Reducing Math Anxiety Through Art

By Mercedes Pruitt

Submitted in Partial Fulfillment of the Requirements for the

Degree of Master of Education

May 2021

Graduate Programs in Education

Goucher College

Table of Contents

List of Tables

Abstract

The purpose of this study was to determine if reduction of math anxiety through an art-related therapeutic session would improve accuracy on a math-based assessment among eighth grade students. Previous research demonstrates that consistently used mindfulness activities that involve the arts have been successful in alleviating anxiety and improving assessment scores; however, teachers often lack time to complete mindfulness activities. Eighth grade math students were administered pre and post assessments of basic math facts in a virtual environment due to COVID-19 closures. After baseline data was collected, the experimental group (n = 19) was provided a 5-minute free draw art session prior to administration of the post assessment; the control group (n = 13) received a 5-minute return to school safety presentation. The mean score on the post-assessment was not significantly different between the children in the control group (Mean = 78.54, SD = 23.97) and the children in the experimental group (Mean = 71.68, SD = 21.82) [$t(30) = 0.84$, $p = .41$]. There was no significant evidence in this study that a one session art therapeutic improved assessments scores by reducing math-related anxiety. Further studies should consider changes in physical environment, types of art (free draw, specify drawing, color, complex designs), and frequency of intervention.

CHAPTER I

INTRODUCTION

Overview

As a student, this researcher struggled with math. Since the popular thought was that girls were just not as good at math, the struggle was brushed off due to gender stereotypes. The problem was not learning the material, but the amount of anxiety that accompanied classroom and high-stake assessments given that failure was not going to be unusual for a girl. As complexity increased, anxiety due to math made learning more difficult, and acceptance of failure took root. This anxiety did not present in reading, science, or social studies; the anxiety was present solely in math.

That student that had crippling math anxiety is now charged, as a special education teacher, with teaching mathematics to academically struggling eighth grade students. An abundance of this student population will readily admit that they hate math. Even those students who are in advanced levels of math often find it stressful. Academically struggling students often lack basic skills to be successful in eighth grade math due to their own cognition deficits, their familiar environment and influence, personal biology and psychological influence, and a lack of appropriate interventions to address mathematical skills acquisition.

Math anxiety is not just a middle school concern. Up to 93% of the population has experienced episodic or continuing math anxiety (Luttenberger et al., 2018). There are many theories as to the genesis of math anxiety; they range from neuro-physiological dysfunction (Ferguson et al., 2015), to environmental influence (Casad et al., 2015), to causes related to a lack of skill acquisition (Lindskog et al., 2016). There is a lack of research regarding specific strategies that can be employed within a classroom to reduce mathematics related anxiety

without significant programming considerations; most suggestions offered by researchers are anecdotal in nature and are based on feedback from individuals with generalized anxiety disorders.

Given the time demands of curriculum pacing and the expense of psychological interventions, it is difficult to institute robust therapy programs within the school day. Educators have turned to multiple mindfulness activities to reduce anxiety within the classroom such as journaling, deep breathing, listening to calming music, movement, or art. Given the unique emotional traits of middle school students, the introduction of mindfulness activities should consider the degree of buy-in an activity will have. Using art or drawing as a therapeutic offers readily available supplies and students who can already perform the activity. Middle school-aged students may be less likely to scoff at art as a therapeutic in comparison to other activities such as deep breathing exercises, movement, or calming music, making it a viable option to reduce anxiety prior to math assessments.

Statement of Problem

The purpose of this study was to determine if reduction of math anxiety through an art-related therapeutic session would improve accuracy on a math-based assessment among eighth grade students.

Hypothesis

The null hypothesis was that there would be significant statistical difference in basic math fact assessment scores between a treatment group of students that participated in an art-related therapeutic session prior to the test and a control group.

Operational Definitions

Therapeutic art session: Students in the treatment group participated in a five-minute drawing session prior to the administration of the post treatment assessment. The students required paper and a writing utensil to draw something that makes them happy; if completed early, they were instructed to doodle or add to their drawing until the allotted time ended.

Math fact-based assessment: Both pre and post treatment assessments contained all single digit addition and subtraction facts that result in a positive calculation. The fact-based assessment was created and administered on It'sLearning, a school-based learning platform the students use daily. The assessment's facts were randomized by the platform, and students received five minutes to complete the assessment; the platform's timed feature will not allow input after the allotted time has passed. Upon starting the assessment, a horizontal format addition or subtraction fact will appear on the screen one at a time. Students were expected to type in the solution and click the next button to advance to the next problem. The maximum score available was 144.

CHAPTER II

LITERATURE REVIEW

This literature reviews examines what recent research has shared about math anxiety. Section One provides an introduction to math anxiety in regard to what math anxiety is, what it looks like, its prevalence, and discussion of whether math or anxiety is the catalyst for this disorder. Section Two evaluates contributing factors of math anxiety that include gender bias, parental influence, personal biology, and influence of teacher attitudes. Consequences of math anxiety are discussed in Section Three. These consequences include effects on the brain, math performance, and vocational considerations. Suggested behavioral and classroom strategies to reduce math anxiety are presented in Section Four.

Defining Math Anxiety

For educators who have spent any time in the math classroom, it is not unusual to hear comments from students and parents about their dislike of math. While some of these individuals favor other subjects, many have a very real physical response to math in the form of math anxiety or math phobia. Math anxiety is the feeling of tension, apprehension, or fear that interferes with math performance (Ashcraft, 2002) In addition to psychological symptoms of fear, lack of confidence, and helplessness, physical symptoms such as an increased heart rate, sweating, nervous shaking, irregular breathing, abdominal "butterflies," and nausea are common. In daily life, individuals with math anxiety often avoid math due to frustration of not being successful before attempting a problem, confusion on starting procedures, and/or long developed negative attitudes toward math. Math anxiety has been noted to affect up to 93% of the population, with one study citing that math anxiety in 11% of the population warrants counseling or cognitive therapy (Luttenberger et al., 2018). In contrast, the specific learning disability of

dyscalculia affects approximately 3 - 6% of the population (Butterworth et al., 2011). While math anxiety is not associated with a specific learning disorder, the source can be difficult to discern – does math, anxiety, or other factors begin this pathway? The answer is not so straightforward.

When considering math anxiety, one should consider the causal relationship between math and anxiety. Did anxiety create deficits in math, or did deficits in math create anxiety? Ashcraft (2002) shared that individuals who are high in math anxiety also tend to score high on other anxiety tests. The strongest interrelationship is with test anxiety, a .52 correlation. This interrelationship may suggest other interfering behaviors coincide with math anxiety, such as attention or focus, other learning disabilities, or natural predispositions toward anxious behavior. Ashcraft demonstrated that math anxiety is only weakly related to overall intelligence but felt the .17 correlation is inflated due to the quantitative items included on assessments that those with math anxiety have difficulty with.

This does not mean to say that math anxiety is not a result of math deficits; the study did not demonstrate an extensive gap between math and other intelligences. Deficit Theory reveals that adults with high math anxiety have numerical processing deficits compared to adults with low math anxiety. Maloney et al. (2011) stated that the findings from reviewed studies suggest that math anxiety may result from a basic low-level deficit in numerical processing that compromises the development of higher-level mathematical skills. In contrast, the Debilitating Anxiety Model points to physical responses to math that may further deficits. This model is characterized through avoidance and rushing through mathematical concepts or calculations. Research in this area suggests that anticipation of math causes activation of the neural 'pain network' in high math anxiety individuals, which may help to explain why high math anxiety

individuals avoid math (Lyons & Beilock, 2012). However, not all studies agree. Grežo & Sarmány-Schuller's (2018) results suggest that trait anxiety and math anxiety are clearly distinct and differ in construct. Trait anxiety refers to a person's predisposition to experience generalized anxiety. In the study, trait anxiety did not significantly predict math anxiety. Although math deficits and generalized anxiety are large factors, research suggest that there are other contributing factors that affect the development of math anxiety.

Contributing Factors of Math Anxiety

Math anxiety is not merely the sum of math deficits and generalized anxiety. Math anxiety is a complex network of complicating factors and outcomes. There are factors that relate to both biology and external influences. In this literature review, the main contributing factors of math anxiety research focus on cognition, gender, parental attitudes, and teacher attitudes.

Cognition is often measured by standardized tests such as the Weschler Intelligence Scale for Children or the Stanford-Binet Assessment. Elements of cognition that tests measure include comprehension, visual spatial reasoning, fluid reasoning, working memory, and processing speed. Cognition is thought to remain stable unless a traumatic event occurs in a person's life. Before other possible external factors could influence a person, the chemistry of one's body and "wiring" of one's brain could prove a hurdle in the area of math. Ferguson et al. (2015) found that those who demonstrated math anxiety had deficits in working memory and completing math work that required extended use of working memory. These individuals have difficulty committing new concepts to long-term memory, which reduces fluency and ease of recall. Spatial deficits are also a concern in those with math anxiety. Spatial reasoning is relating to, occupying, or having the character of space which, in math, relates to a myriad of skills such as geometry, number lines, and visualization of word problems. High math anxiety individuals

self-reported lower spatial ability and more spatial anxiety than their low anxiety peers. Lindskog et al. (2016) feel these deficits come into play when the formal number system is first taught. With lessened cognition, poor number sense is developed, and anxiety is developed through initial and repeated failures. These learning experiences accumulate and create a negative effect as it relates to math.

Unlike cognition, behavioral traits are more easily changed through remediation. Sometimes, student anxiety comes from failure due to not finding real world significance in a subject. Etcuban et al. (2019) concluded that the attitudes and study habits of the study's participants are significant factors that affect their performance in math. Anxiety can increase when lack of interest may manifest behaviors of avoidance or indifference that may result in reduced focus of task in the classroom. An Al-Mutawah & Fateel (2018) study also supported that grit was positively and significantly correlated to academic achievement in mathematics, demonstrating that through perseverance, anxiety could also have a positive effect on outcomes, if managed appropriately. Educators are often frustrated by another symptom of math anxiety: lack of participation. Florescu & Pop-Păcurar (2016) analyzed college attendees' responses to determine why they did not participate in class. Almost half of the students surveyed do not answer questions during courses and seminars out of fear of making mistakes and to avoid the consequences of giving an incorrect answer. This lack of communication between the student and teacher can raise anxiety levels, and students may not appropriately learn material.

Another biological function at play with math anxiety is sex. It was not too long ago that the stereotype of "girls are not as good as boys" in math was prominent. Through extensive reprogramming of education and outreach, girls are leveling the playing field in the area of math, but it appears the remnants of previous stereotypes linger. Geary et al. (2019) evaluated middle

school students' math performance and math anxiety. Geary et al. found that there was no significance between sex in math performance; however, females had higher mathematics anxiety than did boys. Van Mier et al. (2019) did not see the same result in performance. Their study concluded that math anxiety significantly and negatively affected math performance only in girls. An older study by Woodard (2004) reflected results similar to the Van Mier et al. study. Woodard's scoring showed a significantly low negative relationship between exit exam scores and math anxiety scores. In testing for any differences in anxiety levels between male and female, the results in Woodard's study indicated that female math students are significantly more math anxious than male students. Geary et al. (2019) concluded that adolescent girls' mathematics anxiety and their attitudes toward mathematics are more reflective of their actual mathematical competence than they are for boys. One implication is that, relative to boys with low mathematics achievement, girls with low achievement are at higher risk of developing mathematics anxiety and poor attitudes toward mathematics. Van Mier et al. (2019) noted improvements in female anxiety from grades 2 to grades 4, but still significant. Researchers suggested that early intervention with girls should be undertaken to improve results in math performance and/or math anxiety.

The implications of parental influence on a student's math anxiety are multifaceted depending on a parent's education, socioeconomic status, and their own attitudes toward math. Casad et al. (2015) investigated math attitudes of children in grades three and four, as well as math attitudes in their parents and how attitudes predicted children's math achievement. There was a small-to-medium negative correlation for both parental and child math attitudes when data was combined across grade levels. However, in grade three, there was no relationship between parent math attitudes and children's math achievement, but children's math attitudes

demonstrated a pattern that moderately correlated with their math achievement. Conversely, in grade four, there was no significant correlation between a child's math attitudes and math achievement, but there was a strong significant correlation between parent math attitudes and children's math achievement. The researchers state that this increase in grade four could be due to increased complexity of math concepts. In the same study, researchers demonstrate that those whose parents had higher levels of education performed better than those whose parents had less education. They emphasized that the educational level of the mother has a significant influence on the student's performance when that mother has a higher educational level. Daches Cohen & Rubinsten (2017) echoes the previous study, showing that the role of mothers' behaviors and attitudes toward math is more substantial in the prediction of child's math anxiety. Negative maternal attitudes were not only linked to math anxiety, but overall math performance. They further comment on the positive correlation between family income and parent education and math anxiety in the student.

While parents are their children's first teachers and place a tremendous influence on how they develop, elementary school teachers are typically responsible for the initial academic development of children. Concern regarding teacher attitudes about math at the secondary school level is minimal; however, elementary teachers teach all academic areas without concern to their attitudes or aptitude toward a subject. This does not mean to say that secondary math teachers do not also have negative attitudes in regard to teaching style. Ramirez, Hooper, Kersting, Ferguson, and Yeager (2018) survey results demonstrated that teacher anxiety had a significant inverse effect on ninth-grade math GPA. Higher teacher math anxiety was associated with worse math GPA among students regardless of student achievement and mindset. In the study, many teachers with higher levels of anxiety toward math were more algorithmic in their teaching, having

difficulty teaching math in a different way. Ganley et al. (2019) refutes the idea of high-level anxiety among specialists in the area of math at the elementary level; however, less than 5% of elementary teachers specialize or has a certification in the area of mathematics. With a small math specialist population at the elementary level, teachers' math anxiety can contribute to a student's enjoyment or anxiety in math. Findings demonstrate that early elementary teachers in the sample had higher levels of all measured types of teacher math anxiety than did upper elementary teachers. Ganley et al. (2019) and Ramirez, Hooper, Kersting, Ferguson, and Yeager (2018) both noted the effect of teacher anxiety on teaching style that may suggest stunted mindset. They agree that teachers with higher math anxiety are more likely to believe that students learn best by solving problems the way that the teacher shows them, that students' ability to recall number facts is a prerequisite for solving word problems, and that instruction should strictly follow the scope and sequence of topics in the textbook. This limits differentiation for students that may already struggle in math.

Consequences of Math Anxiety

The most immediate impact of math anxiety affects the human body. Klados et al. (2017) evaluated 1000 participants using an electroencephalogram (EEG) to evaluate brain activity when presented with arithmetic tasks. Overall, the researchers were able to find brain network changes in individuals with high math anxiety during the anticipation phase of participating in a math-related items. All bands or sections of the EEG were elevated, demonstrating great influence of math anxiety prior to mathematical tasks. As previously mentioned in Section One, the activation of pain receptors in the brain during math tasks is a further function of individuals with math anxiety and their desire to avoid such tasks. Neuroscience research involving math anxiety is limited but is a growing area of focus for some researchers.

Tomasetto et al. (2020) demonstrated that children as young as six have acquired heightened levels of math anxiety. Through their study, Tomasetto et al. concluded that math anxiety may reduce the encoding of novel math content in memory in very young children, potentially leading to cumulative gaps in math proficiency for children with math anxiety from the very beginning of their formal education. With gaps starting as early as kindergarten, math anxiety impacts the formation of number sense and fact fluency, which can impact performance throughout their school career. As a result, Al-Mutawah (2015) claims math anxiety is the key psychological factor that can influence students' academic outcomes. Levels of anxiety increase throughout a student's school career making access to curriculum more difficult. Differences between low and high math anxiety student assessment scores can vary from 10% to 34%. When students are not administered traditional assessments, mastery of the same math concept is often higher.

The consequences of math anxiety also extend past the classroom. Rubinsten et al. (2018) share that math-anxious individuals are less likely to have math-related careers, are more likely to experience increased health costs, low socioeconomic status, and mortgage default. In Western society, poor numeracy is viewed as a greater handicap than poor literacy. Ahmed (2018) noted that career-choice for individuals with high math anxiety did not often include careers in STEM. There is also a trend in minority groups who experience higher levels of math anxiety that may impact career choice and socioeconomic status.

Strategies to Reduce Math Anxiety

When considering remediation of math anxiety, the complexity of factors sometimes requires an individualized approach. Behavioral and classroom strategies can be employed to reduce the effect of math anxiety. There are very few new studies that relate to a specific strategy

to mitigate math anxiety; most research seems to focus on the mechanism of math anxiety. From a psychological approach, Aldrup et. al (2020) found some evidence that teacher sensitivity is associated with decreases in students' mathematics anxiety. Teacher awareness of their own biases and how they teach can lessen the anxiety of the students. Furner (2017), agreeing with this finding, states that frequently the problems in the classroom that cause math anxiety are due to a teacher with math anxiety. These teachers teach the few strategies they are comfortable with, which are often rote, in order to reduce their own anxiety. Additional professional development in the area of math mindset and strategies could prove beneficial.

When teachers identify students with math anxiety, they should work with counselors to determine strategies that may be helpful in the classroom as often the psychological and emotional aspects of math anxiety are neglected. Using stories about math at the earliest grades can breed familiarity with match concepts and reduce math anxiety. Ramirez, Hooper, Kersting, Ferguson, and Yeager (2018) referenced previous studies and accounts to offer behavioral solutions to math anxiety. One such suggestion is journaling. They reviewed a Park et al. (2016) study that had higher- and lower-math-anxious adults complete tests of math ability before and after engaging in an expressive writing exercise, in which they wrote how they felt about an upcoming math test. After one session of this writing, the higher math-anxious participants experienced a boost in their math performance relative to their pre-test scores. The use of art is another consideration. Kostyunina & Drozdikova-Zaripova (2016) concluded that a school anxiety correction program, "Magic Power of a Circle," contains effective methods and techniques of mandala art therapy. Rufo (2016) noted the result of drawing reducing anxiety through timely and accurate work completion in a student that presented anxiety unique to math class. Ramirez, Hooper, Kersting, Ferguson, and Yeager (2018) also reference a Dweck (1975)

study that modified failure-reappraisal conditioning, which creates an environment where individuals are forced to fail and were informed they failed because not enough effort was put forth. Some may consider this a form of reverse psychology. In this experiment, declines in failure and participants showed increases in performance. The participants saw failure as a cue to escalate effort. A similar result was noted from a Blascovich and Mendes study in 2010 that noted many overcome their affective reaction by viewing the situation as a challenge that they can overcome rather than as a threat they should avoid.

An overwhelming amount of literature on strategies to limit math anxiety supports early introduction of math play. Ramirez, Shaw, and Maloney (2018) endorse early parent intervention of high-risk populations with math play. The use of number-rich board games may help children to connect math with their everyday lives, model a positive disposition around math in the home, and desensitize heightened anxiety around math. They caution, however, that while activities have shown a link to increased interest in math, its relation to math anxiety has yet to be determined. Once in school, teachers can modify teaching strategies to aid in reducing math anxiety.

Furner (2017) supports a constructivist approach that emphasized whole to part learning, including student interests, manipulatives, scaffolding existing schema, classroom discussions, and alternative means of assessment. The constructivist style is thought to be less intimidating and does not emphasize timed assessments or correct answers. Instead, the constructivist style instead focuses on the process of doing mathematics. Through discussion math flexibility should increase to improve procedural and conceptual knowledge. One of the drawbacks is that this style of teaching does not allow for as much practice as direct instruction does. Shields (2007) supports a similar model that allows students to build interest, move instruction away from

computation and rote memorization of facts and algorithms toward understanding through real-life, relevant applications. Rote memory does not allow for math flexibility and critical thinking skills. This comes into play when students must analyze similar problems. To motivate students, Shields suggests one should replace teacher lecture with student participation, group work, the efficient use of technology, and the application of mathematics in other disciplines and in society.

Conclusion

Math anxiety had previously been a periodic area of study; however, the topic has increased in interest. High stakes testing has added pressure to determine why students underperform or excel. As scientists and researchers continue to gain greater understanding of human biology, there appears to be strong interest in why individuals develop math anxieties. With greater understanding of neurophysiology, researchers are eager to tease out math anxiety's catalyst: does biology or environment play a larger role? What seems to lack in math anxiety research is pointed study on therapies or strategies that reduce such anxieties. Apart from a handful of studies, most therapy studies are not clearly aligned to help math anxiety, but to either help generalized anxiety or help with positive math experiences through immersion. Specific study of targeted strategies appears to be lacking given the scope of math anxiety research.

CHAPTER III

METHODS

Design

This study is a quasi-experimental, non-equivalent control group design. Two eighth grade Math 8 classes were selected that had the same general educator and special educator. Both classes have similar strengths and weaknesses as evidenced by state testing and classroom scores. The two classes were randomly assigned to a condition. Both groups participated in a pre-assessment to determine baseline data. The assessment is computerized and contained positive solution addition and subtraction facts; questions on the assessment are randomized. After a week, a post-assessment was administered. Prior to the post-assessment, the experimental group was asked to draw an image or scene that made them happy or invoked happiness; five minutes was allowed for this activity. The control group, prior to the post-assessment received a five-minute presentation that shared school-based COVID-19 safety measures. The independent variable was the activity employed prior to the post-assessment. The dependent value was the student scores on the assessments.

Participants

The participants in the study were eight grade students who attend a suburban community middle school in Maryland. Both groups are a convenience sample receiving the same Math 8 curriculum in a collaborative classroom with the same educators. The control group consists of 13 students: 5 females, 8 males, of which there are 7 Caucasian and 6 African Americans that range in age from 13 – 15 years old. Three students receive special education services. The experimental group consists of 19 students: 8 females, 11 males, of which there are 7 Caucasian, 8 African Americans, and 4 Hispanic students that range in age from 13 – 15 years old. Eight

students receive special education services, and one student receives 504 accommodations. During virtual learning task initiation and consistent attendance is reduced; students who did not complete one or both assessments were excluded from the study.

Instrument

The pre and post assessments were created on the students' school curriculum delivery platform It'sLearning. All single digit addition and subtraction facts that resulted in a positive solution were provided; there were a total of 144 facts available to students. Options selected when creating the assessment included time restriction of five minutes, randomization of questions, and auto-score. Prior to this assessment, the students have not completed a fast facts assessment in eighth grade. Each assessment's fact and operation order were randomized through the It'sLearning platform and unique to the student. In the student view of the assessment, a five-minute countdown timer was displayed in the upper right-hand corner. Students have had exposure to timed assessments and understood once the timer was at zero that they would be unable to enter in any additional answers. While the assessment was auto-scored, students were unable to view immediate results. Expressions were written in horizontal form with a box to enter the solution, and a next button advances to the next problem. Assessments were also manually checked for unique errors, such as spacing, that could had been marked wrong by the auto-correct feature.

Procedure

The participants were students in two separate collaborative classroom of the researcher and a general educator. Students are enrolled in Math 8. While considered grade level curriculum, the course represents many students who struggle with math concepts and negative math attitudes. While some students do struggle with basic math fact acquisition and fluency,

most eighth grade students are secure in this concept; however, based on previous experience of timed assessments, knowing they cannot complete assignments outside of the class or timeframe creates anxiety in students, as evidenced through virtual chatroom questions, complaints, or students exiting the virtual class. Due to district privacy policy during virtual learning, students are not required to turn on web cameras for proctoring; it is not known if students were actively listening to instructions, following the rules of the assessment, or if the experimental group participated in the treatment. The control and experimental group both participated in the created timed assessment of basic single addition and subtraction facts at the beginning of class.

One week later, towards the beginning of class, the students were administered the same assessment. Students were told before beginning the assessment that it is timed and not to use any electronic calculation devices. Prior to the assessment, the control group was provided a five-minute, non-math, procedural presentation as it related to COVID-19 safety protocol prior to the return to the building. The presentation, given by the researcher, shared seating layouts, photographs of classrooms with barriers, instructions of maintaining social distancing, instructions on mask wearing, provision of orientation on day one (students are in a newly constructed building), and telling the students which cohort they are a part of. The experimental group was instructed to have paper and a writing utensil as a part of their entry procedures to class. At the start of class, the students were instructed to draw, for five minutes, something on the paper that makes them happy or that they enjoy. If they were done before the five minutes, they were encouraged to enhance the picture, add to the picture, or doodle on the edges of the paper. The group ended the drawing time by verbal re-direct. Immediately after the presentation and the drawing sessions, the students were instructed to access the post-assessment through the

It'sLearning platform. Students were reminded that the assessment is timed and not to use electronic calculation devices.

Each assessment result was auto-graded, but also hand-checked for input errors in grading that may had caused by spacing errors. Each correct response was rewarded one point. The correct responses were totaled to produce raw scores. Raw scores of the two groups were compared by an independent samples t-test. A comparison of pre-test scores indicated that there was no significant difference in basic math facts performance between the control group (Mean = 71, SD = 15.58) and the experimental group (Mean = 66.21, SD = 25.94) [$t(30) = 0.60$, $p = .56$]. Consequently, it was not necessary to control for any pre-existing differences in the comparison of post-test scores.

CHAPTER IV

RESULTS

The purpose of this study was to determine if reduction of math anxiety through an art-related therapeutic session would improve accuracy on a math-based assessment among eighth grade students.

An independent samples t-test was conducted with the independent variable being the activity before a math test, a procedural or art therapeutic session, and the dependent variable being the score on the basic addition and subtraction math fact assessment. The mean score on the basic math fact assessment tests was not significantly different between the children in the control group (Mean = 78.54, SD = 23.97) and the children in the experimental group (Mean = 71.68, SD = 21.82) [$t(30) = 0.84$, $p = .41$]. Please see Table 1. Consequently, the null hypothesis that there would be no significant statistical difference in basic math fact assessment scores between a treatment group of students that participated in an art-related therapeutic session prior to the test and a control group was retained.

Table 1

Means, Standard Deviations, and t-statistic for basic math fact assessments after procedural and art-therapeutic sessions

Group	N	Mean	SD	t-statistic
Control	13	78.54	23.97	0.84*
Art-therapeutic	19	71.68	21.82	

* non-significant at $p < .05$

CHAPTER V

DISCUSSION

The purpose of this study was to determine if math anxiety could be reduced through an art-related therapeutic session would thereby improve accuracy on a math-based assessment among eighth grade students. The null hypothesis was that there would be significant statistical difference in basic math fact assessment scores between a treatment group of students that participated in an art-related therapeutic session prior to the test and a control group was retained. In this study, students who participated in an art-related relaxation activity did not perform with greater accuracy on a basic math fact assessment than students in a control group.

Implications of the Results

The results of the study would imply that an art therapeutic session, without student buy-in, direct instruction, and modeling, does not improve eighth grade student assessment scores during virtual instruction. While there are multiple mindfulness activities that have proven successful in previous studies and anecdotes, quickly introducing a new activity without the benefit of students understanding "the why" and allowing for limited practice was not successful in this study. Given the challenges and time constraints placed upon educators, they appreciate quick, tested strategies that can be used in the classroom to aid in student success. Given the time that may be required to allow a strategy such as art-therapeutic sessions to be successful, teachers may be less likely to give up instructional time to provide direct instruction and modeling on a technique regardless of the mindfulness activity.

Observational data did not provide information as to whether the intervention was effective for different outcome measures. Students did not make comments about whether they liked or disliked the drawing activity. Behaviors did not differ in a positive way; rather there was

confusion among some students. This further suggests that as implemented, the intervention is not effective in improving classroom engagement or performance.

Threats to Validity

There are several threats to validity that may have impacted the results. The study was completed during the COVID-19 closure; all instruction during this time was virtual. Due to privacy protocols, students cannot be forced to put on their webcams. It is unknown if the students completed the art-therapeutic treatment. This affects internal validity.

The total population that took part in the study was low. While the intended groupings were expected to be larger, attrition resulted from non-compliant behaviors and lack of attendance. The students that did not participate have attendance concerns and historically have low math skill acquisition. While care was taken to mimic the schedule of the class, inserting the pre/post assessments within the timeframe of the daily warm up, the students did not have access to the assessment prior to the class; students were not given a warm-up, which may explain why some students did not participate. Many students prefer to do the beginning of class work and do not follow along with instruction through active participation.

Prior to the experiment, students were told a baseline and a final data point would be conducted for the teacher's research project. One student asked if the assessment would be graded; students were told the assessment would be treated as a completion grade. Baseline data was gathered after a warm-up. During the experimental group class, students who were normally engaged were confused as to why there was not a warm-up like normal. When the students were told they were going to draw for five minutes prior to the math-fact assessment, they did not comment. When students were drawing, both teachers were muted, and no other students unmuted. Once the five-minute art-therapeutic was completed, students were instructed to

access the math fact assessment. During this time, the researcher had to prompt individual students to start the assessment. With the novel therapeutic session, several students who usually follow along with instruction did not initiate the assessment until the researcher unmuted the microphone and called students by name; others did not complete the assessment at all. Participation was lower than higher-stake assessments that are correlated with their individual grade. If the classroom was better represented and if students had participated in their typical manner, results may had been different. This affects external validity.

The pre/post assessment model may have affected the results. While some students found it a challenge to improve their score, other students may have viewed the assessment novel or irrelevant as it was not directly related to content or grade. After the first assessment, students were curious about the reason for the assessment; the co-teacher shared it was a part of a research project. While the students did not ask further questions and no discussion of the assessment's purpose occurred prior to administration, the awareness of study participation may have positively or negatively affected their performance. This is a threat to external validity.

Connections to Previous Studies/Existing Literature

Most studies cited demonstrated a correlation between a mindfulness activity and the reduction of anxiety. Kostyunina & Drozdikova-Zaripova (2016) has one of the more closely related designs to the current study. The researchers used a robust program that demonstrated the ability to reduce anxiety by coloring in mandalas. The researchers used other coloring activities but found intricate mandala patterns generated a significant reduction in anxiety. Data was gathered using rating scales pre and post treatment; however, researchers did not investigate whether the anxiety reduction resulted in better academic gains. Rufo (2016) shared anecdotally of a student who increased math performance by encouraging the student to draw or doodle on

the margins of note pages and assignments. Rufo and Kostyunina & Drozidokova-Zaripova both required multiple sessions to see results; however, their measured data differ. Rufo's study is more closely related to this study due to the measure of academics rather than perceived anxiety through rating scales. With success in both art-related studies, multiple repetitions appear to be key in anxiety reduction.

Implications for Future Research

This study left some unanswered questions within the scope of the planned study's time frame. Given the one treatment trial and the inability to know who completed the treatment and who did not, completion of the study within a traditional classroom would be preferred. Without changing the treatment of the study, more trials may show a closer relationship between the treatment and assessment scores. Students were asked to draw an image that makes them happy. The mandala study appears to support the idea that students need more guidance in selecting what to draw or color. Skill acquisition is said to be easier the younger you are. It may be beneficial to attempt a larger, multi-grade study to determine when a therapeutic session would be more appropriate or identifying the ceiling where introduction of such sessions would not be beneficial to the whole.

Conclusion

Providing a single art-therapeutic session prior to an assessment did not impact eighth grade basic math fact fluency accuracy when compared to the control group. Short, easy applications would increase teacher buy-in and, in return, anxiety reduction in students that would result in academic gains. While standing research suggests that art-related therapeutics and similar mindfulness activities are effective in reducing student anxiety, barriers to possible success included the virtual environment and applying only a single treatment. Effectiveness in

a traditional classroom should be evaluated to determine if compliance in participation of the therapeutic can improve the desired result or if long-term application is required for success as demonstrated through previous studies.

References

Ahmed, W. (2018). Developmental trajectories of math anxiety during adolescence: Associations with STEM career choice. *Journal of Adolescence*, 67, 158–166. https://doi-org.goucher.idm.oclc.org/10.1016/j.adolescence.2018.06.010

Aldrup, K., Klusmann, U., & Lüdtke, O. (2020). Reciprocal associations between students' mathematics anxiety and achievement: Can teacher sensitivity make a difference? *Journal of Educational Psychology*, 112(4), 735–750. https://doi-org.goucher.idm.oclc.org/10.1037/edu0000398.supp (Supplemental)

Al-Mutawah, M. A. (2015). The Influence of Mathematics Anxiety in Middle and High School Students Math Achievement. *International Education Studies*, *8*(11), 239. https://doi.org/10.5539/ies.v8n11p239

Al-Mutawah, M. A., & Fateel, M. J. (2018). Students' Achievement in Math and Science: How Grit and Attitudes Influence? *International Education Studies*, *11*(2), 97. https://doi.org/10.5539/ies.v11n2p97

Ashcraft, M. H. (2002). Math Anxiety: Personal, Educational, and Cognitive Consequences. Current Directions in Psychological Science, 11(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Butterworth, B., Varma, S., & Laurillard, D. (2011). Dyscalculia: from brain to education. *Science*. 2011 May 27; 332(6033): 1049-1053. doi: 10.1126/science.1201536. https://www.ncbi.nlm.nih.gov/pubmed/21617068

Casad, B. J., Hale, P., & Wachs, F. L. (2015). Parent-child math anxiety and math-gender stereotypes predict adolescents' math education outcomes. *Frontiers in Psychology*, 6. https://doi-org.goucher.idm.oclc.org/10.3389/fpsyg.2015.01597

Daches Cohen, L., & Rubinsten, O. (2017). Mothers, intrinsic math motivation, arithmetic skills, and math anxiety in elementary school. *Frontiers in Psychology*, 8. https://doi-org.goucher.idm.oclc.org/10.3389/fpsyg.2017.01939

Etcuban, J. O., Capuno, R., Necesario, R., Espina, R., Padillo, G., & Manguilimotan, R. (2019). Attitudes, Study Habits, and Academic Performance of Junior High School Students in Mathematics. *International Electronic Journal of Mathematics Education*, *14*(3). https://doi.org/10.29333/iejme/5768

Ferguson, A. M., Maloney, E. A., Fugelsang, J., & Risko, E. F. (2015). On the relation between math and spatial ability: The case of math anxiety. *Learning and Individual Differences*, 39, 1–12. https://doi-org.goucher.idm.oclc.org/10.1016/j.lindif.2015.02.007

Florescu, M. H., & Pop-Pacurar, I. (2016). Is the Fear of "Being Wrong" a Barrier for Effective Communication between Students and Professors? A Survey Study at Babes-Bolyai University Romania. *Acta Didactica Napocensia*, *9*(2), 47–66. https://eric.ed.gov/?q=what+is+math+anxiety&pr=on&ft=on&ff1=dtySince_2016&pg=7&id=EJ1110311

Furner, J. (2017). Teachers and Counselors: Building Math Confidence in Schools. *European Journal of STEM Education*, *2*(2), 1–10. https://doi.org/10.20897/ejsteme.201703

Ganley, C. M., Schoen, R. C., LaVenia, M., & Tazaz, A. M. (2019). The Construct Validation of the Math Anxiety Scale for Teachers. *AERA Open*, *5*(1), 233285841983970. https://doi.org/10.1177/2332858419839702

Geary, D. C., Hoard, M. K., Nugent, L., Chu, F., Scofield, J. E., & Ferguson Hibbard, D. (2019). Sex differences in mathematics anxiety and attitudes: Concurrent and longitudinal

relations to mathematical competence. *Journal of Educational Psychology*, 111(8), 1447–1461. https://doi-org.goucher.idm.oclc.org/10.1037/edu0000355

Grežo, M., & Sarmány-Schuller, I. (2018). Do emotions matter? The relationship between math anxiety, trait anxiety, and problem solving ability. *Studia Psychologica*, 60(4), 226–244. https://doi-org.goucher.idm.oclc.org/10.21909/sp.2018.04.764

Klados, M. A., Pandria, N., Micheloyannis, S., Margulies, D., & Bamidis, P. D. (2017). Math anxiety: Brain cortical network changes in anticipation of doing mathematics. *International Journal of Psychophysiology*, 122, 24–31. https://doi-org.goucher.idm.oclc.org/10.1016/j.ijpsycho.2017.05.003

Kostyunina, N. Y., & Drozdikova-Zaripova, A. R. (2016). Adolescents` School Anxiety Correction by Means of Mandala Art Therapy. International Journal of Environmental & Science Education, 11(6), 1105–1116. https://files.eric.ed.gov/fulltext/EJ1114285.pdf.

Lindskog, M., Winman, A., & Poom, L. (2016). Individual differences in nonverbal number skills predict math anxiety. *Cognition*, 159, 156–162. https://doi-org.goucher.idm.oclc.org/10.1016/j.cognition.2016.11.014

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. Psychology Research and Behavior Management, 11.

Lyons, I. M., and Beilock, S. L. (2012). When math hurts: math anxiety predicts pain network activation in anticipation of doing math. *PLoS ONE* 7:e48076. doi: 10.1371/journal.pone.0048076

Maloney, E. A., Ansari, D., and Fugelsang, J. A. (2011). The effect of mathematics anxiety on the processing of numerical magnitude. *Q. J. Exp. Psychol.* 64, 10–16. doi: 10.1080/17470218.2010.533278

Ramirez, G., Hooper, S. Y., Kersting, N. B., Ferguson, R., & Yeager, D. (2018). Teacher Math Anxiety Relates to Adolescent Students' Math Achievement. AERA Open. https://doi.org/10.1177/2332858418756052

Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. *Educational Psychologist*, 53(3), 145–164. https://doi-org.goucher.idm.oclc.org/10.1080/00461520.2018.1447384

Rubinsten, O., Marciano, H., Eidlin Levy, H., & Daches Cohen, L. (2018). A Framework for Studying the Heterogeneity of Risk Factors in Math Anxiety. *Frontiers in behavioral neuroscience,* 12, 291. https://doi.org/10.3389/fnbeh.2018.00291

Rufo, D. (2016, November 30). *Math hater: How one child overcame her math anxiety through Self-Administered art therapy.* https://eric.ed.gov/?id=EJ1198085.

Shields, D. (2007, April). *Taking Math Anxiety Out of Math Instruction*. National Association for Developmental Education. https://files.eric.ed.gov/fulltext/EJ1097774.pdf

Tomasetto, C., Morsanyi, K., Guardabassi, V., & O'Connor, P. A. (2020). Math anxiety interferes with learning novel mathematics contents in early elementary school. Journal of Educational Psychology. https://doi-org.goucher.idm.oclc.org/10.1037/edu0000602.supp

Van Mier, H. I., Schleepen, T. M. J., & Van den Berg, F. C. G. (2019). Gender differences regarding the impact of math anxiety on arithmetic performance in second and fourth graders. *Frontiers in Psychology*, 9. https://doi-org.goucher.idm.oclc.org/10.3389/fpsyg.2018.02690

Woodard, T. (2004). The Effects of Math Anxiety on Post-Secondary Developmental Students as Related to Achievement, Gender, and Age. *Inquiry: Critical Thinking Across the Disciplines,* 9.