GROWTH MINDSET: HOW DOES IT AFFECT MATH ACHIEVEMENT IN SECOND GRADE?

By

Tracy L. Sachs

An Abstract of a thesis submitted in partial fulfillment of the requirements for the degree of Education Specialist in Elementary Mathematics in the Department of Elementary & Early Childhood Education University of Central Missouri

July, 2017
ABSTRACT

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The purpose of this research was to investigate if a student’s and/or parent’s mindset affects math performance and growth. Students’ and parents’ mindsets were assessed using a mindset quiz. Data was collected from two different second grade math classes with the same teacher. Explicit instruction about growth mindset was implemented in only one of the classrooms. Math growth was compared using data from the Renaissance Star math test. The class that had growth mindset instruction median student growth percentile was 85 and the class without the growth mindset instruction had a median student growth percentile of 72. The average change in scaled score in the intervention class was +180, whereas the average change in scaled score in the non-intervention group was +133. Changes in percentile ranks were +33 for the intervention class and +20 for the non-intervention class. The research supported the conclusion that explicit growth mindset instruction has an impact on math achievement in second graders.
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CHAPTER 1
NATURE AND SCOPE OF
THE STUDY

“Some assert that an individual’s intelligence is a fixed quantity which cannot be increased. We must protest and react against this brutal pessimism”, Alfred Binet, inventor of the original IQ test, 1909 (Shenk, 2011). With the development of the IQ test by Alfred Binet it became generally accepted intelligence was a fixed trait, although that was not his original intent. Teachers, students, and parents have long held onto to this belief. There is no question intelligence can influence learning, but can a child’s belief about their intelligence affect their learning? Can their parents’ beliefs about intelligence affect their child’s learning? Is this long-held belief that intelligence is something unchanging and inherent really supported by research?

This fixed mindset is very pervasive especially in the field of mathematics. In recent decades, an alternative theory has been gaining ground. This alternative school of thought is referred to as a growth mindset. It is the belief that intelligence is malleable and can change through effort and application, whereas a fixed mindset proposes that intelligence is innate and unchangeable. Carol Dweck (2006), Stanford professor and author has dedicated her life to researching and writing about the growth mindset. She has found having a growth mindset has a powerful impact on all aspects of one’s life. Basically all facets of our being can be changed through effort including our intelligence, talents, and temperaments according to Dweck. She believes that your mindset has a direct impact on your behavior and the decisions you make throughout your life. Dr. Jo Boaler (2015) takes the work of Dweck’s further and applies it directly to the mathematical learning. She coined the term “mathematical mindset” which refers to having a belief that mindset is just as important, if not more important, than one’s innate ability to learn math. She
explains that the myth of the superior “math mind” does not exist and anyone is capable of learning high-level mathematics. Her work has helped educate teachers about how to create a growth mindset classroom by teaching their students about how to approach mistakes as opportunities for learning and obstacles as skills that are not mastered “yet”. Much of the focus of the current research is derived from these two researchers and applying their ideas in a second grade classroom.

**Statement of Problem**

Having a fixed mindset changes the way students view the world. Students with a fixed mindset believe they are only so smart and hard work does not always lead to success. They do not enjoy challenges because if they are struggling it means they aren’t smart enough to figure it out. They are quicker to give up, aren’t as receptive to feedback, and feel more threatened by the success of others. In contrast, students with a growth mindset have more perseverance and see challenges as positive experiences that can help them learn and grow. They believe that effort is what leads to success, not how “smart” you are. They tend to use feedback to better themselves and learn from other successful people. In particular, this idea of a fixed mindset, is more entrenched in math classrooms than in other subjects (Boaler, 2015). As teachers, we see parents passing this belief that it is acceptable and understandable if their child doesn’t understand math because they as children weren’t good at math either.

**Background**

Teachers have anecdotal information about how a child’s attitude can affect their learning. Once children believe they can’t do something, whether they’re right or wrong, it becomes a self-fulfilling prophecy. Much of the inspiration for this study came from the work of Jo Boaler and Carol Dweck, who challenge these beliefs that have impacted the learning of math
for many generations. In the last decade, more research is showing that a child’s belief about their intelligence is a powerful predictor of math success.

**Purpose of the Study**

The purpose of this study was to investigate if children’s mindsets and their parent’s mindsets about math actually can have an effect on their math performance and the amount of growth they have over a school year. The research also explored the question if children were explicitly taught about growth mindset and the corresponding research that supports its existence if they would develop a growth mindset and if that could impact their mathematical learning. The insight gained from this research could help design interventions for low-performing students. Additionally, schools could identify students with fixed mindsets and design curriculum to foster a growth mindset which would lead to more academic growth throughout their lives.

**Research Questions**

This study was guided by the following research questions.

Research Question One: Does a child’s mindset affect math achievement?

Research Question Two: Does a parent’s mindset affect what a child is able to learn in mathematics?

Research Question Three: If a child is directly taught about research that supports a growth mindset, does that influence their mindset and consequently impact their progress in the learning of mathematics?
There has been significant research related to mindset and mathematical performance and it has generally supported the theory that there is a positive correlation between having a growth mindset and superior achievement. In this chapter, research on the brain and its relationship to learning will be presented followed by an explanation and history of self-theories of intelligence. Next, specific studies related to students’ mindsets and how it relates to academic achievement will be presented. The question of do mindset interventions, wherein researchers or teachers explicitly teach about growth mindset, change academic performance will be discussed. Briefly, parents’ mindsets and their impact on learning will be discussed. Lastly, the work of Jo Boaler and her idea of mathematical mindsets will be explored.

**Brain Research**

Scientists’ understanding of the brain and how people learn has changed in recent years with technological advances. A major study that began to shift experts’ thinking about learning ability involved London taxi cab drivers. In London, cab drivers need to learn over 20,000 streets and landmarks and have to take a 2-4 year course to become qualified to drive for the Black Cab Company. It was found the cab drivers’ brains actually changed due to the training. Specifically, their hippocampus, which is responsible for learning and applying spatial knowledge actually grew. Furthermore, after they retired from their profession and no longer used this area of the brain to the degree they did while employed, their hippocampus shrank back (Maguire, et al., 2000). This finding that the brain actually physically changes with use supports the idea that our brain is like a muscle and the more it is used, it can actually change.
Brain activity when students make math mistakes vs when they get answers correct has been shown to be different (Moser, et al., 2011). Furthermore, this study showed that people’s brains with a growth mindset actually react to mistakes differently than those with a fixed mindset. It was shown that people with a growth mindset were more aware of when they made a mistake and therefore were more likely to go back and fix their errors and learn from them.

Multiple studies have shown the brain has incredible plasticity, meaning that parts of it can take over when another part is damaged or destroyed (Boaler, 2013). Additionally, brain scanning has been used to monitor subjects receiving special training and in only three weeks changes in the brain were noted (Karni et al., 1998).

**Self-Theories of Intelligence**

According to Carol Dweck (2006), there are two broad categories of theories of intelligence, one being entity theories, which view intelligence as a fixed trait and the other being incremental theories, in which intelligence is believed to be changeable. Students who are entity theorists typically are concerned about continually proving they are smart and avoid tasks that are challenging which may show their lack of intelligence, while incremental theorists seek out and view challenges as opportunities for growth and learning. Furthermore, academic choices and how one responds to setbacks is determined by one’s individual theory of intelligence. An incremental theorist responds to setbacks by working harder and putting in more time to master concepts because they believe that is what will make them learn more. An entity view leads to decisions that will most likely result in a good grade or successful outcome, regardless of the amount of learning. A significant amount of research has sought to determine if a student’s view of intelligence has an effect on their level of academic achievement. Elliot and Dweck (2005) showed there is a correlation between the two. The focus of this research and Dweck’s work is
how the individual learner views intelligence and how that affects learning, not necessarily the meaning or definition of intelligence itself. While most studies have focused on adolescents and general academic achievement, this current study, looked at the mindset of younger children and specifically how it relates to their math growth throughout one school year. Additionally, the relationship between a parent’s mindset and how it affects their child’s early math achievement has had very limited attention from researchers.

**Students’ Mindset and how that relates to academic achievement**

The term “growth mindset” became synonymous with the incremental view of intelligence and the “fixed mindset” with the entity theory (Dweck, 2006). There has been considerable evidence showing that the mindset a student has can determine their academic success. (Dewar, 2010; Dweck, 2007; Stump et al., 2009). Research has shown that students with a growth mindset academically perform better than those with a fixed mindset (Atwood, 2010; Blackwell et al., 2007). However, this mindset influence tends to be more significant when students face challenges (Blackwell et al., 2007). The Blackwell study looked at seventh graders’ performance over two years and it wasn’t until those students began facing significantly more challenging work that the researchers noted the academic differences between the students who had a growth mindset and those who didn’t. Dweck (2008) specifically addressed how mindset can predict math/science performance, especially for women and minorities. She also showed interventions that change mindsets from fixed to growth have a positive impact on achievement in the math and science fields. Dar-Nimrod and Heine (2006) wrote about research in which they told one group of females the reason females didn’t do as well in math was due to genetic differences (fixed mindset) and the other group was told it was due to differences in experiences males and females have, which was a growth oriented explanation. The group that was given the
fixed mindset explanation performed significantly worse. Other studies have replicated this finding that females’ mindsets play a role in their math performance and whether or not they pursued math classes in college (Good, Rattan, and Dweck, 2012). In the United States there are significantly fewer females entering Science Technology Engineering and Math (STEM) professions than males and Boaler asserts that the reason females aren’t entering these fields is because they believe they can’t do the math for those degrees (Wallace, 2016).

International tests are providing evidence of the impact of growth mindset on student achievement and performance. The Program for International Student Assessment (PISA) team gives international tests and ranks countries in regards to math performance. PISA tests millions of students and in 2012 the assessment also surveyed students to determine if they had a fixed mindset or growth mindset. What they found was that students with a growth mindset were more than a year ahead of their fixed mindset peers (Boaler, 2014).

In another study it was found that students who prescribe to the incremental theory of intelligence actually learned more from mistakes (Mangels et al 2006). They used college students and first surveyed them to see what kind of mindset they held. They quizzed them on various subjects and both did equally well and both groups were shown correct answers for items missed. What is interesting is the growth mindset group actually processed their mistakes differently and did much better than their counterparts when they were retested. These results were replicated more recently (Moser et al 2011).

**Do Mindset Interventions work to improve academic performance?**

Several studies have found interventions to teach the expandability of intelligence can change one’s mindset and consequently improve academic performance (Atwood, 1010; Stump et al., 2009, Dweck, 2008). In one study the group received training in how to answer relational-
type questions typical of IQ assessments and the other did not (Cassidy et al. 2011). The experimental group significantly raised their IQ scores. This study shows that IQ is changeable. In another study (Blackwell, et al, 2007) involving the seventh graders discussed above, one group was given an intervention which taught the expandability of the brain and the other study skills. The group which had the mindset intervention showed positive changes in motivation and their grades improved. In another study, one group simply read an endorsement of the entity theory and researchers compared them to a group who read about the growth mindset. Even this short intervention showed it had an impact on how focused the students were and how they learned more from errors (Schroder et al 2014).

Do Parent Mindsets Matter?

There has not been extensive research related to how parents’ mindsets influence the mindset of their children or their children’s academic performance. In the ones that have been done though, the conclusion has been that it does matter, especially for females. In one study, it was found when mothers who helped their daughters with homework told their daughters that they themselves weren’t good at math that almost immediately their daughter’s math achievement decreased (Eccles & Jacobs, 1986). A parent’s math anxiety has also been shown to negatively impact math performance in first and second graders. If the parent helps with homework, that anxiety transfers to their child (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). Interestingly, the parents’ actual math knowledge didn’t have any effect on their child’s math achievement.

Jo Boaler’s Mathematical Mindset

Jo Boaler, Stanford researcher and author, has greatly contributed to the body of knowledge about mindset and math. She takes much of Dweck’s work and applies it directly to
math learning and in her book sets out practical strategies teachers and parents can use to help children learn math. She confirms what most teachers have instinctively known that math of all subjects carries with it the myth that only certain students have the gift of being able to think at higher levels. She dispels this common American myth through research and shows by changing one’s mindset that it can result in different levels of achievement.

Boaler (2015) outlines positive norms to encourage in math class based on her research. They are as follows:

1. Everyone can learn math to the highest levels.
2. Mistakes are valuable.
3. Questions are really important.
4. Math is about creativity and making sense.
5. Math is about connections and communicating.
6. Depth is much more important than speed.
7. Math class is about learning, not performing.

Dweck and Boaler maintain that the form of feedback and kinds of praise teachers give their students is very important (Dweck, 2007). If teachers tell students they are smart when they are successful, then when they aren’t successful they feel that it makes them not smart. Teachers should instead focus on praising children for perseverance and their thinking and focus on how mistakes are valued. Boaler suggests that it is paramount to let kids struggle in math and not help too much.

Overall, research has supported that mindset matters in academic achievement. More research needs to be done involving primary aged school children, the impact of parents’ and teachers’ mindsets, and whether or not there are differences in math achievement vs. reading
achievement with respect to mindset. Additionally, different types of mindset interventions need to be explored and possibly even interventions involving parents, especially those who help with homework. This chapter covered research about the brain, self-theories of intelligence and the impact of those on mathematical achievement.
CHAPTER 3
METHODS

This chapter will focus on the specific methods used to investigate the research questions

Does a child’s mindset affect math achievement?

Does a parent’s mindset affect what a child is able to learn in mathematics?

If a child is directly taught about research that supports a growth mindset, does that influence their mindset and consequently impact their progress in the learning of mathematics?

Specifically, this study focuses on second graders and their math achievement over one school year. Most prior research has been done with older students and not necessarily focused on math achievement. There has been little research on parental mindsets and the achievement of their children, which is addressed in this study.

Setting

This study took place at an elementary school housing kindergarten through second grade in a small Midwestern city. The city is located in a rural area with a population of approximately 19,000 people. There are approximately 400 children attending the elementary school and of those approximately 40% qualify for free and reduced lunch. The research was carried out in a second grade classroom in the elementary school. Data was kept in a locked file cabinet in researcher’s classroom.

The participants were second graders from two homerooms in the elementary school. Only those students whose parents signed a release allowing them to participate in the study were included in the study. From the first homeroom, eighteen of twenty-two students and their parent/guardians were involved in the study. Fifteen students and their parents from the second homeroom participated in the study. There were a total of thirty-three students participating.
between the two classes, seventeen were male and sixteen female. Two were black males and the rest were Caucasian. There were two biracial females. Seven students participated in the Title Math program because their low scores from previous years qualified them. There were no Asian students or parents in the study. Approximately 40% of the students are eligible for free and reduced lunch. There were no English Language Learners included. Students with learning disabilities, students on Individual Educational Plans, and 504 plans were included in the study. Students were in second grade and were 7-8 years old. Only one parent participated in the research for each student. No data was collected or used in this study unless the parent consented and the child gave assent. Participants were assigned numbers and these were used to identify students’ work.

Measurement Instruments

Mindset Quiz: Students and parents were given a quiz to measure their mindset (See Appendix A). This quiz assigns point values to each question. Answers with the highest point value of 3 indicate a growth mindset and the lowest score of 0 shows a fixed mindset. Upon completion a total score was calculated and the values were as follows:

Strong Growth Mindset = 45-60 points
Growth Mindset with some Fixed ideas = 34-44 points
Fixed Mindset with some Growth ideas = 21-33 points
Strong Fixed Mindset = 0-20 points

Star Enterprise Math test: Students were also administered the Star Enterprise Math test (Renaissance®) throughout the year. The STAR Math™ Technical Manual states, “the STAR Math Enterprise test is a 34-item standards-based version of STAR Math, administered as 6 blocks of items in a single section. Each block of items contains a blend of items from the 4
domains. The number of items administered in a block varies by grade band. The item sequencing calls for more content balance at the beginning, middle, and end of the test by “spiraling” the content throughout the test, thus ensuring that the ability estimate at any point during a test is based on a broad range of content, rather than on a limited sample of skills (pg 12).” Students were given this test during computer lab with the computer lab teacher, not the researcher. The pretest score was gathered in September shortly after the beginning of the school year and the post test was given in May after the conclusion of the study. It is a computerized test and students enter their answers using a mouse. The test has an audio function so questions can be read aloud to the test taker. The test is timed in the sense that if a student takes too long to answer a question it times them out and gives them an alternate question. The test is based on the Common Core State Standards and the Standards for Mathematical Practice. The STAR Math Enterprise test contains questions from the Numbers and Operations, Algebra, Geometry and Measurement, and Data Analysis, Statistics, and Probability domains. Students usually completed the test in less than 30 minutes. The Research Foundation for Star Assessments supports that this test is reliable and valid. (See Appendix B for reliability and validity information)

**Testing Procedures**

Consent forms were sent home with every student in the researcher’s math classes and parents were asked to participate in the study. Students were also asked to fill out the assent form. Two different math classes were involved in this study. Math lessons were planned to be identical although discussion would vary depending on the students. Both classes followed the same curriculum, had equal length class time, and took the same assessments. In Classroom 1, which was the researcher’s home class, growth mindset was explicitly taught. Class 2, which was
the class that just came into researcher’s room for math, was not explicitly taught growth mindset. Both classes took the Star Enterprise Math test at the end of the year with the computer lab teacher. Both classes completed the mindset quiz at the end of the year at the conclusion of the study. Students in both math classes were administered the growth mindset quiz as a whole class. Every student had a copy and the teacher projected it onto the board. The teacher read each question out loud as each student marked their paper. When the children were administered the test the teacher explained any potentially unclear vocabulary to the whole class. She also explained the meaning of “agree” and “disagree”. The mindset quiz was sent home with every child and the parents were asked to complete it at home.

**Growth Mindset Instruction**

One class received growth mindset instruction separate from math class, whereas the control group did not. The primary learning tool the experimental group used was a growth mindset journal. This is a 10 lesson unit and each lesson is approximately 30 minutes long. Each lesson had a corresponding video. A growth mindset bulletin board was placed in the classroom. The teacher chose books to read aloud that had characters whom had a strong growth mindset and discussion about the characters and their mindset was part of read aloud time. A complete list of read alouds and classroom activities is included in Appendix C. It should be noted that even when a book wasn’t selected to highlight a character’s mindset, the students spontaneously began to discuss the mindset of characters and how that impacted the outcome of the story. The experimental group also viewed and discussed a series of growth mindset videos developed for young children. The experimental group also learned more about the brain using a scientific video explaining how the brain functions. Throughout the year, the students discussed growth
mindset as a class, in small groups, and in individual conversations. This intervention was started in the third quarter and all students in the experimental group took part in the activities.

**Consideration of Ethical Concerns**

There were several ethical concerns inherent in this study since it involved young children. The first issue relates to obtaining permission from the school’s administration, parents, and the children themselves. The principal of the participating school granted permission readily. With regard to parents, the researcher sent home the consent form, (see appendix D) which outlined the nature of the study. Attached to the consent form was the mindset questionnaire (See Appendix A). One consideration was how a child may feel if their parent decided not to participate and whether or not that would play into the parent’s decision to participate. There were also several children who didn’t live with their biological parents, and were in the care of grandparents or foster parents. The consent form was made to include “guardians”, not just parents, in order to address this issue. Assent from the children was done at school and is in Appendix E. The teacher/researcher explained the study and read the assent form and children signed it. One concern was if the child didn’t feel comfortable signing it or didn’t really understand what they were agreeing to, were they in a setting wherein they felt comfortable to say no, since it was their teacher asking them to participate. All children gave their assent, although all parents didn’t participate in the study. Only students who had given their assent and their parents or legal guardians who had given consent participated in the study, although all the students in the experimental group learned about the growth mindset. There was no risk, and only benefits to the children learning about the growth mindset. It was also stated to both parents and children that there would be no names used in the results of the study and students would only be identified with numbers throughout the study.
Another ethical concern came up during the research process. The classes began to change in somewhat predictable ways as the mindset training evolved. The experimental group demonstrated more perseverance in problem solving and in general had a more positive attitude about learning. They frequently would refer back to their mindset training. Knowing as a teacher that students were benefitting from the growth mindset training, it then became an issue knowingly not sharing with the control class. Therefore, a lot of informal discussions also came up in the control class about mindset and how the brain works. The vocabulary of “yet” and “perseverance” was also shared with the control group, although not in the formal kind of way the experimental class had.

**Data Analysis**

Star Math data was generated via the Growth Report supplied by Renaissance Place. The growth report for both classes, with only the students who participated in the study selected, gave the Pretest and Posttest scores. The average scaled scores, grade equivalency, percentile rank, and normal curve equivalency score were obtained from the Growth Report. The median Student Growth Percentiles for both classes was also taken from this report. Each student’s end of year SGP was provided the Star Math Growth Reports. Quantitative data was analyzed using the Microsoft Excel® add-in, Analysis ToolPak.

The mindset data was collected from the quiz and the averages for each class or gender group was figured by using Microsoft Excel. The student growth percentiles of each student were also entered into Excel and then the Analysis ToolPak’s correlation analysis tool was used to figure the degree of relationship between the two variables. The correlation analysis tool was used to figure the following correlation coefficients reported in the study.

- Correlation between Student SGP and Student Mindset
- Correlation between Student SGP and Parent Mindset
- Correlation between Student SGP by gender and Student Mindset
- Correlation between Student SGP by gender and Parent Mindset
- Correlation between Parent Mindset and Student Mindset

This Correlation coefficient looks at the degree in which two variables change together. Values closer to one indicate a positive correlation in which both variables change in the same direction together. Values closer to zero indicate no relationship or a weaker relationship. If two variables have a negative relationship they change in opposite directions. No causal relationship can be determined from a correlation.

There were differences found between the two groups and to determine if these were statistically significant differences a one tail t test assuming unequal variances with a significance level of .05 was used. The Excel data analysis tool was also used to figure this statistic. This tool was used to compare the average SGP of the growth mindset class and the average SGP for the control class. It was also used to determine if the difference in Mindset scores between the two classes were significant.

Qualitative data, such as classroom anecdotes, quotes from students, and work samples were kept on the password protected classroom computer in a journal format. Observations from students from both classes were documented and included in the results section.
CHAPTER 4
RESULTS

The goal of this study was to determine if one’s mindset can impact the math achievement seen in second graders. Parents’ mindsets were also investigated to see if there was any relationship to how their child performed. Additionally, the research sought out to determine if explicit growth mindset training could impact the students’ mindset and thus affect their math growth over the school year. Data collected included mindset scores for students and parents and math achievement data from the Renaissance Star Math test. There were two classes involved in this study. One class will be referred to as the growth mindset class and this is the class that received growth mindset explicit instruction. The other class will be referred to as the control group. This is the class that received the same math instruction but did not have any mindset training.

Mindset Data

Each student participating in the study and his or her corresponding parent filled out the mindset quiz. This quiz had 20 statements on it to which a responder could strongly agree, agree, disagree, or strongly disagree. Items such as, “You can always substantially change how intelligent you are”, and “You can learn new things, but you can’t really change how intelligent you are” were included on the mindset quiz. Each item is assigned a 0, 1, 2, or 3. The higher numbers are associated with a stronger growth mindset. Each participant’s responses were then added up to get a grand total. The scoring is as follows:

Strong Growth Mindset = 45-60 points
Growth Mindset with some Fixed ideas = 34-44 points
Fixed Mindset with some Growth ideas = 21-33 points
Strong Fixed Mindset = 0-20 points

This number is referred to as the mindset score. There is a student mindset score and a parent mindset score. Following is a table summarizing the mindset scores.

Table 1

*Growth Mindset Scores of Second Graders and Parents*

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<tr>
<td>Student mean score</td>
<td>42.44</td>
<td>35.33</td>
</tr>
<tr>
<td>Parent mean score</td>
<td>40.5</td>
<td>39.9</td>
</tr>
<tr>
<td>Correlation between Student and Parent Score</td>
<td>-.08</td>
<td>.40</td>
</tr>
</tbody>
</table>

As shown in Table 1, the Growth Mindset Class had a student mean of 42.44 for their growth mindset score, whereas the control class mean was 35.33, which is a statistically significant difference using the t-test assuming unequal variances, one tail test P=.025. The parents’ mean mindset scores between both classes were more similar with the growth mindset parents scoring an average of 40.5 and the control class parents scoring 39.9. As you can see the parents’ scores had less than a one point difference, but the students’ scores differed by over seven points. The correlation between the students and parents’ scores look very different for the classes. The students’ scores from the class that had the growth mindset training didn’t correlate with their parents. Their correlation was -.08. The class that didn’t have any growth mindset training, however, had a positive correlation between their scores and their parents. The correlation was .40 for this group of students with no mindset training at school.
Renaissance Star Math Data

Multiple scores were used from the Renaissance Star math test to compare the two classes’ math achievement and growth. The scores used for comparisons and their definitions follow.

**Grade Equivalent (GE)** is a norm-referenced score ranging from 0.0 to 12.9+. It shows how the test taker compares to other students in the nation. It doesn’t mean that they could necessarily do that level of work.

**Normal Curve Equivalent (NCE)** is also a norm-referenced score. Renaissance math resources describe it as “similar to percentile rank but based on an equal interval scale. This means that the difference between any two successive scores on the NCE scale has the same meaning throughout the scale. NCEs are useful in making comparisons between different achievement tests and for statistical computations such as determining an average score for a group of students. NCE scores range from 1 to 99. NCEs are used mostly for research purposes.”

**Percentile Rank (PR)** is a score that compares how a student ranks compared to other same grade students in the nation. It ranges from 1 to 99 and the numbers represent what percentage of students the test taker did as well as or better than. A score of 50 would mean that student did as well as or better than 50% of the other students in his/her grade.

**Scaled Score (SS)** is based on how many questions a student gets right and how hard those questions are. It ranges from 0-1400. It is useful because the range is consistent across grade levels and time so you can compare how the student does to prior tests and over grade levels.

**Student Growth Percentile (SGP)** is a norm-referenced score that indicates how much a child grew as compared to others in that same test window with similar achievement history. For instance, a SGP 82 means that student grew more than 82% of his peers in same grade.
nationwide. Following are the tables that summarize the data from the Growth Mindset class and the Control Class.

Table 2

**Growth Mindset Class – Star Data**

<table>
<thead>
<tr>
<th></th>
<th>SS* Mean Score</th>
<th>GE** Mean Score</th>
<th>PR*** Mean Score</th>
<th>NCE**** Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>410</td>
<td>2.0</td>
<td>51</td>
<td>50.3</td>
</tr>
<tr>
<td>Posttest</td>
<td>590</td>
<td>3.9</td>
<td>84</td>
<td>71.3</td>
</tr>
<tr>
<td>Change</td>
<td>+180</td>
<td>+1.9</td>
<td>+33</td>
<td>+21.0</td>
</tr>
</tbody>
</table>

*Scaled Score  
** Grade Equivalent  
*** Percentile Rank  
**** Normal Curve Equivalent

Table 2 shows the math data for the growth mindset class. This class started with an average scaled score of 410 at the beginning of the year and ended with 590 at the end of the year, which is a change of 180 points in their scaled score. Their grade equivalency score on their beginning of the year pretest was right at grade level 2.0, and they ended the year by almost two years growth scoring a 3.9 average grade level equivalency, which is a difference of 1.9 grade level points. Their percentile rank was 51 at the beginning of the year, but by the post test their average percentile rank was 84, which is a difference of 33. Their normal curve equivalency score on their pretest was 50.3 and this changed by 21 points during the year, with the posttest average Normal Curve Equivalent being 71.3.
Table 3

Control Class – Star Data

<table>
<thead>
<tr>
<th></th>
<th>SS* Mean Score</th>
<th>GE** Mean Score</th>
<th>PR*** Mean Score</th>
<th>NCE**** Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>439</td>
<td>2.2</td>
<td>59</td>
<td>54.8</td>
</tr>
<tr>
<td>Posttest</td>
<td>572</td>
<td>3.6</td>
<td>79</td>
<td>66.6</td>
</tr>
<tr>
<td>Change</td>
<td>+133</td>
<td>+1.4</td>
<td>+20</td>
<td>+11.8</td>
</tr>
</tbody>
</table>

*Scaled Score  
** Grade Equivalent  
*** Percentile Rank  
**** Normal Curve Equivalent

Table 3 shows math achievement data from the control class who had no growth mindset training and the same math instruction as the class presented in table 1. At the beginning of the year, they scored an average scaled score of 439 and ended the year with an average of 572, which is a change of 133 scaled score points. Their average grade level equivalency was 2.2 at the beginning of the year and they ended with an average grade level equivalency of 3.6, which is a change of 1.4 grade levels. Their average percentile rank at the beginning of the year was 59 and their posttest percentile rank was 79, which is a change of 20 percentile rank points for the year. The Normal Curve Equivalency score started as 54.8 and by the end of the year it was 66.6, which is a change of 11.8.
Table 4

*Student Growth Percentile*

<table>
<thead>
<tr>
<th></th>
<th>Growth Mindset Class</th>
<th>Control Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median SGP*</td>
<td>85</td>
<td>72</td>
</tr>
<tr>
<td>Mean SGP</td>
<td>74.5</td>
<td>68.7</td>
</tr>
</tbody>
</table>

*Student Growth Percentile*

Table 4 shows the comparison in math growth between the two classes using the mean SGP and the median SGP. The growth mindset class had a median SGP of 85 and the control class had a median SGP of 72. The class with the growth mindset training had a mean SGP of 74.5, whereas the control class’ mean SGP was 68.7.
CHAPTER 5
DISCUSSION

This study looked at several different factors related to mindset and math achievement. There were two classes involved in the study and only one of those received mindset training. The math achievement of the two groups was compared. It was determined that the mindset-trained class did in fact have significantly higher growth mindset scores and more math growth throughout the second grade year. The study also looked at the relationship between a child’s student growth percentile and their growth mindset score. Additionally, the mindsets of the parents from both classes were assessed and it was investigated if whether or not the mindsets of the parents had any effect on the math achievement of their child.

Discussion of Mindset Results Between Classes

There were obvious differences between the two groups with respect to mindset. The growth mindset class average was 42.4, which fell in the growth mindset with some fixed ideas range (34-44). Although the control class also fell in this range with an average of 35.3, it is in the lower range whereas the growth mindset class was in the upper range. Using the t-Test assuming unequal variances, one-tail test $P = .025$, this is a statistically significant difference. It is very interesting to note that the parent averages are both essentially the same, 40.5 and 39.9. The students’ mindset scores in the growth mindset class did not correlate with their parents (Pearson Correlation coefficient of -.08), but the students’ mindset scores in the control group had a correlation of .40. This would indicate that the growth mindset intervention at school probably influenced those students to develop more of a growth mindset, independent of their parents. Since research has shown parents’ math anxiety has had an effect on students’ math achievement, especially in girls, this is important to note that explicit growth mindset instruction has some impact in changing the mindset of those students (Maloney, Ramirez, Gunderson,
Levine, & Beilock, 2015). It also indicates that even with young children, efforts to change mindset within a school setting is very important, even if their parents are not growth mindset oriented. Overall, it appears that this explicit instruction had an impact on the students.

**Discussion of Star Data Between the Classes**

The growth mindset class outperformed the control class on every single measurement of math growth and achievement. This is especially remarkable because the growth mindset class actually started off as lower achievers at the beginning of the year. Their average scaled score was 410 vs. the control group’s score of 439. Their average grade equivalency was 2.0 whereas the control class was 2.2 and their percentile rank was 51 whereas the control group’s was 59. The NCE for the growth mindset class was 50.3 and the control class’ was 54.8. The median student growth percentile for the growth mindset class was 85, whereas the student growth percentile for the control class was 72.

The average SGP for the growth mindset class was 74.5 and the average SGP for the control class was 68.7. However, using a one-tail t- Test (P=.23) this is not a statistical difference. Because of the small sample size and the influence that a few scores can have on an average this has to be interpreted cautiously. The growth mindset group had an outlier of a SGP of 23 and the next lowest score was 41. The growth mindset group had 8 of 18 students with SGPS of 90 or above, which means they grew more than 90% of the peers nationwide and this represents 44% of the class achieving at this high level. The control group had only three students achieving at this level which represents 20% of the class.

There was substantial positive growth in both classes. With respect to scaled scores the control group changed by 133 points and the growth mindset changed by 180 points. Scaled scores range from 0-1400 and a star math norming study (Renaissance Learning, 2013) found
that the average scaled score for second graders was 408 at the beginning of the year and 514 at the end of the year, which is a difference of 107 scaled score points and both groups were well above that average. The growth mindset class started with a scaled score of 410, which is only two points away from the average found in the norming study. However, their posttest score was 590, whereas the norming study’s average was only 514, so their posttest score was 76 points higher than the norming study’s average. The control class’ pretest scaled score was 439, which is actually 31 points higher than the norming study’s beginning of the year score. The control group’s end of year scaled score was 572 as compared to the norming study’s score of 514. This is a difference of 57 points. It is important to note that the math instruction, teacher, and curriculum were the same for both these groups, yet their math growth looks very different. The initial higher scoring class, with respect to math scores, actually grew less than the lower scoring class. According to the mindset data, though, the lower scoring math class had more of a growth mindset, which could account for the higher amount of growth in math. The difference in how these two classes approached difficult problems was evident. During math journal time the two differences were most obvious. At this time, the teacher poses a problem in context and students work independently in their journals to figure it out with any method they choose. The only condition is they must show or explain their thinking. After given some time, the teacher uses the Ipad as a document camera and students place their journals under the document camera so the rest of the class can see their work. The student then explains the strategy to the class. In the growth mindset class students were more engaged during this time and approached the problems as a challenge. Each child had something written or drawn in their journal each day. They were excited to show different strategies and explain them to the class. It seemed even the struggling students and the higher performing students were engaged. However, in the class with no growth
mindset training, there was much more passive learning. There were students who frequently did not even give it a try and had nothing written in their journal for the day. They were more reluctant to find their own approaches. There was less encouragement from their classmates. It also seemed that the growth mindset class was much more willing to risk making a mistake. They understood that the strategy and explaining was more important than the correct answer. The whole atmosphere of the two classes was very different especially during this math journal time. These findings would indicate that the growth mindset intervention had an impact on math growth because the math curriculum, math teacher, test administrator, and parents’ mindsets were all the same in both groups.

In the growth mindset class the grade level equivalency grew almost by 2 grade levels (+1.9), whereas the control group GE grew by 1.4. The growth mindset group started out with a GE of 2.0, which is beginning of second grade and ended up 3.9, which is the end of third grade, so in essence they almost grew two grade levels instead of the expected one grade level in a year’s time. The control class started out at 2.2 and ended at 3.6, which is also considerable growth. Overall, though, the growth mindset group grew more.

The percentile rank of the growth mindset class started with 51, which means they performed better than 51% of their peers nationally and ended the year with a percentile rank of 84, which means they performed better than 84% of their peers. The control group also changed their percentile rank significantly starting with 59 and ending with 79. The difference in the two groups’ percentile ranks is 13 points on a 99 point scale.

The Normal Curve Equivalent score is similar to a percentile rank but it has been scaled to make it a normal distribution and ranges from 1-99. The Normal Curve Equivalent for the growth mindset class changed by 21.0 points and the control group only changed by 11.8 points.
Overall, there was a statistically significant difference in mindset between the two classes and the growth mindset group outperformed the control class on every measure of math growth. This leads to the conclusion that a growth mindset intervention did have an impact on the math growth of the students.

**Discussion of How Student Growth Percentile is Related to Mindset**

A Pearson correlation coefficient was used to measure the degree of relationship between each student’s mindset and their math growth. In the growth mindset class, the correlation between their mindset and student growth percentile was .36 which indicates a relationship, albeit not a strong one. The control group had a similar correlation of .33. In looking closer at the data involving student math growth and mindset by gender one correlation was much stronger than the others. The math performance of the females in the class that didn’t have any growth mindset instruction was more strongly correlated with their mindset. They had a correlation of .65, which is a relatively strong correlation. The females in the growth mindset class correlation between their SGP and mindset was .42 and the males in that class was .36. The males in the control class correlation between their SGP and mindset was .34. This is an important finding in that the majority of females in American schools don’t have growth mindset training, yet it is very closely related to how they perform in math. This table summarizes how student growth percentile was related to mindset separated by gender and class.
Table 5

*Mindset and Student Growth Percentile Correlations*

<table>
<thead>
<tr>
<th>Growth Mindset Class</th>
<th>Control Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>Males</td>
</tr>
<tr>
<td>.42</td>
<td>.36</td>
</tr>
</tbody>
</table>

The parents’ mindset and the students’ math achievement as measured by the SGPs had a much weaker relationship in both classes. The growth mindset class’s parent mindset and SGP correlation was .15 and in the control group it was -.07. So in both classes, it didn’t appear that their parents’ mindset made much impact on their actual math achievement. Looking deeper at the impact of parents’ mindset though, it appears that the parents’ mindset had a more powerful impact on the girls than the boys. The correlation between parents’ mindset and student growth percentile for girls was .46, but only .20 for the boys.

These findings can lead to the conclusion that again mindset does matter when it comes to math performance. It appears that for females with no mindset training it is even more important.

**Mindset Class vs. Control Class**

During the research process, it started to become very apparent that the growth mindset group was benefiting from their explicit training. When struggling with a particularly hard problem, other students in the class would offer a hug and suggest that they remember to “have a growth mindset”, or “never give up”, or even to go as far as saying, “remember your brain is growing”. In the control group, frequently children would say, “I can’t”, and immediately ask for the teacher’s help. In the experimental group, we focused on the word, “yet”, and those students
would usually follow up an “I can’t statement” with “yet”. The level of frustration in the control group was greater than that in the group receiving the growth mindset messages and journaling about it. The experimental group went to another teacher for reading class and that teacher inquired about what they were learning about with respect to mindset because she noticed it was seeping beyond just math class. She noted during read-alouds that the children were quick to point out when a character demonstrated whether or not they had a growth mindset. It was obvious they were applying what they were learning. She said “whatever you are doing it is working”, noting their positive attitude and perseverance on tough tasks. A child in the growth mindset group had received a paper back with errors marked. Initially, he was discouraged, but he asked to be late for a special class so he could fix his errors. As he was walking out of the room, he cheerfully said, “Hey I just grew my brain!” Comments like these and other reactions to mistakes became commonplace in the growth mindset class. It was very apparent to both teachers there was beginning to be a dichotomy between the classes. Ethically, this became a concern because as a teacher it was necessary to share knowledge helpful to students. Therefore, the researcher/teacher began to open discussions about growth mindset in the control group. As a class, the ideas of “yet”, and “perseverance” began to creep into the class conversations. Students in the control group began to notice the growth mindset bulletin board and ask about it and refer to it. The teacher began to informally share information about the growth mindset and how it can impact learning. This could have influenced the results of the study, but the growth of the students was more important than the outcome of the study.
Limitations

There were several limitations of this study, one having to do with the measurement tools and the other pertaining to the size of the sample. People can hold a growth mindset about some areas of learning and not others. The scale used in this study was a general mindset scale so one just specific to beliefs about math may have yielded more accurate information. In fact, one of the second grade students even inquired if when it said, “intelligence” if it was referring to “math intelligence or reading intelligence”. She went on to state that she believed you could change how smart you are in other subjects, just not math. Additionally, there aren’t research-based valid and reliable growth mindset questionnaires designed for young children. The vocabulary and complexity of sentences on the mindset scale used was above many of the students’ reading levels so the teacher had to read aloud each question. This may have led to certain students feeling rushed or not totally understanding what the question was asking. One of the parents even said the questionnaire was somewhat hard to understand. The readability of the assessment could have led to a wrong conclusion with regard to a student or parent mindset. The Star math test, on the other hand, has been validated through research. However, this was only one measure of the student’s math achievement. The study could be improved upon by using common assessments, math grades, self-assessments, and/or more problem solving tasks to also measure math achievement.

With regard to the size of the sample, eighteen students in the experimental group and fifteen in the control limited the ability to generalize the results. One or two outliers could have influenced the results significantly.
Recommendations for Future Research

Research has just begun to skim the surface of the power of mindset and learning, and in particular math performance. What research has been done, though, supports the conclusion that a student’s mindset affects math achievement so there is a need to investigate how people develop a growth mindset. Scientists and educators know that it is helpful to learning to hold the incremental view of intelligence, but why is it that some people have this and others don’t? What are the predictors of a person developing a growth mindset? What kind of environment allows for one to develop the growth mindset and its helpful characteristics of perseverance and embracement of mistakes should be studied. The question of how teachers’ mindsets influence that of their students and their performance needs to be further explored. Do females and males differ in their mindset development and if so, why?

How parents’ mindset influences that of their kids and their performance in math vs. other subjects needs to be studied, and is it the same for males and females. It is important to know what types of interventions are successful in developing a growth mindset. More research is needed to investigate the types of interventions and for what ages they should be implemented and if they are equally effective for males and females. Since minorities are also underrepresented in the STEM fields, it is important to research if their mindset has influence on their decisions to pursue these professions or take higher level math classes in college. Because there has been some research that has shown that mindsets matter more in the long-term after which students have experienced setbacks and challenges, more longitudinal studies need to be done.
**Conclusions and Implications**

This research is part of a body of evidence showing a student’s belief about their own intelligence has an impact on their academic success. Students and parents have the concept that intelligence is either a fixed trait or intelligence is expandable. Those students with a growth mindset typically outperform those with a fixed mindset in the long run. Parents’ mindset could also have an influence on their child’s mindset and therefore their academic performance.

The fact that the growth mindset group’s mindset did not correlate with their parents, but the group that had no intervention did correlate with their parents is a very important finding. This means educators can have an impact on developing a child’s mindset even if at home they are hearing different kinds of messages. As schools, we should be formally teaching students about their mindset, how the brain works like a muscle, and help all children see that through effort and perseverance they can succeed. Additionally, the parents’ mindset wasn’t correlated with the students’ math achievement in either group. This is important to know because interventions at school should probably focus more on changing the students’ mindsets rather than the parents.

In this study, females with no formal mindset training had a stronger mindset/performance correlation than males with or without training or females with growth mindset training. This is an important finding given the fact that females are less likely to pursue degrees requiring higher level mathematics. Educators need to be fostering a growth mindset, especially in females, by explicitly teaching them about the incremental theory of intelligence and the brain research that supports it. The data from this study further support the idea that the influence of parents’ mindset is lessened when there is training at school.
In conclusion, this study is part of a building body of research that supports it isn’t just actual ability that influences math success. It is also one’s belief about their own intelligence that matters. A student can have an incremental view of intelligence, which is the growth mindset, or a fixed view of intelligence. This research and other similar research provides evidence that those students with a growth mindset will likely outperform their classmates with a fixed mentality. This appears to be especially important for females.
References


## APPENDIX A

### Mindset Quiz

Place a check in the column that identifies the extent to which you agree or disagree with the statement.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Your intelligence is something very basic about you that you can't change very much.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>No matter how much intelligence you have, you can always change it quite a bit.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>You can always substantially change how intelligent you are.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>You are a certain kind of person, and there is not much that can be done to really change that.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>You can always change basic things about the kind of person you are.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Music talent can be learned by anyone.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Only a few people will be truly good at sports – you have to be &quot;born with it.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Math is much easier to learn if you are male or maybe come from a culture who values math.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>The harder you work at something, the better you will be at it.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>No matter what kind of person you are, you can always change substantially.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Trying new things is stressful for me and I avoid it.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Some people are good and kind, and some are not – it's not often that people change.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>I appreciate when parents, coaches, teachers give me feedback about my performance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I often get angry when I get feedback about my performance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>All human beings without a brain injury or birth defect are capable of the same amount of learning.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>You can learn new things, but you can't really change how intelligent you are.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>You can do things differently, but the important parts of who you are can't really be changed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Human beings are basically good, but sometimes make terrible decisions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>An important reason why I do my school work is that I like to learn new things.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Truly smart people do not need to try hard.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Circle the number in the box that matches each answer.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ability mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. ability mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3. ability mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4. personality/character mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. personality/character mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6. ability mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7. ability mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. ability mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. ability mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>10. personality/character mindset - growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>11. ability mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12. personality/character mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13. ability mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>14. ability mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>15. ability mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>16. ability mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>17. personality/character mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>18. personality/character mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>19. ability mindset – growth</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>20. ability mindset – fixed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Strong Growth Mindset = 45 – 60 points
Growth Mindset with some Fixed ideas = 34 – 44 points
Fixed Mindset with some Growth ideas = 21 – 33 points
Strong Fixed Mindset = 0 – 20 points

Adapted from:

http://www.classroom20.com/forum/topics/motivating-students-with
## APPENDIX B

Reliability and Validity Table for Star Renaissance Math Test

Table 1: Internal Consistency and Retest Reliability of STAR Math Enterprise Assessments

Taken Between June 2012 and June 2013

<table>
<thead>
<tr>
<th>Grade</th>
<th>Internal Consistency</th>
<th>Retest Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students</td>
<td>Reliability Coefficient</td>
</tr>
<tr>
<td>All</td>
<td>9,311,595</td>
<td>0.97</td>
</tr>
<tr>
<td>1</td>
<td>805,980</td>
<td>0.90</td>
</tr>
<tr>
<td>2</td>
<td>1,254,611</td>
<td>0.91</td>
</tr>
<tr>
<td>3</td>
<td>1,330,600</td>
<td>0.92</td>
</tr>
<tr>
<td>4</td>
<td>1,306,386</td>
<td>0.92</td>
</tr>
<tr>
<td>5</td>
<td>1,227,139</td>
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</tr>
<tr>
<td>6</td>
<td>968,367</td>
<td>0.93</td>
</tr>
<tr>
<td>7</td>
<td>785,789</td>
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</tr>
<tr>
<td>8</td>
<td>721,994</td>
<td>0.94</td>
</tr>
<tr>
<td>9</td>
<td>327,455</td>
<td>0.93</td>
</tr>
<tr>
<td>10</td>
<td>241,728</td>
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<tr>
<td>11</td>
<td>167,902</td>
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</tr>
<tr>
<td>12</td>
<td>108,492</td>
<td>0.95</td>
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</table>
Table 2: Summary of Star Math Validity Studies

<table>
<thead>
<tr>
<th>Grade</th>
<th>Predictive</th>
<th></th>
<th>Concurrent</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Studies</td>
<td>Students</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>11,880</td>
<td>.55</td>
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<td>2</td>
<td>10</td>
<td>33,076</td>
<td>.63</td>
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<td>3</td>
<td>30</td>
<td>52,604</td>
<td>.66</td>
<td></td>
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<tr>
<td>4</td>
<td>23</td>
<td>55,285</td>
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<td>5</td>
<td>29</td>
<td>39,869</td>
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<tr>
<td>6</td>
<td>13</td>
<td>27,663</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>18,919</td>
<td>.75</td>
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<td>8</td>
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<td>2,236</td>
<td>.79</td>
<td></td>
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<td>11</td>
<td>6</td>
<td>1,921</td>
<td>.80</td>
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<tr>
<td>12</td>
<td>2</td>
<td>885</td>
<td>.77</td>
<td></td>
</tr>
</tbody>
</table>


APPENDIX C

Growth Mindset Read-Alouds and Classroom Activities


Class Dojo Growth Mindset videos: (n.d.). from https://ideas.classdojo.com/b/growth-mindset


Growth Mindset Bulletin Board Set: Change your words, change your mindset! From


Growth Mindset Journal by Angela Watson: from

https://www.teacherspayteachers.com/Product/Growth-Mindset-1983160


Mystery Science. (2017, March 6). Retrieved from mysteryscience.com:


APPENDIX D

Parental Consent Form

CONSENT FORM

Identification of Researchers: This research is being done by Tracy Sachs, a second grade teacher and graduate student. Dr. Ann McCoy is the supervising advisor for this research. I am completing my Elementary Math Specialist degree at University of Central Missouri and this will be used for my thesis.

Purpose of the Study: The purpose of this study is to research factors that influence a student’s growth in math. I will be studying if their growth mindset or lack of growth mindset and their parents’ mindset affects their growth in math.

Request for Participation: We are inviting you and your child to participate in this study of math progress and growth mindset. It is up to you whether you would like to participate. If you decide not to participate, you will not be penalized in any way. You can also decide to stop at any time without penalty. If you do not wish to answer any of the questions, you may simply skip them. You may withdraw your data at the end of the study. If you wish to do this, please tell us before you turn in your materials.

Description of Research Method: This study involves completing a short survey. Your child will complete the same survey. The survey will ask you your opinion about several factors affecting a fixed or growth mindset. You will mark on your survey the degree to which you agree or disagree with the statements. This study will take about 5 – 10 minutes to finish. You will also have a chance to ask questions. Please note that we cannot give you your individual results because the data are confidential.

Privacy: All of the information we collect will be confidential. We will not record your name, student number, or any information that could be used to identify you.

Explanation of Risks: There are no risks associated with participating in this study other than those similar to the risks of everyday life. Your child’s participation in this study does not involve any physical or emotional risk to your child beyond that of everyday life.

Explanation of Benefits: You will benefit from participating in this study by getting firsthand experience in educational research. The information obtained in this study may benefit other students and parents in the future by learning more about how mindsets affect performance in math.

Questions: If you have any questions about this study, please contact my advisor Dr. Ann McCoy. She can be reached at meccov@ucmo.edu. If you have any questions about your rights as a research participant, please contact the Human Subjects Protection Program at (660) 543-8562.

If you would like to participate and you give your child permission to participate, please sign a copy of this letter and return it to me. The other copy is for you to keep.

Parental Permission for Child’s Participation in Research

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in this study and I give permission for my child to participate in the research study described above.

Student name: ________________________________

Signature of parent and/or legal guardian: ________________________________

Date: ________________________________

Reviewed 10/2010 JP
Growth Mindset: How Does it Affect Math Achievement in Second Grade?  
Aassent Form

Researcher and Research Topic: My name is Tracy Sachs. I am trying to learn about what factors affect a student’s growth in math. I will be studying if their mindset and their parents’ mindset affect their growth in math. If you would like, you can be in my study.

What will happen in this Research? If you decide you want to be in my study, you will take a short survey about math and mindset and so will your parent or legal guardian.

What are the good and bad things that come from you being in the research study? Nothing good or bad will happen if you decide to be in the study or if you decide not to be in the study.

We will not share your personal information: Other people will not know if you are in my study. I will put things I learn about you together with things I learn about other students and their parents, so no one can tell what things came from you. When I tell other people about my research, I will not use your name, so no one can tell who I am talking about.

Parent/Guardian Approval: Your parent or guardian will have to say it’s OK for you to be in the study. After they decide, you get to choose if you want to do it too. If you don’t want to be in the study, no one will be mad or upset with you. If you want to be in the study now and change your mind later, that’s OK. You can stop at any time.

Researcher Contact Information: My telephone number is (660)422-5770. You can call me if you have questions about the study or if you decide you don’t want to be in the study any more. I will give you a copy of this form in case you want to ask questions later.

Agreement: I have decided to be in the study even though I know that I don’t have to do it. Tracy Sachs has answered all my questions and I know that I can stop being in the study at any time. If you have any questions about this, please contact the UCM Research Compliance Officer at (660) 543-8562.

Signature of Study Participant ____________________________ Date __________

Printed Name of Study Participant ____________________________

Printed Name of Parent/Guardian ____________________________

Signature of Researcher ____________________________ Date __________