
   1 = Very much like me
   2 = Mostly like me
   3 = Somewhat like me
   4 = Not much like me
   5 = Not like me at all

3. Add up all the points and divide by 8. The maximum score on this scale is 5 (extremely gritty), and the lowest score on this scale is 1 (not at all gritty).

*Adapted from:*

Duckworth, A. L., & Quinn, P.D. (2009) Development and validation of the short grit scale (GRIT-S). Journal of Personality Assessment, *91*(2), 166-174. Doi: 10.1080/00223890802634290

Hall, L., Hume, C., & Tazzyman, S. (2016). Five degrees of happiness: Effective smiley Likert scale for evaluating with children. Interaction and Design and Children: *Proceedings of the 15th International Conference on Interaction Design and Children*, 311-321.

doi:org.umiss.idm.oclc.org/10.1145/2930674.2930719

APPENDIX G

TEACHER LEARNING CONCEPTUAL FRAMEWORK

(Cochran-Smith & Lytle, 1999, p. 252)

| TEACHER LEARNING: A CONCEPTUAL FRAMEWORK | |
|---|---|
| **KNOWLEDGE-PRACTICE RELATIONSHIP** | **What is understood or assumed to be the relationship of knowledge and practice? What is assumed about how "knowing more" and "teaching better" are connected?** |
| **IMAGES OF KNOWLEDGE** | **What knowledge are teachers assumed to need in order to "teach better"? What are the domains, sources, or forms of that knowledge? Who generates that knowledge? Who evaluates and interprets that knowledge?** |
| **IMAGES OF TEACHERS, TEACHING, AND PROFESSIONAL PRACTICE** | **What is assumed about the nature of the activity of teaching? What is included in the idea of "practice"? What are assumed to be the primary roles of teachers in and out of classrooms? What is the relationship of teachers' work in and out of classrooms?** |
| **IMAGES OF TEACHER LEARNING AND TEACHERS' ROLES IN EDUCATIONAL CHANGE** | **What is assumed about the roles teachers and teacher learning play in educational change? What are assumed to be the intellectual, social, and organizational contexts that support teacher learning? What is the role of communities, collaboratives, and/or other collectives in these?** |
| **CURRENT INITIATIVES** | **What are current initiatives in teacher education, professional development and/or teacher assessment that are based on these images?** |

APPENDIX H

RESEARCHER REFLECTION JOURNAL

| | |
|---|---|
| Session:<br>Date:<br>Teacher: | |
| Images of Teacher Knowledge | |
| Images of Student Knowledge | |
| Images of Student Learning and Student Roles | |
| Images of Teacher Learning and Teacher Roles | |
| Images of Student Discussion and Collaboration | |
| General reflection notes: | |
| Memorable quotes: | |
| Concerns: | |
| Questions: | |
| Next Steps: | |

*Adapted from:*

Cochran-Smith, M., & Lytle, S. (1999). Relationships of knowledge and practice: Teacher learning communities. *Review of Research in Education, 24*, 249-305.

APPENDIX I

TREATMENT CLASS WRITING PROMPTS

Directions: Complete each sentence below.

1. Growth mindset means _____

   _____.

2. Grit means _____

   _____.

3. I have made my neurons talk by _____

   _____.

4. My favorite part about seeing Mrs. Sam was _____

   _____.

5. The biggest challenge in solving the Rubik's cube was _____

   _____.

6. Did you like learning how to solve the Rubik's cube? Why or why not? _____

   _____

   _____.

APPENDIX J

CONTROL CLASS WRITING PROMPTS

Directions: Complete each sentence below.

1. Growth mindset means _____

   _____.

2. Grit means _____

   _____.

3. I have made my neurons talk by _____

   _____.

4. My favorite part about seeing Mrs. Sam was _____

   _____.

APPENDIX K

TEACHER INTERVIEW PROTOCOL

**Guiding Research Question**: How does a teacher's orientation to grit and growth mindset instruction influence student experience?

**Semi-structured interview** (mixture of more and less structured questions)
*Opening*

- Introduction
- Consent
- Thank you

*Script*
Thank you for participating in my study! I have enjoyed working in your classroom this semester. During this interview, I will be asking you several questions that are related to your orientation of using grit and growth mindset instruction in the classroom as it relates to student motivation and perseverance. There are no wrong answers, and I encourage you to say whatever comes to mind. If at any point during the interview you decide to no longer participate, please feel free to share your concern, and we will immediately end the questions. If you decide after the interview that you do not want your response included in the research findings, please call or email me, and I will immediately remove your interview from the data. Do you have any questions before we start?

*Questions for teachers in the control group*

1. How long have you been a teacher?
2. What do you hope your students have acquired from being in your classroom this year?
3. How do you feel about integrating 21st century skills, such as grit and growth mindset, into classroom instruction?
4. What can you tell me about your students' interaction with the grit and growth mindset instruction from this semester?
5. Were you able to notice any changes in student motivation and perseverance over the course of the nine weeks?
6. Can you think of any other ways you intentionally promoted grit and growth mindset outside of my whole group instruction?
7. Do you have any additional comments you would like to share that might be helpful in my research?

*Questions for teachers in the treatment group*

1. How long have you been a teacher?
2. What do you hope your students have acquired from being in your classroom this year?
3. How do you feel about integrating 21st century skills, such as grit and growth mindset, into classroom instruction?

4. What can you tell me about your students' interaction with the grit and growth mindset instruction from this semester?
5. Were you able to notice any changes in student motivation and perseverance over the course of the semester?
6. Can you think of any other ways you intentionally promoted grit and growth mindset outside of my whole group instruction?
7. How often would you say that students interacted with the cube outside of the designated instructional time of me being present?
8. How would you describe the overall attitude of your students when working with the cube?
9. Do you have any additional comments you would like to share that might be helpful in my research?

*Closing*

- Summary on moving forward
- Any additional questions/comments
- Thank you

**Interview Response Notes**

| Question | Control Group Teacher |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |

| Question | Treatment Group Teacher 1 |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |

APPENDIX L

PACING GUIDE

**Study Kick Off Prep:**
*Completed by 3.14.21*

1. Meet with teachers to explain the procedures and get the zoom meeting link
2. Get their STAR Reading and Math reports from BOY
3. Give grit and growth mindset surveys to the teachers (hard copies)
4. Give permission slips to the teachers (hard copies)
5. Give Rubik's cubes, manuals, and solving cards to Treatment Class
    - 20 cubes and manuals for the classroom (2 extra)
    - An additional 18 cubes for students to take home
      *(Placed student numbers on the cubes to keep track of cubes)*

| Date | Treatment + Control Instruction | Treatment Instruction | PowerPoint Link |
|---|---|---|---|
| 3.16.21 | -Grit and Growth Mindset Kickoff<br>-Grit and growth mindset surveys<br>-"Your brain is like a muscle" Video | Distribute the cubes + introduce the white cross | Session 1 |
| 3.18.21 | "Growth Mindset" Series Video 1: "The Magic of Mistakes" | Simon Says to review the parts of the cube + White Cross review<br><br>Introduce the Yellow sunflower | Session 2 |
| 3.23.21 | "Growth Mindset" Series Video 2: "The Incredible Power of Yet" | Simon Says to review the parts of the cube + White Cross review<br><br>Review Sunflower<br><br>Introduce orienting the sunflower | Session 3 |
| 3.25.21 | "Growth Mindset" Series Video 3: "The Mysterious World of Neurons" | Simon Says to review the parts of the cube + White Cross review | Session 4 |

| | | | |
|---|---|---|---|
| | "Ned the Neuron" Video | Review Sunflower<br><br>Review orienting the sunflower | |
| 3.30.21 | "Growth Mindset" Series Video 4: "MoJo Puts it altogether" | Simon Says to review the parts of the cube + White Cross review<br><br>Review Sunflower<br><br>Review orienting the sunflower<br><br>Introduce the top layer with the top layer mat | Session 5 |
| 4.1.21 | Read Aloud: The Girl Who Never Makes Mistakes by Mark Pett and Gary Rubinstein | *Top Layer Review*<br><br>Cross review<br><br>Review Sunflower<br><br>Review orienting the sunflower<br><br>Review the top layer with the top layer mat | Session 6 |
| 4.6.21 | "Perseverance" Series Video 1: "Kate Discovers the Dip" | *Top Layer Kickout*<br><br>*C*ross review<br><br>Review Sunflower<br><br>Review orienting the sunflower<br><br>Review the top layer with the top layer mat<br><br>Top Layer Kickout Video | Session 7 |

| | | | |
|---|---|---|---|
| 4.8.21 | "Perseverance" Series Video 2: "Climbing out of the Dip" | *Top Layer Kickout Review*<br><br>*C*ross review<br><br>Review Sunflower<br><br>Review orienting the sunflower<br><br>Review the top layer with the top layer mat | Session 8 |
| 4.13.21 | "Perseverance" Series Video 3: "The Big Show" | Reviewed the cross, sunflower, and orienting the sunflower<br><br>Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-)<br><br>Used the interacting cube and students helped me solve the top layer | Session 9 |
| 4.15.21 | "Big Challenges" Series Video 1: "The High Dive" | *Review from Tuesday*<br><br>Reviewed the cross, sunflower, and orienting the sunflower<br><br>Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-)<br><br>Used the interacting cube and students helped me solve the top layer<br><br>Introduction to Middle Layer | Session 10 |
| 4.20.21 | "Big Challenges" Series Video 2: "Taking Small Steps" | Reviewed the cross, sunflower, and orienting the sunflower | Session 11 |

| | | | |
|---|---|---|---|
| | | Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-)<br><br>Used the interacting cube and students helped me solve the top layer<br><br>Discussed the solving cards<br><br>Continued introducing the Middle Layer by modeling<br><br>Practiced making the "T" and orienting | |
| 4.22.21 | "Big Challenges" Series Video 3: "Making a Splash" | Reviewed the cross, sunflower, and orienting the sunflower<br><br>Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-)<br><br>Used the interacting cube and students helped me solve the top layer<br><br>Discussed the solving cards<br><br>Continued introducing the Middle Layer<br><br>Practiced the formula steps going to the Right (Set 1); Video 15 | Session 12 |
| 4.27.21 | "Moods and Attitudes" Series Video 1: "Mojo is in a Mood" | Reviewed the cross, sunflower, and orienting the sunflower<br><br>Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-) | Session 13 |

| | | | |
|---|---|---|---|
| | | Used the interacting cube and students helped me solve the top layer<br><br>Discussed the solving cards<br><br>Continued introducing the Middle Layer<br><br>Practiced the formula steps going to the Left (Set 2); Video 16 | |
| 4.29.21 | "Moods and Attitudes" Series Video 2: "A Bad Mood Storm" | Reviewed the cross, sunflower, and orienting the sunflower<br><br>Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-)<br><br>Used the interacting cube and students helped me solve the top layer<br><br>Practiced solving the middle layer using both the right and left formula sequences | Session 14 |
| 5.4.21 | "Moods and Attitudes" Series Video 3: "What Can You Control?" | Reviewed the cross, sunflower, and orienting the sunflower<br><br>Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-)<br><br>Used the interacting cube and students helped me solve the top layer<br><br>Introduced the Yellow Kickout Formula (Video 18) | Session 15 |

| | | | |
|---|---|---|---|
| | | Practiced solving the middle layer using all three formulas using the interacting cube | |
| 5.6.21 | Inside Out Video Clip | Reviewed the cross, sunflower, and orienting the sunflower<br><br>Discussed the top layer formulas and reviewed F, R, and B, along with (+) and (-)<br><br>Used the interacting cube and students helped me solve the top layer<br><br>Used the interacting cube and students helped me solve the middle layer using all three formulas | Session 16 |
| 5.11.21 | Read Aloud: After the Fall: How Humpty Dumpty Got Back Up Again by Dan Santat | Reviewed all the steps learned during the semester<br><br>Students helped me solve up to the middle layer using the interacting cube<br><br>Students worked with table partners to solve the cube | Session 17 |
| 5.13.21 | Toy Story Video Clip | Reviewed all the steps learned during the semester<br><br>Students helped me solve up to the middle layer using the interacting cube<br><br>Students worked with table partners to solve the cube | Session 18 |

| | | | |
|---|---|---|---|
| 5.18.21 | -I read "I Can't Do That, Yet: Growth Mindset" by Esther Pia Cordova<br>-Student Grit Surveys<br>-Shared Writing Prompts<br>-Teacher interview for Treatment class | Students worked with a partner for "Mix It Up Math" | Session 19<br>*No PowerPoint was used* |
| 5.20.21 | -I read "Your Fantastic Elastic Brain: Stretch It, Shape It" by JoAnn Deak<br>-Student Growth Mindset Surveys<br>-Teacher interview for Control class<br>-Collected writing prompt responses | Students worked with a partner for "Mix It Up Math" | Session 20<br>*No PowerPoint was used* |

*Topics and videos will come from Class Dojo's Social and Emotional Learning. Retrieved from https://ideas.classdojo.com/*

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APPENDIX M

PARENT PERMISSION

**Consent for Your Child to Participate in Research**

**Teaching the Rubik's Cube**

**Investigator:**
Samantha E. Gilbert
School of Education
333 Guyton Hall
The University of Mississippi
(662) 230-0981

**Faculty Sponsor:**
Dr. Joel Amidon
School of Education
322 Guyton Hall
The University of Mississippi
(662) 234-8846

**The purpose of this study**
The purpose of this research project is to promote grit and growth mindset. Students will develop critical thinking skills, along with pride, confidence, and enthusiasm with learning. It is anticipated gains will be shown in reading and mathematics scores by the end of year, all while fostering grit and perseverance.

**What your child will do for this study**
1. Work with the Rubik's cube in whole group instruction each day
2. Work with the Rubik's cube one-on-one with the research investigators throughout the school year
3. View a video demonstrating each step of the Rubik's cube
4. Read a manual that explains each step of the Rubik's cube

**Time required for this study**
The study will take 15-20 minutes two times a week for the remaining 4th nine weeks.

**Possible risks from participation**
Students may feel discouraged and uncomfortable when solving the steps of the Rubik's cube.

**Benefits from participation**
You may benefit from this project with increased reading and mathematics scores, along with a "grittier" and persistent attitude.

**Confidentiality**
All information in the study will be collected from you and your child anonymously: it will not be possible for anyone, even the researchers, to associate you with your responses or your child's responses.

**Right to Withdraw** Your child does not have to participate, and there is no penalty if you do not allow consent.

**IRB Approval**
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please ask the researcher if there is anything that is not clear or if you need more information. When all your questions have been answered, then decide if you want your child to be in the study or not.

**Statement of Consent**
I have read the above information. I have been given an unsigned copy of this form. I have had an opportunity to ask questions, and I have received answers. I consent to allow my child to participate.

---

Signature of Parent/Legal Guardian Date

---

Printed name of Parent/Legal Guardian Printed name of Child

APPENDIX N

RUBIK'S CUBE INSTRUCTIONAL HANDOUTS

# Rubik's Cube Instruction

## Middle Layer

***Directions:***

1. Find an edge die that is NOT connected to yellow
2. Match the edge die to the correct center die color (it will form a "T")
3. Look at the connecting color with the edge die
4. If the connecting color matches the right center die, follow the "right" sequence below
5. If the connecting color matches the left center die, follow the "left" sequence below
   **When you are moving it to the left, move the left to the front of the cube*
6. If all edge dies are connected to yellow, follow the "yellow kickout" sequence

| | |
|---|---|
| **Right** | **B - R - B + R + B + F + B - F -** |
| **Left** | **B + F + B - F - B - R - B + R +** |
| **Yellow Kickout** | **B - R - B + R + B + F + B - F -** |

## Placing the Corners

***Directions:***

1. Find **two** corners that match the center dies on each side
   *Example: If you have a blue, green, yellow die- you want it between the blue and green center dies*
2. Rotate the bottom layer until you have 2 corners that are in the desired location
3. If the two matched corner dies are side by side, place them in the back and follow the "Side by side" sequence
4. If the two matched corner dies are diagonal, follow the "diagonal" sequence

| | |
|---|---|
| **Side by Side** | **R - B - R + F + B + F - R - B + R + B 2** |
| **Diagonal** | **R - B - R + F + B 2 F - R - B + R + B +** |

Once all the colors are on the correct corner, go to the next step.
Continue the sequence below until all 4 corner dies are matched with the colors.
**R - B - R + B - R - B 2 R + B 2**

## Possible Positions Four Bottom Corners

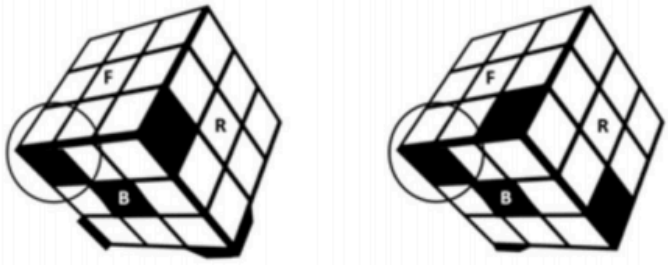
**The Sequence: R – B – R + B – R – B 2 R + B 2**

**Continue the sequence until all of the corners are placed and oriented**

**YOU ARE LOOKING STRAIGHT AT THE BOTTOM OF THE CUBE**

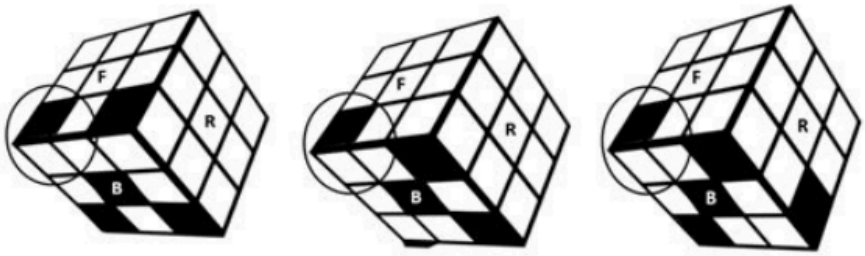
**NOTE: Black is yellow on your cube.**

**1 Corner**



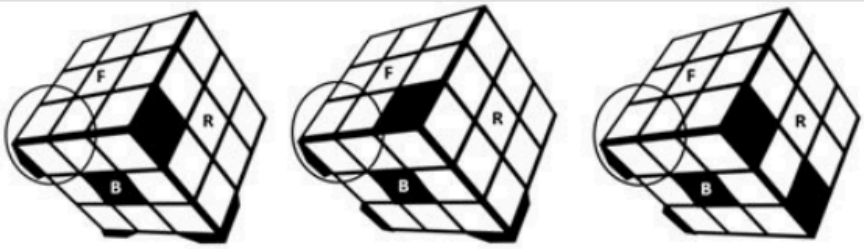

See One, Almost Done, LFB Face Down

**2 Corners**




See Two, LFB Face You
Then One, Almost Done, LFB Face Down

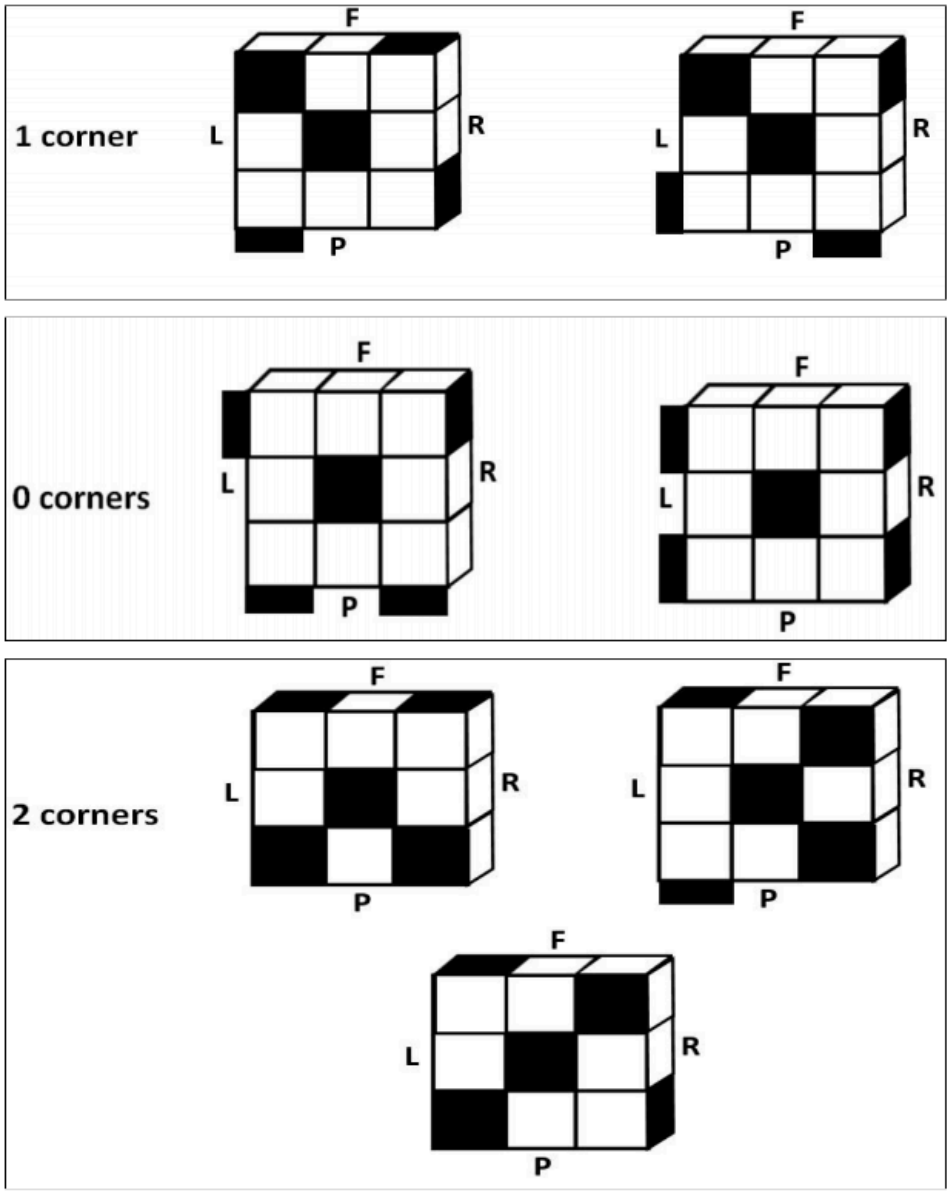
**0 Corners**




See None, LFB Face Left
Then One, Almost Done, LFB Face Down

## Seven Figures of All Possible Positions

**The Sequence: R – B – R + B – R – B 2 R + B 2**
**YOU ARE LOOKING STRAIGHT AT THE BOTTOM OF THE CUBE**
**NOTE: Black is yellow on your cube.**




**Continue the sequence until all of the corners are placed and oriented.**

| Orienting the Edge Dies: Basic Sequence |
| --- |
| ***Directions:***<br><br>1. Find a side of the cube that is completely solved<br>2. If a side is not completely solved, find a side that has an edge die with the same color as the center die<br>3. Follow the Basic Sequence below: |
| **Push/Push, F +, Pull/Pull, B 2, Push/Push, F +, Pull/Pull** |
| Continue the Basic Sequence until all of the edge dies are placed with the matching center die.<br>You want the four edges on the bottom layer to be placed AND oriented. |

**Once the Edges are placed, find the possible position and complete the sequence**

None Oriented

(L – R +) F 2 (L + R - ) B 2
(L – R +) F (L + R - ) B 2
(L – R +) F 2 (L + R - ) B –

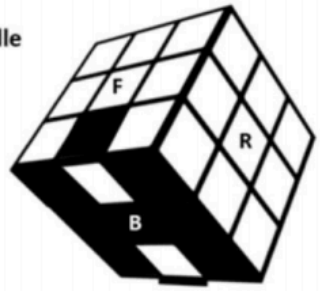
Completes Cube


On the bottom yellows show only on the 4 corners and center.

Two not oriented: Left and Rear Middle

(L – R +) F (L + R - ) B
(L – R +) F (L + R - ) B
(L – R +) F 2 (L + R - ) B
(L – R +) F (L + R - ) B
(L – R +) F (L + R - ) B 2

Completes Cube

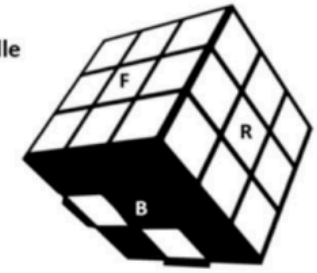



On the bottom yellows show on the 4 corners, the center and the left and right middle.

Two not oriented: Left and Rear Middle

(L – R +) F (L + R - ) B –
(L – R +) F - (L + R - ) B –
(L – R +) F 2 (L + R - )

Result: one correctly in place. Put the correctly placed edge front center. Do BASIC. This completes the cube.

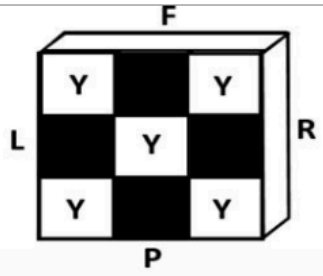



On the bottom yellows show on the 4 corners, the center and the front and right middle.

None Oriented

(L – R +) F 2 (L + R - ) B 2
(L – R +) F (L + R - ) B 2
(L – R +) F 2 (L + R - ) B –

Completes Cube

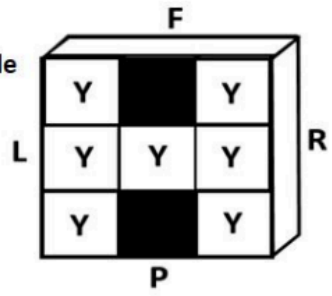



On the bottom yellows show only on the 4 corners and center.

Two not oriented: Left and Rear Middle

(L – R +) F (L + R - ) B
(L – R +) F (L + R - ) B
(L – R +) F 2 (L + R - ) B
(L – R +) F (L + R - ) B
(L – R +) F (L + R - ) B 2

Completes the Cube

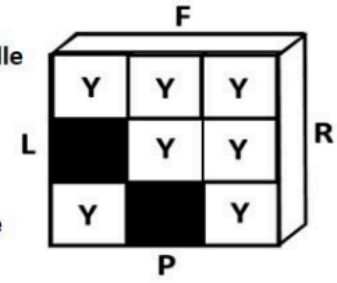



On the bottom yellows show on the 4 corners, the center and the front and right middle.

Two not oriented: Left and Rear Middle

(L – R +) F (L + R - ) B –
(L – R +) F - (L + R - ) B –
(L – R +) F 2 (L + R - )

Result: one correctly in place. Put the correctly placed edge front center.
Do BASIC. This completes the cube.



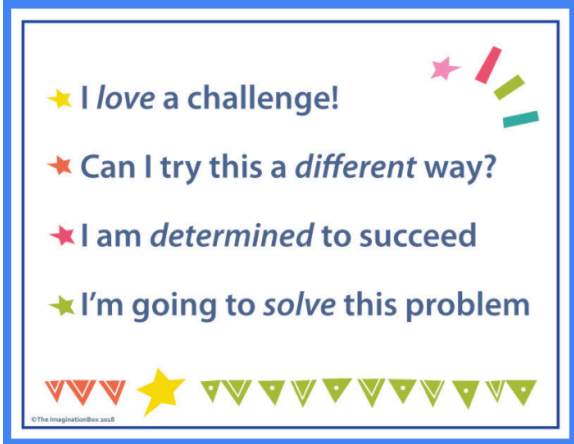

On the bottom yellows show on the 4 corners, the center and the front and right middle.

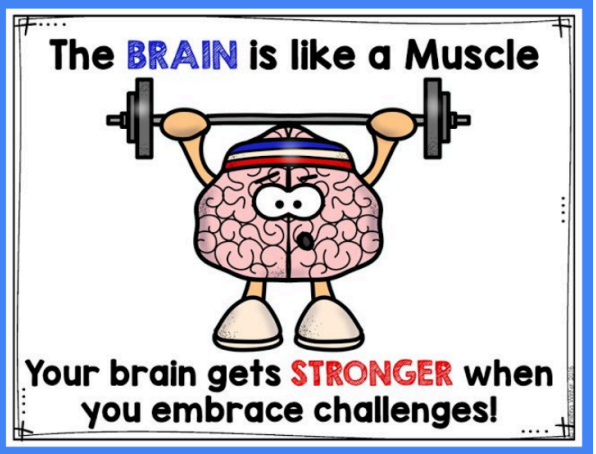
APPENDIX O

SAMPLE INSTRUCTIONAL POWERPOINT

## Rubik's Cube + Grit and Growth Mindset Instruction


## Magic of Mistakes



## Growth mindset

- When we make mistakes, our brain grows!!
- The Incredible Power of Yet
- What is something you couldn't do last year that you can do now?


## Review the Cube

- Faces
- 3 Layers
- Center Die
- White on Top
- Rotate the sides

# Mix It Up Math

Step 1: White Cross

Step 2: Yellow Sunflower

Step 3: Orient Yellow Sunflower

*Objective: TSW practice solving the steps of the cube while practicing addition skills*

## MIX IT UP MATH

**DIRECTIONS:**
**STEP 1**
- Get with a partner
- Complete the white cross
- Add the four corners using the key

***Whoever has the greatest sum wins the first round!***

**DIRECTIONS:**
**STEP 2**
- Stay with the same partner
- Complete the yellow sunflower
- Add the 4 corners using the key

***Whoever has the greatest sum wins the second round!***

**CUBE KEY**

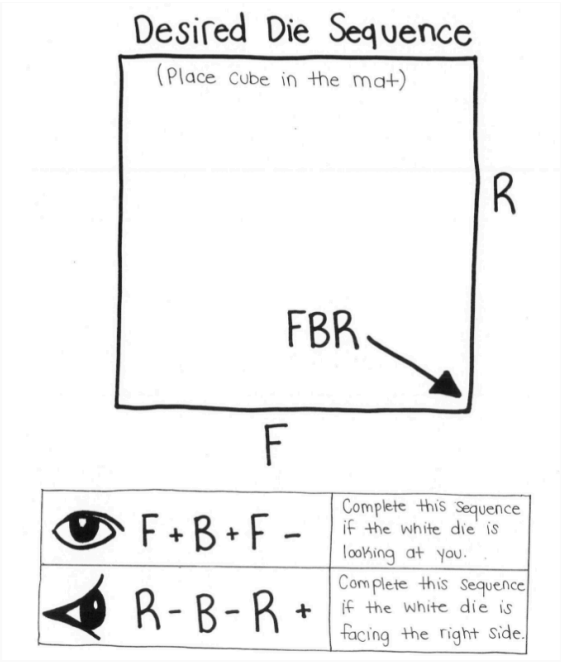
Red = 8
White = 4
Yellow = 2
Green = 1
Orange = 6
Blue = 5

# Top Layer Instruction

-Work with your partner on Mix It Up Math until the song ends

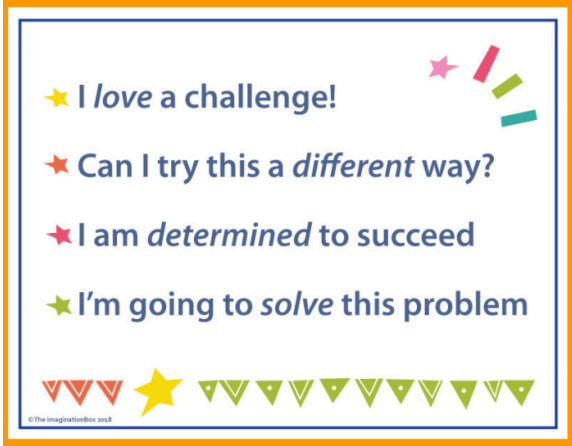
-If you are with Mrs. Sam, we will work on solving the top layer

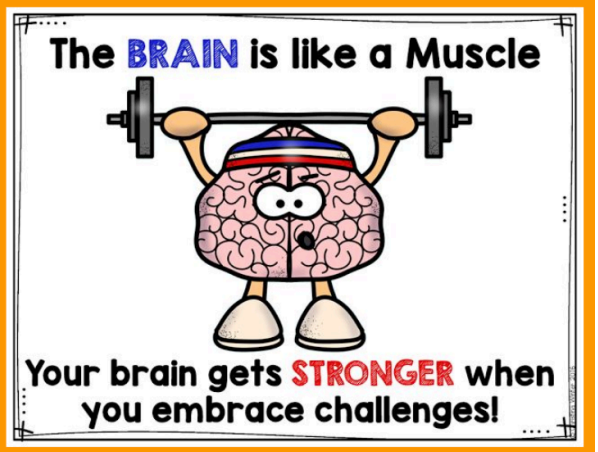
-I will switch out groups each visit

# Grit and Growth Mindset Instruction


# Magic of Mistakes

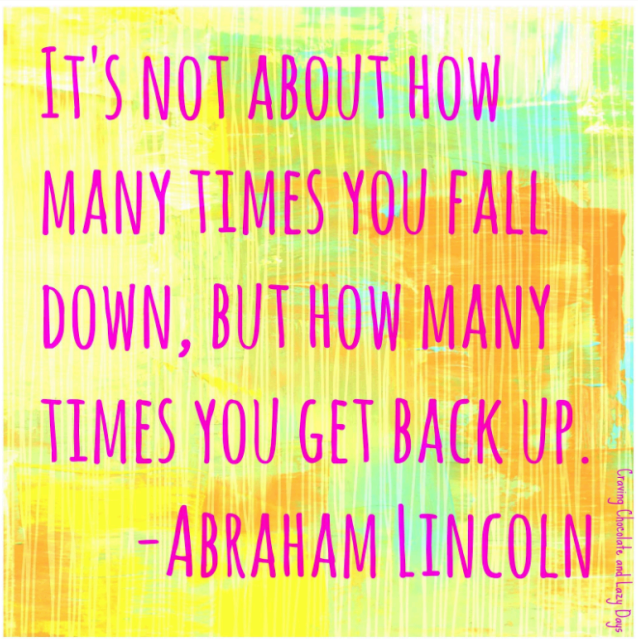


# Growth mindset

- When we make mistakes, our brain grows!!
- The Incredible Power of Yet
- What is something you couldn't do last year that you can do now?


**Read Aloud**
**AR Level 2.6**


## After the Fall:

- What was Humpty Dumpty afraid of? Why?
- What did he miss watching?
- What did he decide to make?
- What happened to his plane?
- How did Humpty Dumpty respond to this event? What is a character trait you could give him?
- Did Humpty Dumpty change from the beginning of the book to the end of the book?
- What is something you can learn from Humpty Dumpty?

# VITA

Sam E. Gilbert
samedwardsgilbert@gmail.com

## EDUCATION

| | | |
|---|---|---|
| Ph.D. | The University of Mississippi<br>July 2021<br>Dissertation: Instilling Motivation, Embracing Mistakes, and Fostering Grit: Using the Rubik's Cube in Elementary Classrooms<br>GPA: 4.0 | Elementary Education |
| M.Ed. | The University of Mississippi<br>July 2014<br>GPA: 4.0 | Curriculum & Instruction<br>Reading and Language Arts |
| B.A. | The University of Mississippi<br>May 2013<br>GPA: 3.9 | Curriculum & Instruction<br>Elementary Education |

## PROFESSIONAL EXPERIENCE

Fall 2018 to present

**Graduate Instructor**
*Department of Teacher Education, The University of Mississippi*

- Designed and taught 12 undergraduate courses in elementary education
- Created and designed the technology component of all courses for accessibility to an online system using Blackboard and Google Classroom
- Supervised practicum and student teaching field experiences
- Delivered a range of teaching and assessment activities, including tutorials directed towards the delivery of elementary education content at the undergraduate level
- Applied departmental protocol related to the academic discipline process
- Helped with ongoing development and design of the curriculum

- Participated in the assessment process and provided appropriate feedback to students to support learning
- Contributed to the development of appropriate teaching materials to ensure quality continent and methods of delivery
- Pursued professional development to remain current in recent advances in knowledge and teaching

Fall 2020 to present

**High-Quality Instructional Materials Ambassador**
*Mississippi Department of Education*

- 2020-2021 Pre-K – 2nd Grade High Quality Instructional Materials Review Team Member
- 2020-2021 Pre-K – 2nd State Textbook Rating Committee Member
- Participated in EdReports training
- Participated in the Mississippi Department of Education High-Quality Instructional Materials training
- Reviewed the Houghton Mifflin Harcourt Into Reading 2nd grade curriculum
- Reviewed the EL Open Up Resources 2nd grade curriculum
- Read and scored the curriculum using the guidance documents and provided a score and rational for each component
- Reviewed all Mississippi College and Career Readiness standards in the Houghton Mifflin Harcourt Into Reading and EL Open Up Resources curriculum
- Recommended quality curriculum to the Mississippi State Board
- Participated in a 3-part webinar series for district teams to learn about the process for selection and adoption on high-quality instructional materials in English Language Arts
- Facilitated Zoom breakout rooms for district teams to learn about the process for selection and adoption on high-quality
- Explained and shared the review process with district teams using the high-quality instructional materials rubric

Spring 2019 to present

**Rubik's Cube Ambassador**
*You Can Do the Rubik's Cube Program*

- Presented at professional development workshops
- Shared the benefits of using the Rubik's cube in elementary classrooms
- Engaged with other Rubik's Cube ambassadors to brainstorm, plan, and share curriculum ideas to help promote student learning
- Communicated with K-12 teachers on critical thinking skills
- Promoted the use of Rubik's cubes in K-12 classrooms

- Networked with K-12 teachers, researchers, and ambassadors using social media platforms
- Contributed to the You Can Do the Rubik's Cube website by providing research, articles, and curriculum ideas

Fall 2014 to Spring 2018 **Second Grade Teacher**
*Batesville Intermediate School, South Panola School District*

- 4 years experience
- English Language Arts Curriculum Planning Team Leader
- Mathematics Curriculum Planning Team Leader
- Summer School Interventionist
- Professional Learning Community Facilitator
- Title 1 Planning Team Member
- Created high-quality curriculum with appropriate assessments
- Delivered effective classroom management plans and procedures
- Pursued professional development opportunities to remain current in recent advances in knowledge and teaching

Fall 2013 to Spring 2014 **Graduate Assistant**
*The University of Mississippi, School of Education*

- Supported faculty research projects
- Helped with ongoing development and design of the instruction
- Facilitated small groups during course instruction
- Participated as a guest lecturer for EDRD 414 and EDEC 301
- Participated as a 5th grade Reading Fair Judge at Grenada Upper Elementary
- Visited a Kindergarten classroom in Maynooth, Ireland in the study abroad program

## HONORS AND ACTIVITIES

**Mid-South Educational Research Association**

Mid-South Educational Research Association 2020 Research In Progress Award

**The University of Mississippi**

2021 Summer Dissertation Fellowship Recipient
2021 Career Mentor for Ole Miss Women's Council
2021 Young Alumni Council Mentor
2019 - Nominee - Who's Who Among Students
2018 Outstanding Doctoral Student in Elementary Education
2016 - Nominee - School of Education Hall of Fame
Summa Cum Laude Graduate

Chancellor's List
Gamma Beta Phi Honors Society
Phi Kappa Phi Honors Society
Golden Key International Honor Society
Society for Collegiate Leadership and Achievement Honor Society

**Batesville Intermediate School**

May 2018 Teacher of the Month
2015 -2016 Teacher of the Year

## HIGHER EDUCATION TEACHING EXPERIENCE

**EDRD 414; The University of Mississippi; Oxford, MS**

- Reading Diagnosis and Intervention
- Survey of knowledge base necessary for teaching reading, emphasis on basics, focuses on fundamentals of diagnosis and remediation of reading disabilities.
- Fall 2018 | Overall rating: 4.83/5
- Fall 2019 | Overall rating: 4.9/5
- Fall 2020 | Overall rating: 4.97/5

**EDEL 402; The University of Mississippi; Oxford, MS**

- Art of Teaching Literacy in the Elementary School
- Research-based methods and techniques for teaching reading, writing, speaking, listening, viewing, and visually representing as expressive forms. Emphasis on theories and principles of language learning, planning and developing process and procedures for facilitating language development and evaluating student learning.
- Fall 2019 | Overall rating: 5/5
- Fall 2020 | Overall rating: 4.97/5

**EDCI 353; The University of Mississippi; Oxford, MS**

- Planning & Teaching Strategies for Effective Instruction
- Introduction to teaching strategies and models including direct instruction, discovery and inquiry, cooperative/collaborative learning, concept teaching in a developmental-constructivist context; attention to taxonomies for cognitive, affective, and psychomotor domains; reflection of classroom practices; curriculum design and planning; classroom management; evaluation and assessment; use of technology across the curriculum
- Spring 2019 | Overall rating: 4.64/5
- Spring 2020 | Overall rating: 4.71/5
- Spring 2021 | Overall rating: 4.95/5

**EDRD 400; The University of Mississippi; Oxford, MS**

- Reading Instruction in the Elementary School
- Methods and materials for teaching vocabulary, fluency, comprehension, and content-area literacy. Management of instruction, learners, and the schedule of the reading program.
- Spring 2020 | Overall rating: 4.75/5
- Spring 2021 | Overall rating: 5/5

**EDLE 417; The University of Mississippi; Oxford, MS**

- Senior Practicum
- Laboratory experience designed to support elementary methods courses
- Fall 2018 | Overall rating: 4.86/5

**EDLE 464; The University of Mississippi; Oxford, MS**

- Student Teaching: Elementary Education
- Full-time, full-semester student teaching; preparation of portfolio of teaching and interview materials; staff development activities at PDS sites
- Spring 2019 | Overall rating: This course was exempt from evaluation due to student enrollment (5 students)

## RESEARCH

### PUBLICATIONS

Gilbert, S. E. (2020). Thinking outside the cube: Instilling motivation and embracing mistakes. *You Can Do the Rubik's Cube.* Retrieved from https://www.youcandothecube.com/blog/thinking-outside-the-cube-instilling-motivation-and-embracing-mistakes

### REJECTED MANUSCRIPTS

Gilbert, S. E. (2021). Is the research practical?

Gilbert, S. E. (2020). Thinking outside the cube: Instilling motivation.

Gilbert, S. E. & Payne, J. S. (2019). Reading and math gains using a Rubik's cube.

### MANUSCRIPTS IN PREPARATION

Gilbert, S. E. Instilling motivation and embracing mistakes: Using the Rubik's cube in elementary classrooms.

Gilbert, S. E. Optimizing student experience: Memory, emotion, and learning.

Gilbert, S. E. The impact of neuroscience on future 21st century citizens.

Gilbert, S. E. Thinking outside the cube: Using a deliberate practice to instill motivation.

Gilbert, S. E. Instilling motivation and embracing mistakes: Using the cube for math gains in elementary education.

Gilbert, S. E. Instilling motivation and embracing mistakes: Using the cube for math and reading gains in elementary education

**CONFERENCE PRESENTATIONS**

Gilbert, S. E. (2021). Instilling Motivation using a Rubik's Cube. National Council of Teachers of Mathematics. Zoom.

Gilbert, S. E. (2021). Instilling Motivation, Embracing Mistakes, and Fostering Grit using a Rubik's Cube. Graduate Student Council Research Symposium. Oxford, MS.

Gilbert, S. E. (2021). Instilling Motivation, Embracing Mistakes, and Fostering Grit using a Rubik's Cube. Three Minute Thesis. Oxford, MS.

Gilbert, S. E. (2020). Instilling Motivation and Embracing Mistakes using the Rubik's Cube. Mid-South Educational Research Association. Zoom.

Gilbert, S. E. (2020). Instilling Motivation and Embracing Mistakes using the Rubik's Cube. Mississippi Science Teachers Association. Oxford, MS.

Gilbert, S. E. (2019). Instilling Motivation using a Rubik's Cube. Mississippi Council of Teachers of Mathematics. Hattiesburg, MS.

Gilbert, S. E. (2019). Instilling Motivation using a Rubik's Cube. Mississippi Association for Gifted Children. Starkville, MS.

**PENDING CONFERENCE PRESENTATIONS**

Gilbert, S. E. (October 2021). Productive Struggle using a Popular Puzzle: The Rubik's Cube as an Effective Mathematics Teaching Practice. National Council of Teachers of Mathematics.

**CONFERENCE PROPOSALS IN PREPARATION**

Gilbert, S. E. (2020). Instilling Motivation, Embracing Mistakes, and Fostering Grit: Using the Rubik's Cube in Elementary Classrooms. Mid-South Educational Research Association. New Orleans, LA.

**CONFERENCE ATTENDANCE**

- LETRS 3rd Edition. 2020-2021. Mississippi Department of Education. Zoom.
- English Language Arts Text Complexity Shift Training. 2020. Mississippi Department of Education. Zoom.

- Chess in the Classroom. 2020. The University of Mississippi.
- Graduate Student Writing Boot Camp. 2020. The University of Mississippi.

## SERVICE

### ACADEMIC SERVICE

- Graduate Assistant Interviews at The University of Mississippi
  *Assisted and conducted Graduate Assistant Interviews during the Spring 2019, Spring 2020, and Spring 2021 semesters*
- eLearning Endorsement Program at The University of Mississippi
  *January 2021*
- TeachLive Interactor and Facilitator at The University of Mississippi
  *Fall 2020; Spring 2021*
- Resilient Teaching Leader at The University of Mississippi for Teacher Education
  *Fall 2020*
- Capstone Reader for Graduate students at The University of Mississippi
  *Fall 2019; Spring 2020; Fall 2020*
- Capstone Mentor for Graduate students at The University of Mississippi
  *Fall 2019; Spring 2020; Fall 2020*
- Online Learning Video for the Provost at The University of Mississippi
  *Fall 2020*
- Exemplar Unit Writing Committee for the Mississippi Department of Education
  *Fall 2015; Spring 2016*

### PROFESSIONAL SERVICE

- Career Mentor for the Ole Miss Women's Council
  *Spring 2021*
- Young Alumni Council Member and Mentor
  *Fall 2020 & Spring 2021*
- Amidon Planet Podcast Guest Speaker
  *Episode 16: Teaching Math as Agape | Fall 2019*
  *Episode 24: GRIT | Spring 2020*
- Resilient Teaching Leader at The University of Mississippi for Teacher Education
  *Fall 2020*
- Reference for teacher candidates
  *Spring 2019; Spring 2020; Spring 2021*

### MEMBERSHIP

- Young Alumni Association
- Association for Supervision and Curriculum Development (ASCD)
- National Council of Teachers of Mathematics (NCTM)
- Mississippi Association of Educators

- Gamma Beta Phi Honors Society
- Phi Kappa Phi Honors Society
- Golden Key International Honor Society
- Society for Collegiate Leadership and Achievement Honor Society