

The Effect of a Growth Mindset Program on
Mathematics Achievement of High School Upperclassmen

By Alicia Coleman

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Abstract

The purpose of this study was to evaluate the effectiveness of a growth mindset intervention program on the mathematics achievement of upperclassmen. Students participated in a four-week long program in which they learned and reflected on brain growth, varying mindsets and goal-setting. Students' mathematics grades were assessed using quarterly report card grades, including classwork, tests, and overall grades, as well as homework completion grades. This study utilized a quasi-experimental pretest-posttest design and found that a growth mindset program did not statistically impact students' mathematics achievement. Additional research including a larger sample size and a prolonged intervention program should be considered in the future.

CHAPTER 1

INTRODUCTION

Students' successes in education are largely based on their confidence with the content and belief in their own abilities. Students with fixed mindsets do not persevere through challenging tasks, and therefore give up easily. Contrarily, students with growth mindsets view tasks as an opportunity to grow and, therefore, tend to participate more willingly (Dweck, 2006).

Upper level mathematics courses require students to cumulatively apply their knowledge. Because of this, students in upper level mathematics courses are often tasked with challenging assignments. When these same students subscribe to a fixed mindset, they may give up easily on these tasks and ultimately not learn from them. This can affect their overall mathematics grade in a negative way. When students consider intelligence to be ever-growing, they will, contrarily, persevere through tasks and ask questions that help develop content knowledge. They will also acknowledge that hard work can impact their grades and outcomes on tasks (Dweck, 2006). This connection can affect their overall mathematics grade positively. A fixed mindset will affect any student's academic achievement, regardless of age, but it is important to help students develop and utilize a growth mindset in high school to best prepare for college and careers.

The researcher's interest in this topic stems from years of experience teaching at the high school level and, more specifically, observations made regarding students' unwillingness to persevere through challenges in upper level mathematics courses. A challenge to working with upperclassmen is that students are often under the impression that intelligence is fixed. The researcher wanted to explore the impact of a growth mindset intervention in upper level mathematics courses to determine its effectiveness on the students' overall mathematics grades.

Statement of Problem

This study was designed to examine the effects of a growth mindset intervention program on high school juniors' mathematics grades.

Hypothesis

The following null hypothesis will be tested to determine the effectiveness of a growth mindset intervention.

Null Hypothesis

The implementation of a growth mindset intervention program will have no effect on high school juniors' mathematics grades.

Operational Definitions

The independent variable in this study is the implementation of a growth mindset intervention. The growth mindset intervention that was implemented included a series of lessons regarding brain plasticity and growth mindset. There are four interventions that occurred biweekly for approximately 30 minutes. The teacher presented the material and students had an opportunity to reflect, discuss and apply the information.

The dependent variable in this study is the students' mathematics grades. Student grades were tracked prior to the implementation via their quarter two mathematics grades. Student grades were then tracked post-intervention via their quarter three mathematics grades. These quarterly grades encompass students' classwork, quizzes and test grades, and reflect the student's mastery of the content. Classwork and quizzes make up 70% of the quarterly grade, while tests make up 30%. Homework completion is tracked, but it does not affect the overall quarter grade. For that reason, homework completion was also considered and compared. Students' pre- and post-implementation grades were compared to student grades in the same course who did not receive the growth mindset intervention.

CHAPTER II

REVIEW OF THE LITERATURE

Students respond to challenges in different ways. While some students persevere through difficult tasks, others tend to get frustrated and give up quickly. Some students learn from their mistakes and failures while others are not as resilient. Teachers can sometimes be perplexed by students' reactions when given a task, especially because these reactions can differ from intelligence. Research has found that students' responses to challenges may be based on the two varying mindsets, growth and fixed, in conjunction with brain activity (Dweck, 2006).

Research has determined that students with growth mindsets often learn from challenging tasks and mistakes. While experts in education suggest strategies for teachers to use that may help the development of growth mindsets in students, there is limited research regarding the effects of many of those strategies on students' academic achievement (Sun, 2018a). This literature review will discuss the existing research on the contrasting mindsets and their differing effects on education.

Educational Definition of a Growth Mindset

The Two Mindsets

Dweck is an educational professor who has done extensive research on students' achievement and the reason why some students learn from challenges while others seemingly do not. Through her research, Dweck (2006) found that there are two varying mindsets that people have, and these mindsets could be a large indicator of why certain people succeed. The first mindset is called a fixed mindset. This is the idea that intelligence is an inherent trait and cannot be changed. The opposing mindset is referred to as a growth mindset. A growth mindset is the belief that intelligence can be developed through practice and persistence. While babies are born

with a growth mindset, this can change over time, and most often changes when children enter school. In early adolescence, children develop the ability to evaluate themselves and begin to fear failure and, in turn, avoid challenges because they do not think they are capable (Brock & Hundley, 2016). These children subscribe to a fixed mindset. On the other hand, when children have the perception that their intelligence can grow or change, they become motivated to complete difficult tasks and persevere through their education (Hochanadel & Finamore, 2015).

Science Behind Brain Growth

While many people believe that the brain is static, research has indicated that the brain is ever-changing. This means that, with practice, the brain has the ability to grow and develop. Like a muscle, the brain must be exercised in order to become stronger. One of the most well-known studies about brain growth researched the brains of cab drivers in London. The study found that the hippocampi of each cab driver grew as they studied and practiced for their licensing examination, in which they were required to memorize over thousands of streets in the city (Brock & Hundley, 2016). This study shows that with persistence, it is possible for humans to develop their brains.

Implications for Adolescents

Because children often adopt a fixed mindset during their early adolescence, it is important to investigate the cognitive development of young adolescents. Psychologically, people develop the ability to think abstractly and reflectively during their adolescence stage, or what Piaget referred to as the Formal Operations Stage (Day, 1981). Because they are gaining the ability to think at higher levels, they begin to get excited about new and abstract learning. With this, young adolescents also develop judgements about themselves and others during the formal operations stage. Young adolescents' cognitive and psychological development allow

them to either begin to form a fixed mindset or continue to utilize a growth mindset. The mindset that they adopt influences their motivation and perseverance throughout their educational career (Manning, 1995). Because young adolescents are still developing, educators should plan lessons that will have a positive effect on students' mindsets and encourage persistence in the classroom.

Impact of a Growth Mindset in the Classroom

Effect on Behavior

A growth mindset can affect children's behavior in the classroom and, thus, academic achievement in a positive way. On the other hand, a fixed mindset can affect classroom behavior and academics in a negative way. Students with a fixed mindset tend to be under the impression that learning is instant, rather than a gradual process. Because of this, they often show signs of impatience and frustration, such as fidgeting and disengaging from attempted learning (Miller, 2013). Contrarily, instead of giving up, students with a growth mindset show perseverance through a difficult task. Their behavior shows that they are focused and working through their learning and they ask meaningful questions to their teacher and/or peers.

Townsend, Slavit and McDuffie (2018) explain that students with a growth mindset engage in a productive struggle through difficult tasks. During a productive struggle, students persevere through difficulties; this includes helping or seeking help from peers. Students with a growth mindset will engage in an educational discussion with their peers to help proceed with the next step of the task. It is believed that students with a growth mindset utilize self-advocacy, whether it is from peers or a teacher. They ask questions, rather than make negative statements that are typical of a fixed mindset. On the other hand, students with a fixed mindset will not engage in a productive struggle. Instead, their behavior will demonstrate that they have given up

on the task. This may include statements such as “This is too hard” or “I can’t do this.” Their behavior can also include agitation, boredom or disrupting others. This would include statements such as “I don’t know what we are supposed to be doing” or “I don’t care.” Additionally, students with a fixed mindset may display poor self-esteem and show behaviors that demonstrate anxiety and avoidance, such as being slumped in their seat (Pueschel & Tucker, 2018).

Effect on Academic Achievement

Ultimately, student behavior and academic achievement goes hand in hand. Students who are not completing the assigned task in the classroom due to frustration are not receiving the same educational experience as those who are persevering. Because they are not mastering tasks, their educational self-efficacy is declining. They then feel even less prepared to complete tasks in the future and begin to feel overwhelmed, which causes them to shut down (Yeager & Dweck, 2012). When students do not build their confidence with the content, they are not only affecting their current academic performance, but also their future performance. The judgements they have on the content area follow them into the next grade; for example, students who have a poor experience in a mathematics class may have preconceived notions about mathematics in the future. Additionally, students who miss content due to disengaging from class material will have gaps in their knowledge. These students may enter the next class without the prerequisite knowledge that they need to be successful, or may even have to repeat the course (Usher, 2009).

Teachers’ Impact on Students’ Mindsets

Strategies used in the Classroom

Teachers can utilize several strategies to promote a growth mindset with their students. Engaging lessons, positive feedback, reframing teachers’ mindsets and intelligence education can

all play a role in students' mindsets. Implementation of these strategies during the regular school day may positively impact students' behavior and academic achievement.

When students are involved in their own learning, they tend to take ownership over the lesson and develop a higher self-efficacy. Because of this, teachers should implement lessons that engage students in the instruction, rather than simply giving direct instruction. Lessons should often include student communication about the content and opportunities for students to respectfully disagree with one another. When students can form an opinion about the content and attempt to see a peer's perspective, they are engaging in that content in an effective way (Willingham, 2017). Encouraging peer discussion also allows an opportunity for teachers to give students process-based feedback.

The way teachers give feedback to their students can affect the students' self-efficacy and mindset about that content area. There are two types of feedback that teachers primarily utilize – outcomes-based and process-based. Outcomes-based feedback is feedback that is focused only on the result or the correctness of the task, whereas process-based feedback is feedback that is focused on the steps and strategies that students used. Process-based feedback promotes a growth mindset in that it sends a message to the students that all students can receive positive feedback and can contribute to the given task. When giving written feedback, teachers should focus on the process rather than simply the final answer (Sun, 2018b). For example, in a mathematics class, teachers can provide partial credit for correct steps, even if the answer is incorrect. They can also provide written feedback to both praise students for their correct work and direct them to their mistakes. Cimpian, Arce, Markan and Dweck (2007) found that giving students praise for their intelligence, rather than effort, makes them think that their abilities are fixed. This can lead to students giving up on or avoiding difficult tasks entirely to avoid

appearing unintelligent. On the contrary, Cimpian et al. found that giving students praise for process or effort encourages them to work through challenging tasks and improves their confidence long-term. This study did not determine the long-term effect of process-based feedback on academic achievement.

While teachers should focus on process-based feedback, rather than outcomes-based, they should also utilize qualitative feedback in conjunction with quantitative feedback. Northcote, Williams, Fitzsimmons and Kilgour (2014) found that quantitative feedback impacts students' feelings of self-worth, whereas qualitative feedback impacts students' understanding of the given task. Low numerical scores may cause students to shut down and view their score as an endpoint, whereas written, qualitative feedback directs students to their mistakes and encourages students to learn from them. While this study focused on students' feelings about feedback, more research regarding the effect of qualitative feedback on academic achievement would be beneficial.

Teachers can also provide feedback by demonstrating the value of mistakes to their students. Rather than reprimanding students when they make mistakes, teachers can use the mistake as a teachable moment. Sun (2018a) discusses the fact that children's beliefs are affected most by experiences. This means that teachers cannot simply make statements that align with a growth mindset, but rather show the importance of a growth mindset in class. A strategy called "My Favorite Mistake" is a way to show the value of mistakes to students. After giving an assessment, a teacher will anonymously display their "favorite" mistake. Students can then discuss what the mistake was and why the teacher feels it is their favorite mistake. Demonstrating that mistakes are okay through activities similar to this one promotes both a growth mindset and classroom environment conducive to learning.

Teachers cannot help their students develop a growth mindset without reframing their own mindset about education and their students. In several situations, teachers can change their thinking to develop a growth-mindset response, rather than a fixed-mindset response. For example, when assessing students, teachers with fixed mindsets may be under the impression that their students are failing because of a slow working speed. On the other hand, teachers with growth-mindsets would place more weight on students' procedures, rather than quickness.

Additionally, teachers often compare their students to one another. Teachers with fixed-mindsets believe that difficult work is only appropriate for their higher performing students, and lower students are incapable. However, teachers can reframe their thinking regarding difficult tasks by giving all students the opportunity to work on rigorous tasks. This will send a message to students that their teacher believes in them and feels that they are capable (Sun, 2018a).

Blackwell, Trzesniewski and Dweck (2007) performed a study to test the effect of seventh grade students' beliefs about intelligence on their academic achievement. In this study, students in the experimental group were taught about brain growth, particularly that the brain is like a muscle that can grow stronger the more you use it. In this study, the control group learned about study skills, but not about brain growth. Blackwell et al. found that students in the control group's grades declined over time while students in the experimental group's grades improved over time. The research also found that teachers observed an increase in motivation in the students in the experimental group compared to the control group. Further research should be performed to test a quantitative determination of student motivation.

Another study that was completed to determine the effects of intelligence education was a study performed by Good, Aronson and Inzlicht (2003) on students at Stanford University. In their study, Good et al. utilized an experimental group who received a workshop about the

varying types of intelligence and a control group who did not. The study found that at the end of the semester, the students in the experimental group earned a higher grade point average than those in the control group. Further research should be performed to determine the varying academic effects on student subgroups.

Dweck (2006) recommends for educators to teach students about the science of brain plasticity to promote growth mindsets. Children tend to believe that the brain is static and intelligence is a trait that people are born with. Instead, teachers should emphasize the fact that students can improve their intelligence through hard work and persistence. Comparing the brain to a muscle is a recommended strategy because it allows adolescents to make a connection with something they are already familiar with, and that they can physically see.

Math is a unique subject in that many people believe that they are not a “math person.” Research indicates that the math brain is a myth and, as discussed earlier, with practice, brains can develop and grow (Dweck, 2006). When students are not exposed to rigorous mathematics tasks, they do not have the opportunity to develop their brains. Because of this, math teachers should provide all students rigorous tasks that promote the connection between different mathematical concepts. Multidimensional math tasks, or tasks that focus on student engagement, rather than an answer, can be utilized in classrooms of varying student needs because all students can access the intended connections. These tasks also allow room for students to explore further. This means that all students can work their brain through the same tasks, regardless of mathematics level. The main goal of a multidimensional math task is to show students what they are capable of and increase their confidence and self-efficacy with the topic (Sun, 2018a).

Conclusion

It is critical for educators to provide their students with tasks in which they can persevere though as students' brains develop because of these tasks. Students with growth mindsets persevere and learn from these experiences, while students with fixed mindsets get frustrated and disengage. Their disengagement will ultimately lead to a decline in their academic achievement (Dweck, 2006).

Experts in education identify strategies that teachers should utilize in their classroom to ensure students are learning from complex tasks. These strategies include providing engaging lessons that promote classroom discussions, giving process-based and qualitative feedback, reframing their own mindsets and providing intelligence education. Though these strategies are recommended, there is limited research on many of them. Specifically, research on the effects of engaging lessons on students' mindsets in combination with academic achievement is lacking. To test the effectiveness of these strategies, further research is needed. This research would contribute to the existing research in that educators can ensure that they are developing a plan for their own classroom that will have lasting effects on both students' mindsets and achievement.

Research regarding a growth mindset in the classroom has pinpointed the effects of teaching students about brain growth and intelligence. Blackwell et al. (2007) have found that teaching students about the brain, specifically that the brain can develop through hard work and application, can improve their academic achievement. Additionally, Good et al. (2003) have found that teaching students that there are varying types of intelligence can improve both their self-worth and academic achievement. Educators can encourage students to work hard and persevere by teaching them about a growth mindset, ensuring that they do not disengage from class lessons and challenging tasks. Through persistence and hard work, students can improve their own academic achievement through these experiences.

CHAPTER III

METHODS

The purpose of this study was to examine the effect of a growth mindset intervention on the mathematics grades of high school juniors. Mathematics grades were mastery-based and were calculated from classwork, homework, quiz and test grades. The growth mindset intervention was a four-session program in which the teacher facilitates discussions and reflections based on videos and readings.

Design

This study was based on a quasi-experimental design using a pre-test and post-test and a convenience sample of two groups. One group served as a comparison to the treatment group. Students' quarter two grades, including minor assessments, major assignments, and homework completion were used as a pre-test to determine the starting level of each student. Students participated in a growth mindset program for four weeks. The treatment and comparison groups were tested for statistical significance on the pre-report card grades. After the treatment period, students' quarter three grades were tracked to determine whether the growth mindset intervention affected any part of the students' mathematics performance as compared with the non-treatment group.

Participants

The participants in the study were a convenience sample of high school juniors at a public school in Baltimore, Maryland. Both the treatment and comparison groups include students from diverse ethnic and socio-economic backgrounds. All students range from ages 16 through 17 and were placed in an upper level mathematics course for their junior year due to previous mathematics scores. In the treatment group, there were 25 students, including 16

females and 9 males. Three of these students have a 504 Plan for ADHD/ADD. In the comparison group, there were 20 students, including 7 females and 14 males. Three of these students have a 504 plan for ADHD/ADD.

Instrument

The instrument used in this study were students' quarterly grades. Student grades are mastery-based and reflected student content knowledge. Overall grades for quarters two and three were compared as well as student scores on minor assessments (independent classwork assignments), major assessments (unit tests), and percentage of homework completion.

Procedure

Quarter two grades were tracked and utilized as a pre-test score for each student. The treatment group received four sessions of a growth mindset program for four weeks; each week had two sessions: an "A" session in which students watched a video and reflected in a journal and then with peers and a "B" session in which students practiced the skill from the video. Each session was approximately 60 – 80 minutes long, for a total of five hours.

The focus of Session 1A was brain growth. The video for this session covered the basics of a growth mindset including what it means to have a growth mindset and the importance of self-belief. Students reflected and practiced rewriting fixed mindset phrases as growth mindset phrases. During Session 1B, students practiced self-belief by completing a difficult task using number sense. For this task, students used four 4s and any mathematical operations to write the numbers 1 – 20 as expressions.

The focus of Session 2A was brain plasticity and the importance of mistakes. The students watched a video regarding mistakes and brain synapses. They then reflected in their journals and with a peer before practicing identifying the different parts of the brain and the

function of each part. During Session 2B, students applied this knowledge by correcting their mistakes on a past assessment.

Session 3A focused on the importance of “yet” and goal-setting. After students watched this video and reflected on it, they practiced this information by matching pre-written goals to actions that would help achieve that goal. During Session 3B, students set goals for themselves and identified three actions they could take to help reach that goal - one immediately, one short-term, and one long-term.

Session 4A and 4B were a combined wrap-up session. Students reflected on their new knowledge of growth mindset and how they would apply this knowledge to their education. In lieu of watching a video, students worked in groups to create their own video, poster, brochure or graphic organizer to promote growth mindset. Each group’s project was then either displayed in the classroom or sent out via message for other classes to see and learn from.

All sessions took place during quarter three and were complete by the conclusion of the quarter. The comparison group did not participate in the program and therefore did not receive the growth mindset intervention. Instead, the comparison group received additional content practice during the time allotted for the growth mindset intervention. Students’ mathematics quarter grades were then tracked, as well as their minor assessment and major assessment grades and homework completion.

CHAPTER IV

RESULTS

The purpose of this study was to determine the effectiveness of a growth mindset intervention on high school students’ mathematics grades. The independent variable, the growth mindset intervention was a 4-week program in which students learned about brain growth and

the varying mindsets. The dependent variable was the students' overall report card grades. Also assessed were the students' test grades, classwork grades and homework completion. At the conclusion of the study, the null hypothesis was not rejected as the correlation between growth mindset intervention and students' mathematics grades were not statistically significant below 0.05.

Tables 1 through 8 show the mean differences in students' pre- and post- intervention data. Pre-intervention data was collected at the conclusion of quarter two and post-intervention data was collected at the conclusion of the growth mindset program, at the end of quarter three. Tables 1 and 2 show the sample mean differences for pre- and post-test report card grades. Tables 3 and 4 show the sample mean differences for pre- and post-test homework completion grades. Tables 5 and 6 show the sample mean differences for pre- and post-test student test score grades. Tables 7 and 8 show the sample mean differences for pre-and post-test classwork grades. For the components of test grades, classwork grades and overall report card grades, student scores were similar for both the control and treatment groups. Post-test scores were not significantly different for any of the components of the grade.

Table 9 shows the mean differences in students' pre-test and post-test data change (student report card grades). The null hypothesis was not rejected for the change. Table 10 shows the mean differences in students' pre- to post- homework completion change. The null hypothesis was rejected for the change in favor of the control group. Because the homework grades were not factored in to students' overall grades, this would not affect the other data. Table 11 shows the mean differences in students' test score change. Again, the null hypothesis was not rejected for the change. Table 12 shows the mean differences in students' classwork grade change. The null hypothesis was not rejected. There was insufficient evidence to reject

the null hypothesis for any of the posttest or pre-to-post change scores because the change score averages were not statistically significant. The only significant result was for the homework pretest grades that favored the treatment (Table 3) and the homework pre-post change that favored the control (Table 10) .

Table 1. *Test of Sample Mean Differences for Pretest Report Card Averages*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	84.035	2.149226	9.611631	79.53662	88.53338
Treatmen	25	86.596	1.81972	9.098602	82.84028	90.35172
combined	45	85.45778	1.388079	9.311515	82.66029	88.25527
diff		-2.561001	2.798631		-8.204978	3.082976
diff = mean(Control) - mean(Treatmen)					t =	-0.9151
Ho: diff = 0					degrees of freedom =	43
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.1826		Pr(T > t) = 0.3652		Pr(T > t) = 0.8174		

Table 2. *Test of Sample Mean Differences for Posttest Report Card Averages*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	80.14	2.598901	11.62264	74.70044	85.57956
Treatmen	25	82.7256	3.10558	15.5279	76.316	89.1352
combined	45	81.57644	2.063106	13.83974	77.41853	85.73436
diff		-2.585601	4.181372		-11.01814	5.84694
diff = mean(Control) - mean(Treatmen)					t =	-0.6184
Ho: diff = 0					degrees of freedom =	43
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.2698		Pr(T > t) = 0.5396		Pr(T > t) = 0.7302		

Table 3. *Test of Sample Mean Differences for Pretest Homework Averages*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	66.7245	5.270717	23.57136	55.69276	77.75624
Treatmen	25	85.142	4.244191	21.22095	76.38242	93.90158
combined	45	76.95644	3.562813	23.90008	69.77607	84.13682
diff		-18.4175	6.687027		-31.90318	-4.931826
diff = mean(Control) - mean(Treatmen)					t =	-2.7542
Ho: diff = 0					degrees of freedom =	43
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.0043		Pr(T > t) = 0.0086		Pr(T > t) = 0.9957		

Table 4. *Test of Sample Mean Differences for Posttest Homework Averages*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	80	5.98243	26.75424	67.47863	92.52137
Treatmen	25	73.6	7.635007	38.17504	57.84212	89.35788
combined	45	76.44444	4.976262	33.38178	66.41545	86.47344
diff		6.4	10.08319		-13.93469	26.73469
diff = mean(Control) - mean(Treatmen)				t =	0.6347	
Ho: diff = 0				degrees of freedom =	43	
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.7355		Pr(T > t) = 0.5290		Pr(T > t) = 0.2645		

Table 5. *Test of Sample Mean Differences for Pretest Test Score Averages*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	81.687	3.014312	13.48041	75.37797	87.99603
Treatmen	25	84.9604	2.179551	10.89776	80.46203	89.45877
combined	45	83.50556	1.800958	12.08119	79.87596	87.13515
diff		-3.273401	3.632117		-10.59826	4.051461
diff = mean(Control) - mean(Treatmen)				t =	-0.9012	
Ho: diff = 0				degrees of freedom =	43	
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.1862		Pr(T > t) = 0.3725		Pr(T > t) = 0.8138		

Table 6. *Test of Sample Mean Differences for Posttest Test Score Averages*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	76.661	3.533444	15.80204	69.26542	84.05658
Treatmen	25	81.5696	3.518452	17.59226	74.30787	88.83133
combined	45	79.388	2.506537	16.81436	74.33641	84.43959
diff		-4.908599	5.047422		-15.0877	5.270496
diff = mean(Control) - mean(Treatmen)				t =	-0.9725	
Ho: diff = 0				degrees of freedom =	43	
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.1681		Pr(T > t) = 0.3362		Pr(T > t) = 0.8319		

Table 7. *Test of Sample Mean Differences for Pretest Class Work Averages*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	85.6665	2.021812	9.04182	81.4348	89.8982
Treatmen	25	87.8132	2.071762	10.35881	83.53729	92.08911
combined	45	86.85911	1.452942	9.74663	83.9309	89.78732
diff		-2.1467	2.939621		-8.075011	3.781611
diff = mean(Control) - mean(Treatmen)				t = -0.7303		
Ho: diff = 0				degrees of freedom = 43		
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.2346		Pr(T > t) = 0.4692		Pr(T > t) = 0.7654		

Table 8. *Test of Sample Mean Differences for Posttest Class Work Average*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	82.124	2.265447	10.13139	77.38236	86.86564
Treatmen	25	83.5276	3.096158	15.48079	77.13744	89.91776
combined	45	82.90378	1.97508	13.24924	78.92327	86.88429
diff		-1.4036	4.015022		-9.500665	6.693464
diff = mean(Control) - mean(Treatmen)				t = -0.3496		
Ho: diff = 0				degrees of freedom = 43		
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.3642		Pr(T > t) = 0.7284		Pr(T > t) = 0.6358		

Table 9. *Test of Sample Mean Differences for Overall Pre-to-Post Change*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	-3.894999	1.573539	7.037081	-7.188454	-.6015442
Treatmen	25	-3.870399	2.383042	11.91521	-8.788757	1.047958
combined	45	-3.881333	1.481916	9.940997	-6.867939	-.8947264
diff		-.0246	3.016775		-6.108507	6.059308
diff = mean(Control) - mean(Treatmen)				t = -0.0082		
Ho: diff = 0				degrees of freedom = 43		
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.4968		Pr(T > t) = 0.9935		Pr(T > t) = 0.5032		

Table 10. *Test of Sample Mean Differences for Homework Pre-to-Post Change*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	13.2755	5.326047	23.8188	2.127958	24.42304
Treatmen	25	-11.542	5.558605	27.79303	-23.0144	-.0696028
combined	45	-.5119993	4.273577	28.66803	-9.124828	8.100829
diff		24.8175	7.833501		9.019741	40.61526
diff = mean(Control) - mean(Treatmen)					t =	3.1681
Ho: diff = 0					degrees of freedom =	43
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.9986		Pr(T > t) = 0.0028		Pr(T > t) = 0.0014		

Table 11. *Test of Sample Mean Differences for Test Scores Pre-to-Post Change*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	-5.025999	2.072972	9.270614	-9.36478	-.6872184
Treatmen	25	-3.3908	2.605702	13.02851	-8.768706	1.987105
combined	45	-4.117555	1.702117	11.41815	-7.547947	-.6871635
diff		-1.635199	3.456062		-8.605012	5.334615
diff = mean(Control) - mean(Treatmen)					t =	-0.4731
Ho: diff = 0					degrees of freedom =	43
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.3193		Pr(T > t) = 0.6385		Pr(T > t) = 0.6807		

Table 12. *Test of Sample Mean Differences for Class Work Pre-to-Post Change*

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	20	-3.5425	2.235355	9.996814	-8.221152	1.136153
Treatmen	25	-4.2856	2.599328	12.99664	-9.650349	1.079149
combined	45	-3.955333	1.734794	11.63735	-7.45158	-.459086
diff		.7431001	3.529748		-6.375316	7.861516
diff = mean(Control) - mean(Treatmen)					t =	0.2105
Ho: diff = 0					degrees of freedom =	43
Ha: diff < 0		Ha: diff != 0		Ha: diff > 0		
Pr(T < t) = 0.5829		Pr(T > t) = 0.8343		Pr(T > t) = 0.4171		

The pre- and post- intervention data on report card averages do not support the claim that a growth mindset intervention would result in higher report card grades. Pre-intervention data was taken at the end of the second marking period, and post-intervention data was taken at the conclusion of the third marking period. With the exception of homework averages, the pre-test

values of the components for both the control and treatment groups were similar. The homework completion grades were higher for the treatment group than the control group.

Post-intervention, the overall averages and the three components (homework, test grades and classwork grades). Therefore, the pre-to-post change score averages for these three components were not statistically significant except for homework, where the pre-post change favored the control, as the control improved while the treatment declined from pre to post. There was insufficient evidence to reject the null hypothesis for any of the post-test or pre-to-post change scores except for homework that worked against the treatment.

CHAPTER V

DISCUSSION

The purpose of this study was to examine the effects of a growth mindset intervention program on high school students' mathematics grades. The correlation between growth mindset program participation and mathematics scores in homework, test, classwork and overall report card grades were not statistically significant, so the null hypothesis could not be overturned. There was insufficient evidence that growth mindset intervention differentially advantaged student achievement in mathematics as compared with the customary instruction of similar students.

Implications of the Results

The results of this study indicated that students who participated in the growth mindset program did not score significantly higher than the control group of students in four areas – homework completion test, classwork and report card grades. Observation data, however, suggests that there were benefits to the intervention program. Students who participated in the intervention tended to stay on task for class assignments longer and did not reach a frustration

level as quickly when completing difficult tasks. Students also learned positive groupwork skills that they utilized after the program was complete. Overall, the researcher believes that students who participated in the growth intervention program were more engaged in their classwork, though their grades did not reflect a significant difference.

Theoretical Consequences

The results of this study show that there is no significant difference between the variables, therefore the growth mindset program had no significant effect on students' grades.

Threats to Validity

One significant threat to validity was the differences between the control and treatment groups. Though pre-test scores were similar, the overall differences in the population and classes could affect the results of the study. One difference in population is that control group had a higher percentage of male students (70%) than the treatment group (36%), and, because of this, these students could interact to class material differently. For example, women typically score lower on the mathematics sections of the SAT compared to males (Sole, 2019). Additionally, the different groups of students could have had varying experiences with growth mindset in relation to mathematics. Students from the control group may have learned about growth mindset in previous courses and therefore could have been affected by the same material presented to the treatment group.

In addition to these differences, the time of day was also a threat to validity. Students in the treatment group were in class during period two, from 9:25 A.M. to 10:50 A.M. Contrarily, students in the control group were in class during period four, from 12:50 P.M. to 2:20 P.M. Students in the control group could have been reaching a frustration level more quickly due to the time of day and fatigue.

Another threat to validity was the information presented to the control group while the treatment group was participating in the program. For the time allotted for the growth mindset program, the control group instead received additional practice with class material. This may have given the control group an advantage to content mastery.

This was a quasi-experimental experiment in which students were not randomly selected. While the study resembled the general population of upperclassmen in a higher-level mathematics course, it can only be associated with students at this particular high school in Baltimore County, Maryland. Students across the country may work with a different curriculum and therefore may have been exposed to a growth mindset intervention in previous grades.

The length of the intervention program was also a threat to validity. The program that students participated in was a four-week long program. This means that, although students were exposed to the meaning of a growth mindset, and practiced skills that would promote a growth mindset, it does not mean that the students necessarily adopted a growth mindset. Further practice with a growth mindset and implementation earlier in the year may be more effective than a short intervention program.

Lastly, using grades to determine the effectiveness of a growth mindset intervention could be a threat to validity. Report card grades are a gross measure and may not adequately measure effects of the program, and therefore, overall grades could have been a limitation. Using a standardized test with difficult, application problems may be a more appropriate tool to utilize in the future.

Connections to Previous Studies/Existing Literature

Research has shown that students with a fixed mindset demonstrate signs of frustration, such as giving up easily and disengaging from classwork, and, on the other hand, students with a

growth mindset persevere through tasks (Miller, 2013). Researchers often suggest that a growth mindset would cause a student to achieve high academic grades because of their willingness to work through tasks and motivation to succeed. Blackwell et al. (2007) found that students in the seventh grade achieved higher academic scores after learning about brain growth. Similarly, Good et al. (2002) found that students at the college level performed higher academically after learning about the different types of intelligence. However, there is little research that makes that jump to correlate mindset directly to academic scores at the high school level.

Observational data aligns with existing research regarding student behavior. For example, students in the treatment group were more willing to work in groups throughout the marking period. They utilized positive groupwork skills that were practiced during the study, such as peer discussions, engaging with the class material and correcting each other's mistakes in a positive way. On the other hand, the control group needed to be redirected more frequently and demonstrated a lack of confidence with the content, often asking for help from the teacher or reaching a frustration level with tasks.

Implications for Future Research

This study showed no significant effect of a growth mindset program on students' mathematics scores. There is little research suggesting that learning about growth mindset would affect students' grades, but rather improve their engagement and motivation in the classroom. More research should be done on the effect on students' grade in various content areas in order to utilize a growth mindset intervention to improve students' grades. Additionally, a larger sample size and a longer intervention program should be utilized in future research. Literature suggests that implementation of growth mindset strategies, such as goal-setting and learning

from mistakes, could positively impact students' class performance and engagement, but there are few quantitative results that suggest that this will help students improve their grades.

Conclusion

This study did not provide significant evidence that a growth mindset intervention program would affect students' grades. However, the sample size of the study was small, and the research was taken over a short period of time. More research should be done on various content areas over an extended period of time to determine the effectiveness on growth mindset programs on student academic achievement.

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