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Efficacy of a Growth Mindset Intervention to Increase Student Achievement

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Approval Page

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Abstract

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This research investigation examined the effectiveness of Brainology©, an online/classroom based curriculum, targeted to increase student motivational behavior and academic achievement. Five middle schools within an urban school district in the piedmont region of North Carolina participated in this study. Seventh-grade students and their teachers were the targeted sample (N=684).

A number of school motivational constructs were measured (mindset, effort beliefs, academic self-efficacy, interest and engagement in science, motivation in science, and use of study skills strategies). Teacher ratings of student motivational behavior were used and student academic achievement in math and science was calculated by quarterly grades and interim math assessments. ANCOVAS were run on all constructs to determine if statistically significant changes occurred to the intervention group. Correlations were run to determine the relationship among constructs. A path analysis prediction model was run to determine which model was the best predictor of student achievement outcomes.

This study found no significant changes in students' mindsets, effort beliefs, academic self-efficacy, and use of study skills strategies for learning. Results showed that the full implementation treatment group showed a positive increase in science engagement and motivation. Students in the partial treatment group used significantly less rehearsal learning strategies by the end of the program. All students showed significant changes in science quarter grades over the course of this study. The survey pre and post data and the focus-group dialogue with students and teachers were analyzed and summarized to obtain insight as to the overall impact of the intervention on participants. This study suggests that further study is needed to determine the effectiveness of interventions that improve student motivational and achievement outcomes.

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Chapter 1: Introduction

Background of Study

The desire for the United States to demonstrate high academic performance both nationally and internationally became a priority under President Lyndon B. Johnson's administration (Whilden, 2010). President Johnson instituted the *Great Society* as his platform to promote social accountability to improve the performance of public education (Association for Educational Communications and Technology, 2001). As a result of President Johnson's push to improve education, the Elementary and Secondary Education Act (ESEA) (1965) was passed under his leadership. ESEA was intended to increase programs and support for public schools for the purposes of promoting a sense of urgency and a moral imperative to increase student achievement. The growth of programs and support for public education was particularly important for schools working with disadvantaged populations (Association for Educational Communications and Technology, 2001). ESEA (1965) has been reauthorized over the past 47 years as a way to continue the push to reform public education (Whilden, 2010).

Since the initial authorization of the ESEA (1965), several presidents have instituted educational reforms to increase student achievement. Some of these reforms include but are not limited to the Space Race, Goals 2000, No Child Left Behind, and most recently, Race to the Top (Initiative, 2012). The goal of each reform has been to put the United States on a trajectory to compete with other nations by illustrating that it has the best and top performing students in all academic disciplines. President Barack Obama (2011) promoted this sense of urgency in his State of the Union message, noting the following:

A world-class education is the single most important factor in determining not just

> whether our kids can compete for the best jobs but whether America can out-compete countries around the world. America's business leaders understand that when it comes to education, we need to up our game. That's why we're working. (Obama, 2011, para. 1)

Despite the various reform initiatives, the United States (U.S.) has not fared well in its ability to compete against other countries around the world, especially in the fields of math and science. Thirty-four countries make up the Organization for Economic Co-Operation Development (OECD) and these countries, among other nations, assess students to determine levels of academic performance. Student assessment is conducted through participation in the Programme for International Student Assessment (PISA). The PISA compares the knowledge and skills of 15-year-old students in over 70 countries in math, reading, and science. According to the 2012 PISA results, the United States performed below average in mathematics and ranked 26th out of 70 countries. U.S. performance in reading and science are both close to the OECD averages, ranking 17th in reading skills, and 21st in science (Organization for Economic Co-Operation Development, 2012). There has been no significant change in U.S. performance since the last PISA assessment in 2009. According to OECD (2012), the U.S., on the 2009 PISA assessment, ranked 14th out of 34 countries for reading skills, 17th for science, and a below-average 25th in mathematics. Though U.S. averages on the PISA assessment have not drastically changed, OEDC indicates that it is evident is that students in the United States have weaknesses in performing mathematical tasks with higher cognitive demands when compared to their peers in other countries. Further, that U.S students lack the depth and ability to solve real-world tasks and interpret mathematical situations.

As a result of these OEDC (2012) and PISA data, the federal government has placed urgent expectation on schools to improve performance in the disciplines of math and science (United States Department of Education, 2009; United States Department of Education, 2010). The results from the PISA (2012) show that in the U.S. there is a disconnection between the content taught and learned and any practical application and demonstration of this knowledge by students. Most recently many U.S. states have adopted a new mathematics curriculum known as the Common Core State Standards for Mathematics (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The rationale for this implementation is that increased rigor with the new Common Core State Standards for Mathematics curriculum and that the reliability of the mathematics curriculum implementation should yield significant performance gains for the U.S. on the PISA in the coming years (Organization for Economic Co-Operation Development, 2012). Providing a new curriculum to address the decline in student achievement is one way at looking at the underachievement of US students compared to their international peers; however, research suggests an investigation into the critical transition years and reasons that cause a consistent decline in American student academic achievement (Eccles, 2004).

According to Anfara and Linka (2003) and Anderman and Maehr (1994), much of the decline in U.S. students' academic achievement occurs during the middle grades years. During these years, many students make decisions about their abilities to be successful as a result of their academic performance (Anderman & Maehr, 1994; Eccles & Midgley, 2008; National Council of Supervisors of Mathematics, 2010). Pajares and Schunk (2002) stated, "the beliefs that children create and develop and hold to be true about themselves are vital forces in their success or failure in all endeavors and, of particular relevance to educators, to their success or failure in school" (p. 2). Focusing on student interest, motivation, and skill development during the middle grades years can help promote greater overall student academic achievement (Eccles, 2004). Consquently, it becomes imperative to investigate the major changes that occur during the adolescent years that adversely impact student success and motivation in math and science.

Statement of the Problem

During the adolescent years, between the ages of 11 and 14, middle school students show a decline in academic performance in math and science (Eccles & Midgley, 2008; Flowers, Mertens, & Mulhall, 2003; Heller, Calderon, & Medrich, 2002). The decline in achievement is characterized by students' disengagement in their courses, particularly in math and science (National Council of Supervisors of Mathematics, 2010). As a result of their decline in achievement in these disciplines, students loose interest in math and science in high school and, consequently, do not engage in career fields which require the knowledge of these disciplines (Denissen, Zarrett, & Eccles, 2007; Fredricks, 2002). Females and ethnic minorities have been shown to demonstrate an even greater decline in a math and science achievement and. therefore, an increase in disengagement in math and science courses than their male counterparts (Fredricks, 2002). According to Flowers et al. (2003) and Heller et al. (2002), this decline in math and science achievement in the middles grades may be attributed to a number of variables including students doing the following: (a) adapting to new and more rigorous expectations, (b) adjusting to expectations for increased autonomy, (c) receiving less individualized interaction with one teacher for large portions of the school day, (d) having more classes and teachers to respond to, and (e) having more work to balance and keep record of.

Middle school students, particularly between the ages of 11 and 14, show a decline in academic achievement in math and science (Eccles & Midgley, 2008). Given this decline in performance, national, state, and local initiatives are focused on improving academic performance in middle schools. Hulleman and Harackiewicz (2009) indicated that students who do not attain academic success in middle school continue to decline academically throughout their high school years. As a result, many students develop psychological beliefs about their abilities to improve and resist opportunities to seek challenges that enhance their growth and learning potential (Anderman & Maehr, 1994; Fredricks, 2002).

Middle school reformers have developed interventions to increase student achievement in the areas of math and science. Many of these interventions have a science, math, technology, and/or engineering (STEM) focus. Despite the many interventions, students continue to show decline in achievement in these disciplines. This achievement decline mirrors the decline in students' desire to pursue careers or activities in math and science nationally (Campbell, Jolly, Hoey, & Periman, 2000). This problem of middle-schoolers showing a decline in academic achievement in math and science is one of considerable consequence and one that will continue to be a focus for researchers and current research. According to the Pajares & Schunk (2002):

> Many students have difficulty in school not because they are incapable of performing successfully, but because they are incapable of believing they can perform successfully—they have learned to see themselves as incapable of handling academic work or to see the work as irrelevant to their life. (p. 22)

One might surmise that these students may not believe they can achieve, may not put forth the effort to improve, and are unable to and therefore, cannot and/or do not reach their full academic potential.

As set forth by the National Council of Supervisors of Mathematics (2010), educators play an important role in improving the academic climate for students by assisting them in developing positive self-beliefs about their intelligence and academic ability. As described above, psychological intervention research indicated positive effects on increasing students' academic achievement during the middle school years (National Council of Supervisors of Mathematics, 2010; Blackwell, Trzesniewski, & Dweck, 2007; Nisbett, 2009). Given the psychological interventions showing positive effects on academic achievement, Blackwell et al., (2007) asked the question, "What are the psychological mechanisms that enable some middle-schoolers to face the challenges of middle school while others that have similar abilities become debilitated or unwilling to meet these challenges?" (p. 247). One such means of answering this question is to examine the effectiveness of psychological interventions that assist students in developing dispositions, skills, and strategies for addressing challenges in middle school.

Purpose of this Study

The purpose of this study is to examine the efficacy of the Brainology© program interventions. Through this examination, the researcher hopes to determine if these program interventions can positively impact middle school students' perceptions of their abilities and increase their academic achievement in math and science. The exploration of the psychological interventions that assist students in developing dispositions, skills, and strategies for addressing challenges in middle school is needed, particularly in the fields of math and science (Campbell, Jolly, Hoey, & Periman, 2000; Hulleman & Harackiewicz, 2009). Because the middle school level is a turning point in determining academic success in high school and beyond, it is imperative to determine middle school interventions that instill coping strategies and that build a student's sense of determination. Such interventions will hopefully ensure that students are able to help themselves learn and to respond positively when learning becomes a challenge.

Anderman and Maehr (1994) indicated students' beliefs about their math and science abilities can have a significant impact on their motivation in school. These researchers also showed that students' beliefs in their abilities in these subjects impacted their willingness to put forth effort, practice, and effective strategies in the face of academic challenges (Blackwell et al., 2007; Ericsson & Krampe, 1993). Students who have high beliefs about their abilities to improve are more likely to put forth effort, engage in opportunities to practice in areas where they need more development, and have higher achievement in comparison to grade-level peers who do not have these high beliefs (Dweck, 2010; Ericsson & Krampe, 1993).

Dweck (2008) supported the use of interventions that focus on building students' beliefs about abilities, effort, motivation, efficacy, and strategies for learning in an effort to increase student achievement. One of the interventions Dweck and Blackwell et al. (2007) supported is Brainology©. Brainology© is a neuroscience-based curricular intervention that teaches about the plasticity of the brain and how through learning one can develop new neural connections that over time improve academic ability and achievement when coupled with the use of study skills and practice.

Brainology© has been found to have a positive impact on teaching students (a) how the brain works, (b) how to use learning strategies to help develop their brains, and (c) how to achieve positive academic outcomes (Blackwell et al., 2007). Yet, further research is needed to determine the extent to which other variables such as student academic efficacy, mindset, ability to seek challenge, and effort beliefs may impact overall student achievement in math and science (Dweck, 1999; Dweck, 2010; Dweck &

Leggett, 1988).

Isolating and researching specific psychological variables that attribute to increased student achievement in math and science will help educators better understand the ways in which these interventions might best be used to improve students achievement (Dweck, 2010). Again, the purpose of this study is to test the efficacy of the Brainology© program interventions by determining if program interventions can positively impact students' perceptions of their abilities and increase their academic achievement in math and science. To date, there have been no published studies reporting the effects of this program on seventh-grade student achievement in math and science.

Background of District/Schools

This research study was conducted in a large, urban school district in the Piedmont Region of North Carolina (NC). This school district is one of the 100 largest school districts in the nation, having been formed by a merger between the city and county school districts in the 1960s. The district serves nearly 53,100 students in 44 elementary schools, 15 middle schools, 11 high schools, and 12 special schools. There are a total of 82 schools within the school district. The collective school district demographics for the 2012-2013 school year were as follows: 43% of students were Caucasian, 28.8% were African American, 21.6% were Hispanic, 3.9% were Multiracial, 2.3% were Asian, and less than 1% of students were American Indian or Native Hawaiian/Pacific Islanders (Helm, 2012).

The district has placed a strong emphasis and expectations on high student academic achievement. Over the past several years, many initiatives have been instituted that target teacher development and student improvement. Some of the student improvement initiatives include quarterly benchmark assessments in reading, math, and some science courses. Improvement initiatives within elementary schools include (a) a core-reading program, (b) teacher incentive grants to increase student performance in high-poverty/low-achieving schools, and (c) a focus on the use of professional learning communities, as a way to promote teacher collaboration.

There have been consistent transitions in the school district over the past year in preparation for the implementation of the Common Core State Standards for Language Arts and Mathematics, and the NC Essential Standards for all other subject content areas. The district has spent considerable staff development funds to address its critical priorities as they relate to transition support for teachers to implement the Common Core Standards and the NC Essential Standards curriculum. Despite the district spending funds to prepare staff for its critical priorities, they are faced with massive state budget cuts and pressure to increase student achievement in the lowest performing schools within the district, specifically, schools that have less than 50% of students who show proficiency in math, reading, and/or science.

Enrollment and demographic data. Ten of the 15 middle schools in the district were identified for inclusion in this research study. These 10 schools expressed an interest in participating in a research study measuring the psychological beliefs of students and the impact of these. However, seven of the 10 original schools participated for the duration of the study. Three schools decided not to continue participation in this research study. Table 1 describes the total student enrollment numbers for the participating schools in 2012-2013. The numbers in Table 1 illustrate the total student enrollment at each school at the onset of the research study.

Table 1

Middle School 2012-2013 Enrollment Data

School	Grade 6	Grade 7	Grade 8	Total Enrollment
A	255	345	276	876
B	280	258	252	790
C	392	416	425	1233
D	267	298	226	791
E	378	368	338	1084
F	331	310	298	939
G	274	231	202	707

Note. Data taken from the North Carolina Student Information system enrollment data sent via electronic correspondence by T. Helm (personal communication, December 12, 2013).

Student participants were in Grade 7 in the 2012-2013 academic year. School enrollment numbers were used to determine the number of students in the target grade-level for the research study. All seven of the middle schools that participated in this research study had student populations ranging from 707 students to over 1200 students.

Some of the grade-levels in these schools had about 250 students with no more than two teachers teaching the Grade 7 science curriculum while other schools had over 400 Grade 7 students and four or more teachers that taught Grade 7 science.

Table 2 shows the student ethnicity breakdown for the seven schools that participated in the research study. This demographic population sample illustrates larger ethnic minority populations in four of the seven middle schools.

Table 2

Middle School 2012-2013 Demographic Data

School	American Indian/ Alaskan Native	Asian	African American	Hispanic	Multi	Native Hawaiian/ Pacific	Caucasian
A	0.2%	3.1%	21.9%	24.9%	4.5%	0.00%	45.4%
B	0.0%	0.3%	36.3%	27.1%	4.6%	0.4%	31.3%
C	0.5%	1.5%	10.0%	19.5%	2.0%	0.0%	66.5%
D	0.0%	4.3%	10.1%	7.4%	3.6%	0.1%	74.5%
E	0.1%	0.7%	33.2%	29.1%	3.2%	0.0%	33.7%
F	0.5%	2.6%	18.0%	10.8%	4.8%	0.2%	63.2%
G	0.0%	1.7%	56.8%	10.1%	5.2%	0.0%	26.3%

Note. Data taken from the North Carolina Student Information system enrollment data sent via electronic correspondence by T. Helm (personal communication, December 12, 2013).

Schools E and F have the largest percentages of minority students with more than 60% of the school's population labeled as minority, while schools C, D, and F had more than 60% of students identified as Caucasian. All seven schools had low numbers of students classified as American Indian/Alaskan Native, Asian, Multi-racial, and Native Hawaiian/Pacific Islanders.

Overview of student achievement data. The Education Value Added Assessment System (EVAAS) uses formulas to calculate each school's level of student academic growth in specific subject areas (SAS Institute, 2013). Each school received a composite index score, a growth status, and a performance composite. These scores compared how students in each school performed compared to other students across the state. Table 3 provides information about the three indicator levels schools received comparing student performance in various subject areas.

Table 3

Effectiveness Levels: Rules for Level Determination

Indicator Level	*Descriptor*
Exceeds Expected Growth	Exceeds Expected Growth: Students are Progressing substantially more than the state growth standard/state average (the school's index is 2 or more.)
Meets Expected Growth	Meets Expected Growth: Students are making the same amount of progress as the state growth standard/state average (the school's index is equal to or greater than -2 but less than 2)
Does Not Meet Expected Growth	Students are making substantially less progress than the state growth/standard average (the school's index is less than -2)

Note. Information taken from the North Carolina Department of Public Instruction EVAAS School Accountability resource support page (SAS Institute, 2013)

These indicator levels are shown by the various colors and shaded on the various charts referenced in this chapter to provide a clearer picture of the schools comparative standings to other schools from 2011-2013 (SAS Institute, 2013).

Table 4 provides the seven participating schools' overall achievement data from 2011-2012 and reflects the percentages of students receiving free and/or reduced lunch, teacher turnover, and student mobility rates. This data is illustrative of the current state of each of the schools at the beginning of this research study. Almost half of the schools served student populations where approximately 50% were economically disadvantaged. The data also shows the schools that have higher rates of student mobility and teacher turnover.

Table 4

Middle School 2011-2012 School Overview

School	2012 F/R Lunch	2011-12 Teacher Turnover	2011-12 Student Mobility	2011-12 Composite Index	School Growth Status	2011-2012 Performance Composite
A	49.3%	13%	9.39%	-0.4	Met	76.6
B	66.4%	15%	12.88%	-4.8	Not Met	64.7
C	29.7%	19%	6.82%	-3.1	Not Met	90.4
D	40.0%	12%	9.96%	-2.3	Not Met	78.1
E	24.2%	7%	8.94%	-2.7	Not Met	92.4
F	69.1%	18%	13.52%	0.5	Met	73.7
G	53.4%	13%	15.37%	-6.1	Not Met	76.3

Note. Data provided by electronic correspondence with T. Helm (personal communication, December 12, 2013) and M. Ward (personal communication, November 25, 2013).

In 2011-2012, two of the seven schools that participated in the study had students meeting growth expectations for overall student performance while the other five schools did not meet student growth progress expectations for students in the school compared to students throughout the state. Additionally, five of the seven schools had negative performance composite indexes related to student growth, indicating that several students within the school are not performing academically as high as predicted by value-added measures used to determine student academic growth.

Since beginning this study, additional data has been released (NC Research and Evaluation and District Public Relations Department, 2013) regarding school level performance. This data represents the state of the schools at the conclusion of this research study, the end of 2012-2013 academic year. Table 5 illustrates the 2012-2013 collective academic performance and overall state of the seven participating schools.

Table 5

Middle School 2012-2013 School Overview

School	2013 F/R Lunch	2012-13 Teacher Turnover	2012-13 Student Mobility	2012-13 Composite Index	School Growth Status	2011 ABC Performance Composite
A	52.05%	*ND	*ND	3.18	Met	44.0
B	72.03%	*ND	*ND	-5.95	Not Met	27.6
C	32.15%	*ND	*ND	3.35	Met	66.3
D	40.18%	*ND	*ND	-0.11	Met	47.4
E	22.58%	*ND	*ND	-1.89	Met	63.6
F	69.50%	*ND	*ND	4.64	Exceeds	33.5
G	55.28%	*ND	*ND	-2.49	Not Met	47.2

Note. *ND= No Data available. Data has not been released for these areas.
Data provided by T. Helm (personal communication, December 12, 2013), M. Ward (personal communication, November 25, 2013), and North Carolina Department of Public Instruction (2008).

This new data is indicative of the new requirements of the Common Core State Standards and North Carolina state exams. These new assessments were aligned to the new curriculum standards implemented in 2012-2013. Assessments administered in 2012-2013 had increased expectations for student performance and increased rigor as indicated by the level at which students were expected to perform. The schools' overall achievement performance composite indicated that one of the seven schools exceeded student growth expectations, four schools met student growth expectations, and that two schools did not meet student performance progress expectations. What is also interesting to note is that school performance composites decreased significantly as compared to the

2011-2012 school composite numbers. This change is a result of the more rigorous accountability expectations.

Higher student outcome expectations for proficiency in math and science are direct results of the National Race to the Top Initiative, Results of the North Carolina Blue Ribbon Commission on Testing and Accountability, and the North Carolina Ready Initiative for higher standards for student proficiency on state assessments. One of NC's key and priority goals is to produce globally competitive students (North Carolina Department of Public Instruction, 2008). This goal requires students to show higher levels of proficiency for understanding grade-level content. This push for students to meet more stringent criteria on standardized assessments is in direct response to the comparison of United States' student achievement compared to student achievement in other nations. The Organization for Economic Co-Operation Development (2010, 2012) highlighted the lagging performance of US students on assessments of grade-level core skills and concepts.

Since the focus of this study is on student performance in math and science as it relates to psychological interventions to improve achievement, Table 6 illustrates the academic achievement for Grades 6-8 in the participating schools in math.

Table 6

Middle School 2010-2013 Math Achievement Data

School	Grade Level	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
A	06	75.1	87.1	85.7	78.6	33.6
A	07	73.6	80.4	82.8	80.4	35.7
A	08	74.6	81.4	86	85.8	33.9
B	06	66.7	75.1	72.6	66.2	19
B	07	76.3	71.9	70.7	71.4	18.6
B	08	65.5	81.3	85.5	77.4	16.7
C	06	>95	94.8	>95	94.8	63.1
C	07	>95	94.2	>95	91.3	65.1
C	08	92.6	>95	>95	95.0	54
D	06	76.3	82.3	78.8	78.0	37.6
D	07	81.3	78.9	87.5	82.3	37
D	08	83.9	83.9	81.4	88.3	38.9
E	06	89.3	>95	94.7	94.4	54.5
E	07	91.6	89.9	92.3	91.9	49.5
E	08	90.6	95	94.9	95.7	45.2
F	06	75.2	81.6	81.3	73.8	26.8
F	07	76.3	83.2	85.6	77.2	22.4
F	08	81.4	84.5	82.9	87.1	23
G	06	79.4	81.4	74.2	77.9	38.8
G	07	76.8	90.7	86.7	79.3	44.6
G	08	79.6	91.9	87.2	78.2	31.6

Note. Data provided by T. Helm (personal communication, December 12, 2013) and M. Ward (personal communication, November 25, 2013).

Overall performance for math showed a positive trend in math academic achievement (with exception to the data from the 2012-2013 academic year due to new assessment norms). Though math achievement showed positive trends, students' collective proficiency in math performance had not increased holistically for all middle schools represented.

Performance scores in math in Grades 6 and 7 do not show scores as positive as those shown for students' in eighth grade. The majority of schools show decreases in achievement from Grade 6 to Grade 7 in mathematics. The mathematics performance in 2011-2012 among the participating schools ranged from 71.4% in Grade 7 (School B) to 91.9% for seventh graders in School E. These data illustrate almost a 20% disparity in mathematics achievement among the participating schools.

Table 7 illustrates the academic achievement for eighth graders in science. These scores represent the only science scores that existed prior to 2012-2013 (North Carolina Department of Public Instruction, 2008). Table 7 illustrates the composite scores for the academic achievement of eighth graders in science.

Table 7

Middle School 2010-2013 Grade 8 Science Achievement Data

School	2009-2010	2010-2011	2011-2012	2012-2013
A	71.5	76.6	78.2	63.7
B	48.3	57.1	67.9	49.2
C	90	91.7	90.0	73.8
D	67.1	70.8	78.8	68.1
E	93.4	92	95.1	89
F	86.5	85.7	87.1	56
G	77.9	78.9	72.2	48.5

Note. Data provided by the Department of Research and Evaluation and District Public Relations Department (2013).

These data show a positive trend in science scores over the years (with exception to the data from the 2012-2013 academic year due to new assessment norms). Student performance in 2011-2012 ranged from 67.9% to 95.1% proficiency. Like math, there is an achievement gap among the participating schools of about 27% in science.

The first Grade 7 science common exam assessments were administered in the spring of 2013. These assessments purported to measure students' academic growth in science and ensure teacher accountability for teaching the North Carolina Essential Standards core curriculum. As seventh-grade science classrooms were the focus of this research study, the science data from the 2012-2013 science common exams can be found in Table 8. Students in each of the seven schools either met or exceeded growth expectations in science as compared to other Grade 7 students across the state.

Table 8

Middle School 2013 Grade 7 Science Common Exam Data

School	Grade Level	2013 Student Mean Percentile Score	2013 School Effect Score	School versus State Average
A	07	52	2.1	Exceeds
B	07	44	1.3	Exceeds
C	07	67	-0.2	Meets
D	07	60	3.0	Exceeds
E	07	72	2.9	Exceeds
F	07	43	0.8	Exceeds
G	07	65	3.1	Exceeds

Note: Data provided by the Department of Research and Evaluation and District Public Relations Department (2013).

Theoretical Framework

This study adds to the current body of knowledge about academic achievement in middle grades in math and science. It builds on the social and psychological research about how motivational and cognitive components impact academic performance (Pintrich & De Groot, 1990). Motivation and self-regulated learning are expected components of academic achiement and performance (Blackwell et al., 2007; Garcia & Pintrich, 1991). For purposes of this study, the cognitive components to be examined include (a) academic efficacy; (b) implicit theories of intelligence, i.e., mindset; (c) effort beliefs; and (d) interest, engagement, motivation, and task value (Pintrich & De Groot, 1990). Each psychological variable has an impact on another psychological variable that can lead to positive or negative outcomes in students' math and science achievement (Garcia & Pintrich, 1991). The purpose of this study is to examine the efficacy of the Brainology© program interventions in positively impacting the academic achievement of middle schoolers in math and science. In examining these program interventions, this research also delves into psychological constructs related to actualized effort, task choice, persistence, and student remediation strategies for learning (Blackwell et al., 2007).

To examine the impact of each of these variables requires using a framework for thinking about the impact of one construct on another. The variables mentioned above have an impact on overall student achievement in math and science. This study will investigate the relationship among these variables and build upon this theoretical framework. This framework illustrates the inverse (+ or -) relationships between variables that contribute to student academic achievement.

This framework illustrates that if a student's academic self-efficacy, mindset, effort beliefs, interest and motivation in science, task value and persistence, and learning strategies are low, then the result will be lower student achievement; the inverse occurs when these variables are high for a student. For example, if student efficacy is high, student mindset will be high, and those students are more likely to put forth more effort to academic tasks and use specific strategies for learning; therefore, their academic achievement in math and science will likely be high. For a student for whom these variables are low, the resulting expectation is lower academic achievement. Figure 1 presents the theoretical framework from which the study will be undertaken.

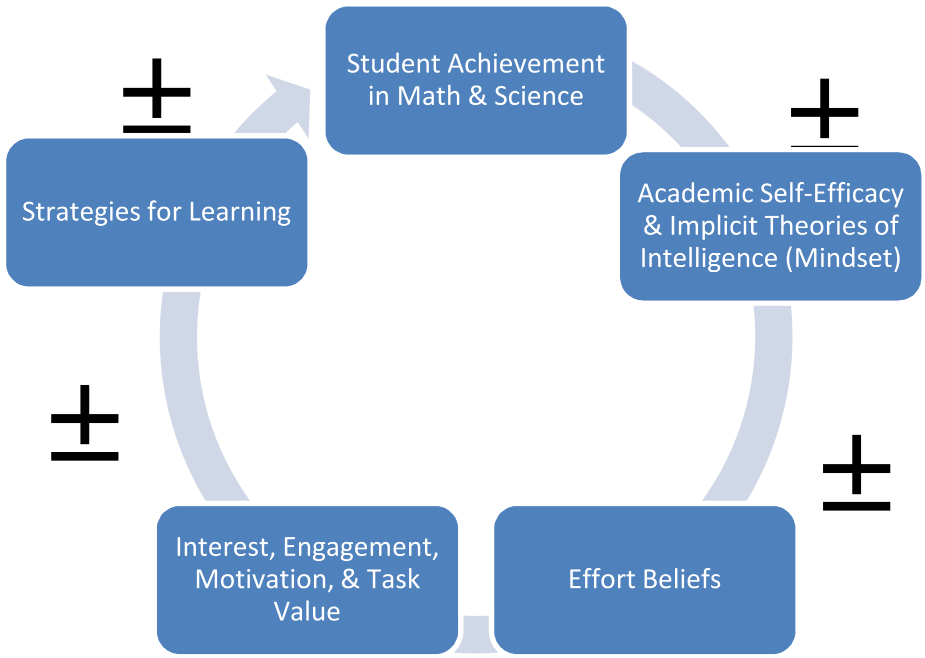

Figure 1. Theoretical Framework. This framework shows the relationship between student achievement and other constructs (self-efficacy, mindset, effort beliefs, interest and engagement, and strategies for learning). The relationship is cyclic (i.e., achievement is high then constructs are high and vice-versa).

Student academic efficacy undergirds the idea that a student has the capability to be successful in learning new information or skills (Bandura, 1997). A student's mindset comes into play after the student has determined their capability; their mindset determines if they believe they have the ability to change their level of achievement (growth mindset) or if they are predetermined to remain at a fixed or pre-determine level (fixed mindset) (Dweck, 2007). Based on their mindset, students determine the level of effort they will exert toward the study or practice of a new skill, which is also dependent upon the student's motivation, interest, and value levels they attribute to learning content/information in class (Liem, Lau, & Nie, 2007). When students have high interest/engagement in class and see value in what they learn, they are more willing to put forth effort to learn more information (Dweck & Sorich, 1999). This effort can manifest itself in the use of learning/study skills strategies that foster improvement (Pintrich & Schrauben, 1992).

Definitions of Terms

There are several definitions that need clarification to better understand the variables measured in this study. For the purposes of this study, the following definitions serve as the framework for defining the manner in which these constructs are measured and reported for this study.

Academic self-efficacy. A student's beliefs and perceptions of their abilities. The construct of self-efficacy will be measured by students' beliefs in their abilities to achieve academic success in math and science (Midgley et al., 2000).

Brainology©. A research-based intervention designed to teach about the neuroplasticity of the brain with the goal of developing growth-mindset oriented thinking in students (Mindset Works, 2002-2011).

Challenge-seeking. A student's choice of a task that has the potential to offer new opportunities for learning (Dweck & Leggett, 1988).

Effort beliefs. The degree of willingness a student/teacher puts forth additional practice with a skill or concept with the goal of improvement in that area (Dweck & Sorich, 1999).

Effort investment. The amount of energy, commitment, time, and/or study a student must exert in order to complete an assignment or task (Dweck & Leggett, 1988).

Elaboration strategies. These are methods such as summarizing and paraphrasing which help students learn new information.

Fixed mindset (entity theory). Belief that intelligence/ability is a fixed trait.

This belief supports the idea that we get a certain amount intelligence/ability that dwells within us and we do not have the ability to change or alter that pre-determined level (Dweck, 2000).

Growth mindset (incremental theory). Belief that intelligence/ability can be cultivated through learning and the amount of effort one puts toward improving in an area or skill leads to improved development in an area (Dweck, 2000).

Helpless response/performance avoidance. A student's withdrawal of effort or the avoidance of a task, due to a belief they are unable to perform the task (Bempechat, London, & Dweck, 1991).

Implicit theories of intelligence. Beliefs individuals hold about their intelligence, abilities, traits, or characteristics. This construct is commonly coined as a person's *mindset* (Dweck, 2000).

Mastery goal orientation. A student's willingness to persist to increase his/her ability or potential through developing competence through practice of a skill (Dweck & Leggett, 1988).

Neuroplascity. An idea which emphasizes malleability of the brain and that the brain can adapt to learn new ideas and concepts over time (Dubinsky, 2010).

Organizational strategies. These strategies are things such as developing outlines or tables that allow students to think more deeply about the content to be learned.

Performance goal orientation. A student's expectation to prove how smart or competent he/she is when faced with providing his/her skill on a specific task.

Personal teaching efficacy. The degree to which a teacher believes that he or she can positively impact student learning outcomes (Midgley et al., 2000).

Rehearsal learning strategies. These are the methods used by students to repeat and memorize information.

Strategies for learning. Methods that are used to process and learn new information. These strategies include Rehearsal, Elaboration, and Organization strategies (Pintrich & Shunk, 2002).

Student achievement. This is an indicator of student academic performance in math and science as measured by various assessment measures such as benchmark tests, as well as student end of quarter grades in math and science.

Student motivation. A student's desire to improve that is driven by the student's mindset.

Task value. The extent to which a task, assignment, or subject has practical value and if the task has potential to have personal or academic learning benefit (Miller & Brickman, 2004).

Significance of the Study

Given that middle school is a pivotal point for predicting academic success in high school and beyond and that middle school helps students determine the career choices that best match their skills and abilities, addressing student motivation and learning in science and math subjects in the middle school years is critical (Denissen et al., 2007; Schmader, Johns, & Barquissau, 2004). According to American College Testing (ACT, 2008), middle school achievement has a larger effect in predicting college and career readiness than anything that is assessed in high school. This study undertakes an examination of how psychological-based interventions can be used in a specific context and the degree to which these interventions may positively impact student achievement in middle school in a large urban school district.

Learning and studying this information will assist educators, teachers, and other professionals working with middle schoolers in better understanding why students are not succeeding in certain academic disciplines. This research determined if students' beliefs about their intelligence, effort, motivation and interest in science, and academic self-efficacy played a role in their academic achievement in math and science. It is important for school districts to uncover these relationships in order to improve training, support, and strategies to increase higher student academic outcomes in these fields. It is also important to determine if providing information to students about how the brain operates can improve their motivation, persistence in the face of academic challenges, and ultimately, their academic success.

Summary

This study adds to the current body of research knowledge on the following: implicit theories of intelligence; effort beliefs; student academic self-efficacy; student interest, motivation, and engagement in math and science; and the use of study-skill strategies to practice and improve when the content in math and science becomes difficult. This research study replicated the use of several research instruments from previous research studies, yet none of these instruments had been exclusively used in the same manner in all previous research studies. These instruments were used to measure student beliefs about their academic self-efficacy, implicit theories of intelligence, effort beliefs, interest and engagement in science, and task value in science. These instruments, along with the use of the Brainology© intervention, added to the knowledge-base about ways to increase student interest and achievement in math and science. In addition, this study used pre- and post-test measures as a way to identify changes in participants after implementation of the interventions. Focus groups were used to enhance the understanding of the impact of the Brainology© intervention on both teachers and students. The qualitative data from the focus groups helped to add a deeper understanding of how these interventions and specific measures may best be utilized by students and also how educators can implement strategies within their classrooms and better use the Brainology© program to support student psychological beliefs about their abilities in order to improve their overall academic performance in all school subjects.

Chapter 2: Literature Review

Introduction

The past 35 years have been marked by an era focused on student performance in the United States, with a particular focus on increasing student achievement in math and science. This is evidenced by *A Nation at* Risk (1983), a report published by the Reagan administration in response to the National Commission on Excellence in Education's (1983) announcement that U.S. educational attainment levels were less than mediocre. In this report, American students were compared to students in other industrialized countries based on several academic assessments in reading, math, and science. On these assessments, the U.S. scored last in seven of 19 assessments. This report also highlighted the sharp decline in SAT scores and the need for improved performance and more accountability in K-12 public education. Additionally, the Nation at Risk Report declared that high school graduates were not ready for the workforce.

In response to this report, succeeding presidents also placed priority on reforming education. Many of the recent reforms have placed high emphasis on reforming high school performance. Research supports the fact that many students determine if school is a place they can be successful by middle school years and especially determine how successful they can be in subjects such as math and science (Anderman & Maehr, 1994; Anfara & Linka, 2003; Eccles & Midgley, 2008; Rattan, Good, & Dweck, 2012). Since there is a need to reform public education, re-evaluating the focus and level of support provided during the middle-grades transition is essential.

The middle school years are marked by normative increases in anti-social behavior and declines in self-esteem, school engagement, and grades (Eccles, 2004; Eccles & Midgley, 2008). The middle grades focus on competition, social comparison, and ability self-assessment, as students begin to identify their limits and capabilities. Many students respond by asking questions and/or making statements such as: (a) Can I do the work? (b) Will my friends like me? (c) Why can't I learn this? and (d) This is too hard—I give up!

This period of intense change causes some students to persevere and put forth high levels of effort to succeed while others withdraw from exerting effort and disengage from the school experience (Blackwell et al., 2007). How students accommodate for the changes in the middle grade years has great implications for their academic trajectories (Anderman & Maehr, 1994; Blackwell et al., 2007).

Researchers have been interested in figuring out why some students are resilient and able to meet the challenges of the middle grades transition (Anfara & Linka, 2003; Flowers et al., 2003; Wigfield & Eccles, 2002). Since middle school students face challenges during the transition from elementary to middle and again during the transition from Grade 6 to Grade 7, determining the factors and variables that attribute to their academic achievement or decline is critical.

Casillas, A., Robbins, S., Allen, J., Kuo, Y.-L., Hanson, M. A., and Schmeiser, C. (2012) found factors other than grades and abilities such as psychological and behavioral factors that predict student success in high school. His study examined prior academic achievement, demographic, behavioral, and psychosocial factors (motivation, self-regulation, social control). The purpose was to predict the level of student performance in high school as measured by grade point average (GPA). Almost 5,000 middle school students from over 24 schools were followed during their transition from middle to high school. This study confirmed that once a student's pre-high school academic achievement is factored, there is little relationship among high school variables that determine future levels of academic achievement. This study suggested that high school grades and academic failure are determined, to a degree, by middle school academic achievement. This study also confirmed that psychosocial and behavioral indicators contribute to future student academic performance and success. At the conclusion of this study, the author makes recommendations about the need for developing intervention programs that support students showing signs of academic failure in the middle grades.

Review of Literature

This chapter provides an overview of the psycho-social research factors that contribute to student achievement outcomes. These constructs have been identified in the research from several psychological and educational researchers as the following: academic self-efficacy, personal teaching efficacy, implicit theories of intelligence, effort beliefs, motivation and task value, task choice and persistence, strategies for learning, and neuroplasticity. These constructs are embedded in the design and development of the Brainology© Program, created by Mindset Works, Inc. (2011). This program focuses on teaching the function and processes of the brain along with learning strategies which assist students in increasing effort and improving learning outcomes. The overall goal of the Brainology© program is to assist students in increasing their academic achievement while engaging them with psycho-social tools and strategies to help them grow academically. This chapter will provide an overview of these constructs and the Brainology© program.

Academic Self-Efficacy

The term academic self-efficacy or academic efficacy was defined by Schunk (1991) as an individual's perception that they can successfully perform given tasks at specific levels. The term academic concept is closely related to academic efficacy but differs slightly. Academic concept refers to an individual's knowledge about themselves which determine their perceptions of the levels to they can be successful in specific academic situations (Wigfield & Karpathian, 1991). This slight distinction may explain why some students believe they can be confident in solving equations with square roots (academic efficacy) but believe that they are not good at math (self-concept) (Ferla, Valcke, & Cai, 2009). The idea that one can have confidence in their capability to perform specific tasks within a discipline but lack the belief in their ability to be successful holistically in this domain is something that occurs frequently as students relate their perceptions to their abilities to achieve success, especially in the disciplines of math and science (Denissen et al., 2007).

Both student academic efficacy and student academic concept are derived from *perceived capability* to perform either a task or do well in a subject at a particular time (Zimmerman, 1995). Bandura (1986) defined perceived capabilities as, "types of outcomes people anticipate [that] depend largely on their judgments of how well they will be able to perform in given situations" (p. 392). According to Bandura (1997), efficacy beliefs have an impact on effort, persistence, and activity choice. Research regarding self-efficacy illustrates that academic self-efficacy is a stronger predictor of academic success than ability (Britner & Pajares, 2006; Usher & Pajares, 2008). This research also supports the idea that students with high self-efficacy in science performed better academically in science than students with the same ability but who had lower self-efficacy in their abilities to perform well in science. In math, students with high academic efficacy persisted when problems were challenging and they showed greater achievement on standardized measures (Blackwell et al., 2007; National Council of Supervisors of Mathematics, 2010).

Students who have a higher sense of self-efficacy set higher goals for academic achievement. Setting these goals creates adaptive responses in how they react when obstacles are encountered (Bandura, 1997; Pintrich, 1990). An adaptive response is characterized by seeking challenge and persisting in the face of obstacles. By contrast, students who have a lower sense of academic efficacy tend to use maladaptive responses when they encounter challenges. Maladaptive responses are characterized by avoidance of challenge and low persistence in the face of difficulty (Dweck, 1986). Students who use maladaptive responses perceive they will be unable to meet these challenges and tend to give up on a task for fear that the task is mismatched with their capabilities (Baird, Scott, Dearing, & Hamill, 2009).

Bandura (1997) noted that self-efficacy beliefs influence whether students think effort in the learning task will secure the desired outcome. Bandura stated, “People do things that give them self-satisfaction and a sense of self-worth” (p. 8). Research supports that student efficacy can be influenced by the classroom environment, teachers’ attitudes, and teachers’ interactions with students. Teachers’ views about their own capabilities can influence the levels at which they perceive they can positively impact achievement in students (Henson, 2001).

Personal Teaching Efficacy

Just as students have beliefs about their capabilities, a teacher’s sense of efficacy or competence perceptions can either help children maximize their learning potential or serve as a deterrent to student academic improvement. Hoy (2000), defined teacher efficacy as a teacher’s confidence in their abilities to promote student learning. Teachers that have high levels of teaching efficacy believe if they try very hard, they can help highly unmotivated and reluctant learners experience academic growth (Henson, 2001).

During this high standards-based accountability era, it is important to have teachers that believe not only that all children can learn but also that they play a key role in insuring that learning occurs (Chetty, Friedman, & Rockoff, 2011). Teacher ownership in the student learning process is an essential element to building a positive academic environment for students (Hoy, 2000). Teachers with strong levels of teaching efficacy are more persistent and resilient when things do not go smoothly during classroom instruction and are more likely to teach these character traits to their students. These teachers are less likely to criticize students when they make mistakes and are less likely to refer students to special education or remove students for minimal disruptions in class (Protheroe, 2008). These teachers are also likely to try another strategy when one approach is ineffective and have high expectations that all their students will learn (Shaughnessy, 2004).

According to Bandura (1997), in self-efficacy theory an individual creates their belief system via several methods of information: (a) enactive mastery, (b) experience, (c) vicarious experience, (d) verbal persuasion, and (e) social persuasion states. Within the realm of teaching, an inactive mastery experience would occur from a teacher learning *how to teach*, during the teaching process or the accomplishment a teacher feels that comes from the satisfaction of learning how to teach students effectively. A vicarious experience would be insights that teachers gain from observing other teachers model new methods and strategies. Verbal persuasion is similar to the knowledge a teacher gains through mentoring experiences or by talking with other veteran teachers. Vicarious experiences, though not a direct result of a teacher's own instructional experiences, help teachers develop expectations about what should occur in the classroom because they have observed or experienced these things. These experiences can provide teachers with effective ways of promoting student learning to the extent that they feel confident that through the use of these vicarious experiences, they can positively impact student learning. In addition to vicarious experiences, teacher efficacy is influenced by social persuasion. Social persuasion includes the positive conversations and feedback that teachers receive that highlight constructive ways for improving student learning outcomes (Bandura, 1997). This vital feedback helps teachers see how close they are to engaging and fostering student improvement. Collectively, engaging in the act of teaching, observation experiences, and evaluation opportunities help teachers develop discernments about their potential to effectively reach and teach students (Henson, 2001; Hoy, 2000; Wagler, 2011).

In addition to the various states that influence teacher efficacy, Bandura (1977) stated that individuals develop performance accomplishments based on perceived achievement or failure during their teaching experiences. These accomplishments or failures influence their perceptions about the level at which they can personally make a positive difference. For teachers, these performance accomplishment perspectives help them decide if they believe they can positively impact student-learning outcomes.

Both academic efficacy and personal teacher efficacy are wrapped up in beliefs about one's capabilities. People make judgments about the degree to which they can shape and control their outcomes in a positive way. The beliefs about an individual's levels of control and capacity to affect outcomes are tied to one's views about individual attributes (i.e., perceptions of ability, intelligence, personality, etc.) (Dweck, 1986; Dweck, 2008; Dweck & Leggett, 1988).

Implicit Theories of Intelligence (Mindset)

Building on the efficacy work of Bandura, other psychologists have worked to foster a better understanding of self-efficacy by expanding theories about individuals' beliefs. Molden and Dweck (2006) indicated that it is necessary to explore what "fundamental assumptions about the nature of the self and the social world influence a person's perception" (p. 195). In order to figure out these fundamental assumptions, researchers have identified the behavioral and emotional effects of viewing personal characteristics, such as an individual's perceptions of ability, intelligence, and personality, to name a few. According to Dweck (1999), these individual perceptions fall into one of two categories: those that are permanent static traits or those that can be developed.

Like the idea of academic self-efficacy, theories of intelligence are based on an individual's perception, but there are differences between academic self-efficacy and theories of intelligence. Academic self-efficacy focuses on confidence in one's capabilities to master new skills and tasks (I can or can't master this) while theories of intelligence looks at individuals' perceived abilities of confidence (I don't have the ability to do this). Comparing academic self-efficacy to theories of intelligence would be similar to one student that might say, "I am confident I can master the skills in science this year, if I try" (academic self-efficacy) versus the student that might say, "I can never be good at science; my brain is not wired that way" (theory of intelligence) (Friedel, Cortina, Midgley, & Turner, 2010).

Individuals vary in their views about intelligence. There are two primary theories about intelligence (Dweck, 1986; Dweck, 1999; Dweck, 2006). People either believe in the entity theory of intelligence (fixed mindset), which supports the idea that you have a certain amount of intelligence, a *fixed entity* or static amount that does not change. Other individuals support the idea of the incremental theory of intelligence (growth mindset), believing that intelligence is “malleable” or can be developed through learning, new experiences and through effort (Dweck, 2000, p. 20). Table 9 illustrates ways individuals with fixed and growth mindsets respond to challenges, obstacles, effort, criticism, and the success of others.

Table 9

Comparison of Fixed and Growth Mindset

Perspectives	Fixed Mindset	Growth Mindset
Challenges	Threat to intelligence	Improve abilities
Obstacles	Give up easily	Persist in the face of setbacks
Effort	Not worth the investment	Path to improving or mastery
Criticism	Ignores feedback	Learns from feedback
Success of Others	Threatened by others successes	Finds lessons and inspiration in success of others

Note. Chart adapted from graphic developed by Nigel Holmes.

The idea of the malleability of intelligence has most recently been termed as the growth mindset (Dweck, 2006). According to Blackwell et al. (2007), “believing intelligence to be malleable does not imply that everyone has exactly the same potential in every domain, or that one will learn everything with equal ease. Rather, it means […] intellectual ability can always be further developed” (p. 247).

In school, students’ theories of intelligence shape how they respond when learning becomes challenging and when their existing abilities exceed the expectations of a current task, especially in math and science (Blackwell et al., 2007; Hong, Chiu, Dweck, Lin, & Wan, 1999). These beliefs impact how much effort, engagement, and persistence one will put towards the completion of a task. Dweck (2000) compares a student’s willingness to expend effort on a school task that is challenging to academic self-efficacy. According to Dweck (2000; 2006), academic self-efficacy is directly correlated with ones views about intelligence.

Previous research supports that a relationship exists between student beliefs about intelligence and student academic achievement (Aronson, Fried, & Good, 2002; Bempechat et al., 1991; Blackwell et al., 2007; Fredricks, 2002). Social psychologists have proven that an individual's mindset plays an important role in helping them meet specific goals and expectations. A person's theory of intelligence shapes how they approach learning, challenges, and respond to their environment (Bempechat et al., 1991; Dweck, 1988; 1999; 2010).

Blackwell et al. (2007) found several factors that correlated with student academic achievement in the middle school context. Those factors included a student's beliefs about their capability to achieve, academic efficacy, and the student's perceptions about the probability to achieve through effort, practice, and hard work. This longitudinal research study involved the use of two different study group approaches to predict student achievement across the transition during the middle grades years. In the control group of the research study, groups of 6th grade students' beliefs about intelligence were assessed and their academic performance was tracked over the course of Grades 6, 7, and 8. Other variables assessed for the control group population included learning goals, positive effort beliefs, performance avoidance, and positive strategies for learning.

In the experimental group, students' beliefs about intelligence were pre-assessed as well. These students received an intervention that taught them how they could improve their abilities over time with hard work and practice. Motivation and achievement were also assessed for this population. The results indicated that the students involved in the experimental group showed no decline in math performance or grades after the intervention in comparison to the control group that showed a decline in achievement over the course of the study. This study confirmed that students who had a belief in the developmental capacity of intelligence showed higher academic achievement in their mathematics courses.

Effort Beliefs

A central point in the growth mindset theory is the role that effort plays in improvement. Psychological research supports that the distinguishing factor between those that succeed at the top of their fields, making valuable contributions, and those with similar ability, but unable to attain success by making contributions, is the effort they put forth in their work (Ericsson, Charness, Feltovich, & Hoffman, 2006). Pushing forward and persisting in the face of adversity are what Duckworth, Peterson, Matthews and Kelly (2007) call *grit*. According to Duckworth et al. (2007), grit is the development of perseverance and passion towards the accomplishment of long-term goals. Effort beliefs and grit center on a willingness to engage in remedial work, learning strategies, or practice, with the goal of improving (Hong et al., 1999). As several studies have shown, it is not IQ that predicts how successful individuals become, but it is the intestinal fortitude and continuous practice that allow some individuals to become *masters* over time (Bloom, 1985; Duckworth et al. 2007; Winner, 1996). These studies provide insight and evidence that suggest that perseverance in accomplishing one's goal may be as essential as intelligence and/or talent. There are other authors that refute that perseverance and passion are key factors in success. According to Gladwell (2008), *outliers* have *gifts* they have been provided that help foster their success. These gifts may come in the form of institutional, familial, demographic, or cultural ties. These individuals are able to access success through *accumulated advantage*, which is made possible by arbitrary rules—age, location of school zone, and attendance. Though

Gladwell (2008) argues these gifts are what may seem like unfair advantages to success, he does not negate that hard work and effort are also components of those that have achieved imminence. Ultimately what many of these authors conclude is that success of an individual is dependent upon whether effort beliefs are positive or negative.

As it relates to school achievement and success, a positive effort belief is a willingness to engage in study and practice to improve skill. A negative effort belief indicates an unwillingness to engage in study or practice for improvement (Dweck & Sorich, 1999). Performance goal orientations support negative effort beliefs by encouraging the idea that putting forth effort to practice is a waste of time because expending effort is futile if you do not have the ability (Dweck, 2007). Students with performance goal orientations avoid demonstrations of low ability and tend to have low task persistence (Dweck & Sorich, 1999; Midgley et al., 2000). An individual's efforts beliefs can be influenced by their type of goal orientation.

There are two primary types of goal orientation—performance goals and mastery goals (Dweck & Sorich, 1999). Performance goals are ones that focus on an individual's competence in relation to others, while mastery goals focus on an individual's competence in relation to the current task (Dweck, 1986; Dweck & Leggett, 1988; Hong et al., 1999). The performance goal-oriented student wants to show how smart he or she is in relation to everyone else, while the mastery goal oriented student wants to practice and improve for the sake of learning something new. There are other students who take a somewhat different approach to goal orientation; these students respond with a performance avoidance goal-oriented approach, also known as the helpless response. These students withdrawal effort and avoid a task due to the belief that they are unable to perform the task (Bempechat et al., 1991). The difference between the student who has a performance goal orientation and a performance avoidance goal approach is that the student with the performance avoidance approach exhibits lower self-efficacy and chooses not to engage in a task for fear of failure. Those with a performance goal orientation engage in a task only when they know they will be successful (Harackiewicz & Elliott, 1993; Ames, 1992). The performance goal oriented student gets fulfillment from *looking smart* while the performance avoidance goal student does not engage due to fear of failure. The student with a mastery goal orientation accepts the challenge of a task, despite whether they will succeed, with the hopes of actualizing improvement and growth toward the goal (Dweck & Sorich, 1999; Svinicki, 2005).

Deci and Ryan (2002) defined *perceived competence* as the perception of the ability to achieve (p. 11). More insight is provided about the connection between one's theory of intelligence, goal orientation, perceived competence, and behavior outcomes (Figure 2).

Figure 2. Achievement Goals and Achievement Behavior. This chart was developed based on information from Dweck (1986) Motivational Processes Affecting Learning.

The fixed mindset individual is most often motivated by performance goals while the growth mindset is motivated by mastery goals. Janzow and Eison (1990) referred to students with a performance goal orientation as having a grade orientation (working for a grade) while students with a mastery orientation were known as having a learning orientation (working to learn and get better). Janzow and Eison's theory supports the idea that those with the mastery goal orientation will put forth a lot of effort in an attempt to master a new skill or concept.

According to Deci and Ryan (2002), "When an event increases perceived competence, intrinsic motivation will tend to be enhanced; whereas, when an event diminishes competence, intrinsic motivation will be undermined" (p. 11). The information in Figure 2 shows an alignment between achievement goals and achievement behavior.

These goal orientations lend support to why some students continue to work even when they may not get the best grades they desire even while encountering frustration (Dweck, 2010). Table 10 illustrates the responses of mastery goal oriented versus performance goal oriented students. This table describes how the various goal oriented students respond to tasks in academic settings.

Table 10

Characteristics of Mastery Versus Performance Goal Oriented Students

Focus-Area	Mastery Goal Oriented Students	Performance Goal Oriented Students
Learning	Interest in learning new skills/concepts	Interest in appearing better or more capable than others
Risk-Taking	Willing to take risk and try new difficult tasks	Sticks to easy or familiar task with anticipated outcomes
Mistakes	View mistakes as learning opportunities	View mistakes as evidence of lack of ability and should be avoided

Note. Chart based on Pintrich and Shunk's (2002) theories of student motivation.

Mastery goal oriented students show a greater promise of improving by their desire to learn more. While performance and grade oriented students want to know the minimal effort required for the grade and if the material is something they are expected to know for the next test (Svinicki, 2005).

In a research study conducted by Hong et al. (1999), Chinese college students who were enrolled in a University were asked to determine if they were interested in participating in a course to develop their English proficiency skills. The expectation for students enrolling in college was they would be fluent in both Chinese and English. Students were identified because they struggled with their English speaking fluency abilities. The students with the positive effort beliefs/mastery goal orientation/growth mindset chose to enroll in the English speaking course, while those with the negative effort beliefs/performance goal orientation/fixed mindset chose not to enroll in the English speaking course. By the end of the semester, the students who enrolled in the course had not only improved their English fluency skills but out-performed those that were unwilling to take advantage of this additional practice opportunity to improve their language skills. The findings of this study illustrated that students who have positive effort beliefs/mastery goal orientation/growth mindsets will take on an opportunity to learn in order to improve skills while students with negative effort beliefs/performance-goal orientation/fixed mindset will not take on new opportunities to improve their skills for perceptional fears of how the additional support may make them look *less smart* (Hong et al., 1999). These individuals gained security in showing how smart they were and minimized the amount of effort they put forth to complete tasks. Putting forth practice or effort is a sign that you are not smart (Dweck, 2000).

This study also highlights an awareness that students had of their own areas for development and the extent to which they believed practice was vital to improvement. Dweck (2000) noted that developing malleable intelligence, takes the right kind of "praise" which creates "adaptive motivation" (p. 3). Adaptive motivation can be most closely linked to intrinsic motivation which is driven by persistent curiosity and a thrust for knowledge and learning. Ryan and Deci (2000) defined intrinsic motivation as "doing an activity for inherent satisfaction rather than for some separable consequence. When intrinsically motivated, a person is moved to act for the fun or challenge entailed rather than because of external products, pressures or reward" (p. 56). Dweck further argued that these beliefs are perpetuated by the type of praise offered to students.

Praise has been widely accepted as a positive reinforcement for children's behavior and motivation. During the self-esteem movement of the 1970s, parents and educators celebrated giving students praise for being *smart* in an effort to increase their self-esteem. In a Columbia University survey, 85% of American parents thought it was important to tell their children they were smart (Bronson, 2007). Giving praise for being smart versus praising students for the *process* in which they are engaged robs them of learning opportunities that can provide critical feedback for growth (Dweck, 2007).

Dweck (2010) indicated this type of praise has developed a generation of children that yearn to hear praise for doing a good job and avoid risks when they think that they do not have the natural ability for a given task. This drive for praise prevents these students from seeking opportunities to master a skill that is challenging although it will lead to skill development. These students hold on to the performance goal-orientation approach that they must show how smart they are by refusing to engage in study or practice because if they need practice, they just are not that smart (Dweck & Sorich, 1999; Dweck, 2007).

Dweck and Leggett (1998) designed a research study in which students were given a series of puzzles to solve. Students were either praised for their ability or effort in completing the puzzles. The researchers increased the complexity of the puzzles and looked at how students responded when the puzzles increased in the level of difficulty. They found that over time, students who were praised for their intelligence began to give up and become disinterested in completing the puzzles when the puzzles were no longer easy and when they did not automatically get them correct. Even after the researchers reverted back to easier puzzles, these students performed worse and were not able to solve puzzles that they had originally mastered.

On the other hand, students who were praised for their effort persisted even when the puzzles became more challenging and welcomed being given more puzzles that increased in complexity. At the end of the study, many of these students were interested in taking puzzles home to practice further in order to improve their speed and ability to solve more challenging puzzles.

At the end of the study, students were asked questions to determine if they would like to try an activity like the puzzle activity again. Students were also asked to write a letter to another student about their experience with the activity and tell them their original score for completing the first set of puzzles. The researchers found that the students praised for their intelligence lied about their performance at a higher rate than those that were praised for their effort.

Leggett and Dweck's (1998) experiment illustrated the detriment of praise for ability and/or intelligence. Praise for intelligence promotes extrinsically motivated youth and can lead students to adopt performance goal orientations where they only focus on their competence in comparison to others as the primary motivation for engaging in a task.

On the other hand, effort related praise affirms student effort for work and the process through which they engage to reach an outcome. This type of praise can lead to new learning, challenge-seeking, and improvement—master goal oriented approach (Dweck, 2007; Dweck, 2008; Dweck & Sorich, 1999). Dweck (2008) indicated that praise focused on process, such as the following example: "'I really like the way you did those hard problems. . . . You stuck to them until you figured out how to do them' versus statements like, 'You are really smart; you got all the math problems correct' will help to promote mastery oriented goal expectations in students" (p. 57). There are other factors in addition to effort beliefs, goal orientation, and types of praise that impact student achievement. These factors include the level of student motivation and the degree to which one sees value in the tasks presented.

Motivation, Task Value, and Choice

The motivational components of a student's goals, self-efficacy, and interest help determine the degree to which that student is willing to invest in a task (Garcia & Pintrich, 1994). This motivation can vary based on the student interest and the level of difficulty of a course (Duncan & McKeachie, 2005). Research supports the idea that positive motivational beliefs such as higher self-efficacy, mastery oriented goals, and high interest in a class leads to higher cognitive engagement (Pintrich & Schrauben, 1992). Earlier theories explaining motivation, describe one's willingness to achieve as a drive. These theories derived from research that explains human desire such as basic human survival needs (Stipek, 1993). Beyond these basic human survival needs are psychological (learned) drives that lead individuals to seek approval, power, and achievement. The drive to seek academic achievement is what psychologist calls a desire to achieve learning goals.

According to Pink (2009), there are three elements of motivation or drive—autonomy, mastery, and purpose—these elements are required for meaningful engagement. Pink notes that when these elements are in place, you do not have to coerce motivation or create mandated-expectations of individuals but that an individual will be intrinsically motivated to work and persist with a task until a goal is met. Once an individual has developed drive, they will have a desire to learn for learning's sake. It is this mastery oriented goal thinking that affords students the opportunity to learn, even when they may not initially be successful at an unfamiliar task (Hong et. al., 1999; Janzow & Eison, 1990; Pink, 2009).

There are several reasons why students choose not to engage in learning and are unmotivated to complete a task or assignment. The research of Aronson et al. (2002), linked an idea known as stereotype threat as a reason for negative motivational beliefs. Stereotype threat promotes disengagement in motivation and promotion of performance oriented goals (Osborne & Walker, 2006). Stereotype threat is the association of a self-characteristic, i.e., being a female or a member of a racial group and how this association validates a negative stereotype about one's social group (Steele & Aronson, 1995). These stereotypes lead many students to not value an area of study like math or science (Aronson et al., 2002) and could also lead to the narrowing of students' career options by supporting their perceptions that they cannot be successful in certain academic disciplines. The latter causes many students to withdraw interest in school (Osborne & Walker, 2006). When stereotype threat occurs, performance can be undermined because of fear of confirming the negative stereotype (Cole, Matheson, & Anisman, 2007). For example, a female student that gives into stereotype threat perceptions about math may disengage in math because females are stereotyped to be less successful in math than males. Therefore, the female student may not put forth as much effort toward being successful in math and may be less motivated in the course. The result would be that she does not perform well in the math class/course. When stereotype threat occurs, an individual has given into a stereotype when they may have previously enjoyed learning in this area, like math, but the stereotype threat perspective causes additional pressure on the student to either disprove the stereotype, usually promoting a performance oriented goal, or sabotage their academic performance by believing they cannot do anything to improve, and they adopt a performance avoidance orientation or learned helplessness disposition.

A student's motivation in a class can be determined by the value components of academic tasks. Those value components determine the judgments that students make about how interesting and useful learning this information is to them (Pintrich & De Groot, 1990). These judgments are weighed by the motivational factors they have for learning and are intertwined with the purpose and value of learning information in that class. Task value requires that the task must be interesting enough and provide some type of perceived benefit for the student in order for the student to choose to engage in that specific task (Liem et al., 2007).

According to Dweck (2002) and Good, Rattan, and Dweck (2010), actualizing effort means that the work and task must become challenging enough and require the use of skill, strategies, and perseverance in order to document improvement. Bandura (1997) indicates that there are attributions that one makes for his or her success or failure. He explains:

> People who credit their successes to personal capabilities and their failures to insufficient effort will undertake difficult task and persist in the face of failure. They do this because they see their outcomes as being influenced by how much effort they expend. In contrast, those who ascribe their failures to deficiencies in ability and their success to situational factors will display low strivings and give up readily when they encounter difficulties. (p. 123)

Students with fixed mindsets tend to attribute their inability to be successful academically on their lack of ability or intelligence while those with a growth mindset attribute setbacks or failures to the need to study harder or put forth more effort towards task accomplishment (Dweck, 2007). The fixed mindset views failure as finite while the growth mindset views failure as feedback. Students who have a high sense of efficacy, “will participate more readily, work harder, and persist longer when they encounter difficulties than those who doubt their capabilities” (Bandura, 1997, p. 129). How does one determine the value of a task?

According to Miller and Brickman (2004), task value is the perceived usefulness that the completion of an assignment offers in regards to its practical application or future utility. In other words, individuals do not give high task values to assignments which are not useful to their interest or future needs. Miller and Brickman (2004) also stated, "human beings simply do not pursue competence in every area open to them" (p. 19). This explains why students exert their best efforts and spend extra time in engaging in academic tasks they perceive are important and useful to them in the future and are less likely to pursue mastery oriented goals on tasks they perceive to be irrelevant (Miller & Brickman, 2004).

In a study conducted by Liem et al. (2007), almost 1500 students in the 9th grade in Singapore were studied to identify the role of self-efficacy, task value, achievement goals and learning strategies in relation to student achievement outcomes in their English academic achievement. This study found that student self-efficacy and task value predicted their achievement goal orientation. This was due to the fact that the students in this study were motivated to develop competence in learning English. Because they were motivated to learn English, these students displayed both types of goal orientations. This research showed that students had both performance and mastery oriented goals related to learning English. These findings support the original research of Miller and Brickman (2004) regarding the perceived instrumentality of the subject and its usefulness to future goals. Students displayed both goal orientation types simultaneously for a couple of different reasons: Students were focusing on getting better with their understanding English (mastery oriented goal) and demonstrating their competence with understanding language by attaining high grades (performance oriented goal). This illustrates that given the task, students can show both a mastery oriented and performance oriented goal approach depending on the task.

This study also found that given the type of language task, students either used surface or deep learning strategies. These learning strategies enable individuals to either improve their skills at a basic level, such as understanding subject-verb agreement, or at a more complex level, such as understanding the nuances of writing (Liem et al., 2007). The use of study strategies in conjunction with the type of goal orientation has been correlated with positive academic achievement.

Strategies for Learning

Learning strategies are approaches to cognitive processing of information via the practice with basic and complex methods for learning information from text and lectures (Garcia & Pintrich, 1994). These strategies promote what is known as cognitive engagement—either the deep or surface learning of information (Fredricks, Blumenfield, & Paris, 2004). Surface learning entails strategies like rehearsal or memorizing information by repeating words over and over to recall that information (Biggs, 1987; Pintrich, Smith, & McKeachie, 1991). These strategies are good to learn basic information but have not been found to be most effective for complex learning (Pintrich & Schrauben, 1992). In order for students to engage in deep learning by critically processing content information, Garcia and Pintrich (1995) proposed that students must engage in more sophisticated learning strategies such as elaboration, organization, or critical thinking and metacognitive control strategies. Elaboration strategies allow students to summarize information, while organization strategies require individuals to develop a way of categorizing information in such a way that brings forth meaning or new understanding (Duncan & McKeachie, 2005). Critical thinking strategies require students to apply previously learned information into a new context. This method helps students use metacognitive control strategies to monitor their own understanding and readjust and use specific strategies that will enable them to improve their learning outcomes (Duncan & McKeachie, 2005). These metacognitive control strategies also include the ability to persist in the face of a difficult task and to regulate effort towards a goal or outcome.

In Pintrich and De Groot's (1990) study of seventh graders, students were assessed on their motivational orientation and their use of various learning strategies to determine the level of effect these variables had on their grades. The researchers contended that student motivation and learning strategies were mediators for student achievement. This study found that students with higher levels of self-efficacy and high use of complex cognitive strategies correlated with higher academic performance. This study provided, "an empirical base for the specification and elaboration of the theoretical linkages between individual differences in students' motivational orientations and their cognitive engagement and self-regulation in a classroom setting" (Pintrich & De Groot, p. 37).

A mastery oriented approach to learning is categorized primarily by the use of strategies that promote deep learning. Pintrich et al. (2003) showed a pattern between the use of deep learning strategies and mastery goal orientation. Wherein, a performance approach goal was related to the use of surface learning strategies. This study also illustrated the positive effect that student persistence and effort had on achievement, grades, and other academic achievement tests. Yet, to better understand the types of study strategies that are most helpful for mastering skills and how information is processed, neuroscientists argue that a basic understanding of the process and functions of the brain can stimulate learning (Dubinsky, 2010).

Neuroplasticity

The idea that the brain can change, grow, and expand its capacity for learning is an idea that has been supported by neuroscientists for decades (Doidge, 2007; Dubinsky, 2010; Faulkner et al., 2008). The idea of the neuroplasticity or capacity for the brain to change itself is why the Learning and the Brain Society (2010) developed workshops that help teachers understand the basic connections between neuroscience, classroom instruction, and capacity for change. Dubinsky (2010) argued that designing an interactive course on the nervous system would empower educators to share new knowledge of the application of neuroscience with their students. This learning will help the educator to reflect on teaching practices by applying this new knowledge in ways that promote inquiry-based pedagogy and an experiential approach to teaching and learning (MacNabb, Schmitt, Michlin, Harris, & Thomas, 2006). Research also shows that this type of learning is beneficial to teachers and can be quite important in helping students to apply themselves in school. This learning can also have a positive impact on student academic trajectories in the future. Cunningham & Kunselman (1999) illustrated positive partnerships when school districts worked to teach students about the mallability of the brain.

In the Blackwell et al. (2007) study, a brain-based intervention was instituted. This intervention helped students embrace an understanding about how the brain functions by growing new synapses. The intervention also stressed the understanding of synaptic plasticity, the idea that we have the ability to alter and change our brains (Draganski, et al., 2006). These students were taught that by working those synapses, through effort and practice, their brains would grow stronger. This experimental brain research helped show students that their work can lead to academic success in school, especially in an area where they might not perceive they have academic competence (Blackwell et al., 2007). Teaching teachers about the neuroplasticity of the brain can help improve teachers' perceptions of student potential and help guide teachers toward a more student-centered view of teaching with the mastery oriented goal of developing student capacity (Dubinsky, 2010).

The development of this intervention from Blackwell et al. (2007) has led to the creation of more interventions that target the understanding of synaptic plasticity for both teachers and students. One example is The Brainology© intervention, developed into a curriculum targeting students in Grades 5 through high school with the goal of motivating them and their teachers with strategies and tools to improve achievement.

Brainology© Program

Research supports that the development of positive psycho-social constructs (high academic efficacy, incremental theory of intelligence, positive effort beliefs, mastery oriented goal approach, and deep strategies for learning) requires experiences that alter individuals perceptions about the nature and ability to change their academic performance (Blackwell et al., 2007; Doidge, 2007; Dubinsky, 2010). Directly teaching these psychological constructs can lead to higher achievement outcomes for both students and teachers (Dweck, 2007; Dweck, 2010; MacNabb et al., 2006).

Recently, Brainology©, a growth mindset intervention, connected the understanding of the neuroplasticity of the brain to academic improvement. According to Mindset Works, Inc. (2011), Brainology©

> is based on research showing that a growth mindset—the understanding that one can develop one's intelligence through learning and effort—leads to increased motivation and achievement, and that teaching a growth mindset through neuroscience is effective in improving students' motivation and academic performance in math and science. (p. 1)

Brainology© is an animated, interactive, internet-delivered computer software program. This *growth mindset intervention*, uses 12 lessons divided into four units that teach students how the brain works and how it becomes stronger and smarter through practice and learning (Mindset Works, 2011). The program also demonstrates to students how the challenges they experience in school—with attention, emotion, learning, and memory—can be understood and managed by using effective study strategies. Further, the program provides activities to reinforce and apply this learning to student's school work (Mindset Works, 2011).

The Brainology© curriculum takes students through an online simulation of scenarios and problems that help students develop practical strategies for addressing challenges and developing a growth mindset—an attitude that focuses on perseverance towards improvement. The online curriculum is projected to take about 130 minutes for completion (Mindset Works, 2011). The program begins with a basic orientation, then practice with a new skill or concept, followed by a progress quiz, and finally, a practical application scenario with the student's course content.

Brainology©® Curriculum for Students was modeled after the success of a workshop from the second study conducted by Blackwell et al. (2007). The Brainology© website can be located at www.Brainology.us. This program is a blended curriculum (online and face-to-face lessons/supports) that teaches middle school students basic neuroscience with an emphasis on understanding key principles related to learning (Dubinsky, 2010; Dweck, 2008). In an introduction and 4 modules of about 35 minutes each, the online program uses interactive animation, resources, and exercises to teach students how the brain works, how it grows stronger with learning, and how students can use this information to help them in their own learning. The classroom activities help students reinforce and apply this knowledge and include discussions, reflective writing, self-assessments and inventories, hands-on activities, and assessments of learning.

In Brainology©, students meet animated teenaged characters Chris and Dahlia, who learn about the brain along with the student. The program also elicits the help of brain scientist, Dr. Cerebrus, during the program. In each unit, Chris and Dahlia identify a challenge that they have in school, and with the guidance of the Brain Orb, formulate a related Quest for knowledge about the brain. They visit Dr. Cerebrus' lab, where he explains key neuroscience related to their Quest, accompanied by animated illustrations and interactive demonstrations using his Virtual Brain. At the end of each unit, students complete an animated challenge with the help of the online Brain Book, and progress to the next level, until they reach the status of Brain Master (Mindset Works, 2011).

Unit 1, *Brain Basics,* is the introduction to the Brainology© program. This introduction focuses on presenting the program purpose to students and helps student conduct an initial assessment by creating an inventory of personal challenges and a mindset profile (Mindset Works, 2011). The purpose of the mindset profile is to help the student get a baseline for how they process regarding their abilities and achievement. In this unit, Chris and Dahlia struggle with concentration in their studies and embark on a quest to understand the basic structure and functions of the brain. The students learn how the brain focuses attention, the role that attention plays in learning, and how they can maximize their ability to focus through study strategies including managing sensory input, active learning, and use of multiple senses.

In Unit 2, *Brain Behavior*, students are taught about the structure and function of the brain. The students are taught about the physical aspect of thinking and learning and how attention and concentration are linked to the way the brain functions. This portion of the program teaches students how the brain functions by sending chemical messages through nerve cells in order to help them understand how the brain changes. This can help students see how emotions can influence the brain. Students are also taught strategies for managing negative emotions and focusing on positive emotions. During this unit, students tackle the challenge of anxiety and learn about the neural structure of the brain, mechanisms of neurotransmission, how the brain processes emotion, and strategies to manage emotion to enhance learning.

In Unit 3, *Brain Building*, students are taught how the repeated use of the neural network in the brain develops by working on a skill or concept. This repeated use changes the capacity for learning. This idea sends the message to students that intelligence is not inherited or *fixed* but can be developed. This unit focuses on the use of activities that promote learning. During this unit, Chris and Dahlia explore how to learn new and difficult material. Students learn the critical lesson of brain plasticity and how new learning changes the brain, view animations of research findings on neuroplasticity, and build neural networks through practice with the Virtual Brain.

Finally, in Unit 4, *Brain Boosters*, students explore the following: how they can retain what they have learned, what they have learned about the processes of memory, and how they can improve retention and consolidate knowledge in long-term memory while building multiple pathways for knowledge retrieval. This portion of the curriculum focuses on helping the student extend the idea of how the brain works and the developmental capacity in the brain by introducing study strategies that help students put into practice, with current coursework, how they can use these new study skills to work hard and get smart (Feinberg, 2004).

The Brainology© program focuses on engaging students by helping them make connections with the science content about how the brain processes and develops in a personal context of challenges to help students see how they can face challenges with hard work and a series of strategies. The program is designed to help students grasp an understanding of neuroplasticity—continual growth and expansion of the brain as a means of supporting them in learning in contexts other than math and science. Students learn basic skills that they can use to develop their intellectual capabilities and learn how to use new learning and study strategies to learn. The idea of neuroplasticity, positive effort beliefs, mastery oriented goals, and the development of a growth mindset can lead to increased self-efficacy, engagement, and effort.

The Brainology© program aligns with National Science Content Standards for Grades 5-8, including Life Sciences (structure and function in living systems; regulation and behavior) and Science in Personal and Social Perspectives (personal health) (National science education standards, 1996). It also aligns with the North Carolina Essential Standards about Life Sciences as well. These standards can be found at http://www.dpi.state.nc.us/docs/acre/standards/new-standards/science/6-8.pdf (Public Schools of North Carolina, 2011).

Research Questions and Hypotheses

Building on prior research expressed in the literature, the overarching hypothesis of this research study is that educating students and teachers about neuroplasticity through the Brainology© program creates a classroom culture where student motivation, challenge-seeking, effort, and resilience increase, and as a result, student achievement increases in science and math. In addition, it is expected that student desire to seek more challenging tasks, from which they will learn but may not initially succeed in, will increase. The primary research questions and related hypotheses for this research study included the following:

Research Question 1. How does the use of the Brainology© intervention affect students' (a) mindset beliefs, (b) effort beliefs, (c) academic self-efficacy, (d) interest and engagement in science, (e) effort in the science classroom, (f) motivation in the science classroom, and (g) use of effective study skill strategies?

Hypothesis (a). There will be an increase in students' perceptions of growth mindset as measured by Theories of Intelligence subscale of the Student Mindset Assessment after the use of the Brainology© intervention.

Hypothesis (b). Student's responses about their abilities, after the completion of the Brainology© intervention, will show an increase in Positive Effort Beliefs as measured by Efforts Beliefs subset scale of the Student Mindset Assessment.

Hypothesis (c). There will be an increase in student academic self-efficacy as measured by the Academic Efficacy subscale of the PALS after the use of the Brainology© intervention.

Hypothesis (d). There will be an increase of student effort in science as measured by the Behavioral Task Choice measure.

Hypothesis (e). The use of the Brainology© intervention will increase student interest and engagement in science as measured by the Motivation Strategies for Learning (MSLQ) Task Value: Subscale.

Hypothesis (f). Students will show an increase in behavioral motivation and positive motivational behaviors in science classes as measured by Teacher Behavior Rating Scale.

Hypothesis (g). The use of the Brainology© intervention will increase a student's use of study skills strategies as measured by the measured by the Motivation Strategies for Learning (MSLQ) Task Value: Rehearsal, Elaboration, and Organizational Strategies subscale.

Research Question 2. What is the relationship between student academic self-efficacy and student science and math achievement?

Hypothesis about correlation between self-efficacy and achievement. There will be a positive relationship between student self-efficacy as measured by the Academic Efficacy subscale of the PALS and science student achievement as measured by the seventh-grade science benchmark tests.

Research Question 3. How does student achievement in science and math change over the course of the school year for students who participated in the Brainology© intervention compared with students not participating in the Brainology© intervention?

Hypothesis about student achievement in math and science. Students involved in the Brainology© intervention will show an increase in the mean score on the seventh-grade math and science benchmarks exams compared to students not involved in the Brainology© intervention.

Research Question 4. Does student mindset predict student academic efficacy and, in turn, student achievement?

Hypothesis about predictors of student achievement. Student mindsets, as measured by Intelligence Fixed or Growth mindset subscales of the student Mindset Assessment and Teacher mindsets as measured by the Motivational Goals and beliefs survey of the Teacher Mindset Survey, will be positive predictors of student efficacy, which in turn will be a positive predictor of student achievement, as measured by the seventh-grade math and science benchmark tests.

Purpose

The purpose of this research study was to test the efficacy of the Brainology©

program intervention by determining if these interventions positively impacted student's perceptions of their abilities and increased their academic achievement in math and science. This study used a series of measures that determined the effect size of this intervention on the students who received the Brainology© intervention during the 2012-2013 academic school year, the year this study was implemented.

Conclusion

This literature review provides a basic understanding of the variables that were analyzed and measured in this research study. There is a wealth of research about academic efficacy (Bandura, 1997); implicit theories of intelligence (Dweck, 2000); the influence that these variables have on student effort beliefs (Dweck & Sorich, 1999); interest, engagement, motivation, and task value (Pintrich, 1990); actualized effort and task persistence (Dweck & Sorich, 1999); and strategies for learning (Pintrich et al., 1991).

In previous research, these variables have shown positive and/or negative outcomes related to student achievement in math and science. The research has shown that there is a sharp interconnectedness between these variables and student achievement. These psychological constructs determine the degree to which students see the value in learning and the extent to which they will actively participate in the learning process. The goal of this research study was to determine the degree to which engaging students in the Brainology© intervention positively influenced their perceptions and beliefs and ultimately helped increase their academic achievement in math and science.

Chapter 3: Methodology

Design

The primary purpose of this study was to determine if the use of Brainology©, a growth mindset intervention, would have a positive effect on students' (a) beliefs about intelligence, (b) effort beliefs, (c) academic self-efficacy, (d) interest and engagement in science, (e) effort in science, (f) motivation in science, (g) use of study skill strategies for learning, and (h) achievement in math and science. This study incorporated a mixed-methods approach, using both qualitative and quantitative measures. This study was an experimental design (Creswell, 2012) because the random assignment of students occurred at the classroom-level. This approach allowed for students to be assigned to either the Brainology© treatment group or control group based on their teacher assignment. Teachers were either assigned to a control or an experimental group. Students in classes with teachers assigned to the experimental group participated in the Brainology© intervention. Assigning students to a group at the classroom level helped ensure that teachers would not have various classrooms with mixed treatments during the study implementation (i.e., no teacher would have period 1=control, and period 2=Brainology©).

The quantitative data collected for this study were from pre- and post-student survey questionnaires that assessed students' beliefs about intelligence, effort beliefs, academic self-efficacy, interest and engagement in science, and use of study strategies for learning. Other quantitative measures for data collection included quarterly seventh-grade math and science course grades for three marking periods—first, second, and third quarters—and benchmark assessments in math.

In addition to the student questionnaires, teachers completed student observation forms that allowed them to evaluate and rate a student's motivation-related behavior. Teachers also completed survey questionnaires about their own mindset, efficacy, and effort beliefs. Though teachers' mindsets were not a focus of this research study, data was collected on teacher beliefs about intelligence, teaching efficacy, and effort beliefs to determine if teachers' mindsets were confounding or mediating variables that may impact students' beliefs about intelligence and/or achievement (Creswell, 2003).

Qualitative data was collected from focus groups with Brainology© participants—teachers and students. This data was used to corroborate the findings from the survey questionnaires, grades, and motivation ratings. The expectation was that focus groups would provide descriptive data about students' perceptions of their experiences in the research intervention program, Brainology©.

The research questions for this study were:

1. How did the use of the Brainology© intervention affect students' (a) mindset beliefs, (b) effort beliefs, (c) academic self-efficacy, (d) interest and engagement in science, (e) effort in the science classroom, (f) motivation in the science classroom, and (g) use of effective study skills strategies?

2. What is the relationship between student academic self-efficacy and student science and math achievement?

3. How did student achievement in science and math change over the course of the school year for students who participated in the Brainology© intervention compared with students who did not participate in the Brainology© intervention?

4. Did students' mindsets predict student efficacy and, in turn, student achievement?

A cross-walk was developed to illustrate the connection between the specific constructs, instrument measures, and research questions (See Appendix A).

Participants

Since this research study focused on student achievement and their perceptions of their abilities in math and science, seventh-grade science classrooms were selected as the targeted group because of the age-appropriateness of the Brainology© curriculum intervention and the ability to apply the Brainology© program to the content of the seventh-grade science curriculum. Participants for this study were also selected as a result of the research surrounding the transition difficulties of middle schoolers moving from Grade 6 to Grade 7 (Heller, Calderon, & Medrich, 2002). According to Bandura (1997), adolescence is a developmental period in which students focus on self and form an identity. According to Blackwell et al. (2007), seventh-grade students are more likely to demonstrate disengagement in school because "the junior high school environment emphasizes competition, social comparison, and ability self-assessment at a time of heightened self-focus [. . .] resulting in a mismatch between the adolescent's needs and the environment" (p. 246). Given these challenges during the middle-grades transition years, there is a need to explore interventions that may help students to develop strategies and support systems to succeed in school.

Thirty seventh-grade science classrooms in seven middle schools were selected for study participation in the 2012-2013 academic school year. At the onset of the study, over 3,000 consent and assent forms were sent to schools for students and parents to sign and return. Teaching sections were randomly assigned to either control or experimental group. The classrooms in the control group implemented the North Carolina Science Essential Standards, customary curricula (control group); and the experimental group implemented the customary science curricula plus the Brainology© intervention, which included several computer units and information to assist students with better use of study skills. Additionally, teachers provided classroom lessons that reinforced principles of the growth mindset (Mindset Works, 2011). Approximately 1,000 ethnically diverse seventh-grade students and 16 science teachers consented to participate in the research study by signing both consent and assent forms. Table 11 illustrates the breakdown of the student participants relative to the group they were assigned.

Table 11

Research Participant Numbers With Submitted Consent Forms

Group	Number of Participants	Percent of Sample
Control	307	30.34
Brainology©	705	69.66

Note. Participant breakdown is based on the number of students who submitted informed assents and parent consents forms.

Student Survey Instruments and Research Measures

All student assessments for this research study were compiled into a unified survey questionnaire for administration (See Appendix B). Teachers also completed a series of assessments that were combined into a unified survey instrument (See Appendix C). The assessments were presented in random order to control for participant fatigue. All survey questionnaires were completed online, using a virtual survey instrument tool: Survey Gizmo. Survey Gizmo was selected as a user-friendly data collection tool as it is paperless and would allow for responses to be deposit into a centralized location for easier analysis of participant responses. It was estimated that both the pre and post assessments would take approximately 30 minutes per survey to complete.

Various survey instruments were selected to assess the primary constructs measured in this study: mindset beliefs, effort beliefs, academic self-efficacy, interest and engagement in science, effort in the science classroom, motivation in the science classroom, and student use of effective study skills strategies. Complete subscales of the various survey instruments were used to measure the different constructs.

Mindset Assessment Subscale

The Student Mindset Assessment—Theory of Intelligence subscale measured whether the students' views about intelligence were more closely aligned with a *fixed* or *growth mindset*. A fixed mindset indicated a belief in a set amount of ability or intelligence, whereas a growth mindset indicated a belief that intelligence could be improved or developed with practice and hard work.

This subscale consisted of six items using a 6-point Likert-type scale that ranged from 1=*Agree Strongly* to 6=*Disagree Strongly*. Selected items were reverse-coded so that a higher score reflected agreement with the construct of a growth mindset. The items were divided into two categories: Entity (fixed mindset items) and Incremental (growth mindset items).

Entity or fixed mindset items. All of these items were reverse-coded so that students who responded as strongly disagree on these items illustrated agreement with the growth mindset. The items for this subscale were as follows.

- Your intelligence is something you can't change very much.
- You have a certain amount of intelligence, and you really can't do much to change it.
- You can learn new things, but you can't really change your basic intelligence.

Incremental or growth mindset items. Higher scores on this subscale showed agreement with the growth mindset. The items for this subscale were as follows.

- No matter who you are, you can change your intelligence a lot.
- You can always greatly change how intelligent you are.
- No matter how much intelligence you have, you can always change it a good amount.

In the research study conducted by Levy, Stoessner, and Dweck (1998) this instrument measured student's theory of intelligence and determined their perceptions about their own abilities. In Blackwell (2002) and Blackwell et al. (2007), a positive relationship was found between implicit theories of intelligence and student motivation and achievement. Blackwell (2002) reported reliability of 0.78 (Cronbach's alpha) with two samples: one sample consisted of 373 seventh-grade students and the other had 99 seventh-grade students. Reliability found for this research study was .76 (Cronbach's alpha).

Effort Beliefs Subscale

The Student Mindset Efforts beliefs subscale of the Student Mindset Assessment measured a student's beliefs about work and effort—whether they believed that effort or practice were worth the investment. Dweck and Sorich (1999) originally developed this effort belief measure. Blackwell (2002) and Blackwell et al. (2007) also used this subscale in subsequent research. The nine-item effort beliefs subscale had four positive and five negative items. Positive items looked at a student's belief that effort leads to positive results while negative items indicated that a student believed that effort did not positively impact results. The items on this scale ranged from 1-*Strongly Agree* to 6-*Strongly Disagree*. The positive items were reverse-coded so that a higher score reflected a belief that effort resulted in improved performance.

This subscale had a reliability of 0.79 with a sample of 373 seventh-grade students and a reliability of 0.60 on a sample of 99 students (Blackwell, 2002). The following item was omitted from the original subscale unintentionally. The omitted item was: If you're not good at a subject, working hard won't make you good at it. Reliability for this subscale without the omitted item in this research study was .68 (Cronbach's alpha).

The items for this rating scale were divided into those that reflect negative or positive effort beliefs. Negative effort beliefs align with the idea that effort investment is not worth investment or does not produce improvement, whereas positive effort beliefs align with the idea that hard work, study, and practice lead to improvement.

Negative effort belief items. All these items were reverse-coded so that students who responded with a 1-*Strongly Disagree* rating were in agreement with positive effort beliefs. The negative effort belief items were as follows.

- To tell the truth, when I work hard at my schoolwork, it makes me feel like I'm not very smart.
- It doesn't matter how hard you work; if you're not smart, you won't do well.
- If you're not good at a subject, working hard won't make you good at it.
- If a subject is hard for me, it means I probably won't be able to do really well at it.
- If you're not doing well at something, it's better to try something easier.

Positive effort belief items. The items that measured positive effort beliefs were as follows.

- When something is hard, it just makes me want to work more on it, not less.
- If you don't work hard and put in a lot of effort, you probably won't do well.
- The harder you work at something, the better you will be at it.
- If an assignment is hard, it means I'll probably learn a lot doing it.

Academic Self-Efficacy Subscale

Academic efficacy focuses on a student's perception of their ability and competence to complete their course work. The Patterns for Adaptive Learning Scales (PALS) was developed using goal orientation theory—student's purpose in developing their competence, intelligence, and abilities over time in order to "examine the relationship between the learning environment and students' motivation, affect, and behavior" (Midgley et al., 2000, p. 2).

The academic efficacy measure of the PALS has 5 items each using a 5-point response scale ranging from 1-*Strongly Agree* to 5-*Strongly Disagree*. The five items from the PALS Academic Self-Efficacy Subscale for the student pre and post survey questionnaire were the following.

- I'm certain I can master the skills taught in class this year.
- I'm certain I can figure out how to do the most difficult class work.
- I can do almost all the work in class if I don't give up.
- Even if the work is hard, I can learn it.
- I can do even the hardest work in this class if I try.

Midgley (2000) reported a reliability of 0.78 (Cronbach's alpha) in a longitudinal study in eight schools in Michigan that followed students from Grade 5 to Grade 9 measuring multiple variables that contributed to turning points in student achievement.

Anchors used on this subscale were modified with the permission of the author from the original subscale. Modifications were implemented in order to decrease students' fatigue or confusion while taking the pre and post assessments, as multiple constructs were measured. Anchors for the subscale ranged from 1-*Strongly Agree* to 5-*Strongly Disagree*. Reliability for this research project was .86 (Cronbach's alpha).

Task Value Subscale

The MSLQ was designed to measure multiple constructs (Pintrich et al., 1991). The Task Value subscale of the MSLQ measured a student's motivation, interest, and engagement in science. The subscale focused on getting a better understanding of students' beliefs on the interest, importance, and utility of the science course they were learning. Task value refers to the student's evaluation of how interesting, how important, and how useful the task was, what they thought of the task, and why they were undertaking the task (Pintrich et al., 1991). It also refers to a student's perception of the course material as it relates to the student's perceptions about the importance, interest, purpose, utility, and enjoyment of the task as related to the course (Pintrich et al., 1991). This scale was utilized to delve into the degree to which the science course offered challenge, provoked curiosity, and increased a students' desire to master understanding of the course content material (Pintrich et al., 2000).

If a student illustrated an intrinsic goal orientation in science, this indicated that the student's participation was fulfilling and not just something to be done to achieve a grade or credit for completing a task (Pintrich et al., 2000). This subscale asked students what they thought about the content they learned in science, how useful the content was to them as a learner, and how much they were motivated to learn in science.

The original measure was used on over 1,000 undergraduate students at the

University of Michigan in 1990. The reliability of this scale, according to Midgley et al. (2000), was .90 (Cronbach's alpha). The reliability of this subscale for this study was .86 (Cronbach's alpha).

The original subscale used ratings of 1-*Not at All True of Me* to 7-*Very True of Me*. The original items of this subscale were as follows.

- I think I will be able to use what I learn in this course in other courses.
- It is important for me to learn the course material in this class.
- I am very interested in the content area of this course.
- I think the course material in this class is useful for me to learn.
- I like the subject matter of this course.
- Understanding the subject matter of this course is very important to me.

The author of this subscale was contacted to receive permission to adapt the subscale to be a bit more congruent with other items asked in the overall questionnaire; the items were slightly adapted to specifically target student task value perceptions in the area of science. The sub-scale was adjusted for the student pre and post questionnaires. The new items had a 6-point rating scale. Those ratings ranged from 1-*Very True of Me*, to 6-*Untrue of Me*. All items on this subscale were reverse coded so a higher score denoted agreement with high science perceptions and task value. The modified subscale items used as a part of the student pre and post survey questionnaire items were as follows.

- I think I will be able to use what I learn in science in other classes.
- It is important for me to learn the information taught in science.
- I am very interested in learning the information in this science class.

- I think the information in science class is useful for me to learn.
- I enjoy learning about science.
- Understanding the science information in this class is very important to me.

Strategies for Learning Subscales

Metacognitive Strategies for Learning Questionnaire (MSLQ) measures the cognitive and metacognitive learning strategies a student uses for learning. The MSLQ contains three subscales for cognitive and metacognitive strategies—rehearsal, elaboration, and organization. The rehearsal strategies subscale focuses on the types of basic rehearsal techniques such as reciting or renaming items from a list. Rehearsal strategies are used for studying/memorizing simple bits of information (Pintrich et al. 1991). The elaboration strategies subscale assesses the types of strategies that a student uses to make connections with course content by paraphrasing, summarizing, creating analogies, or various types of note-taking. Organizational strategies help students arrange content for meaning by doing things such as creating timelines, outlines, or re-writing content in their own words. This level of study strategies requires higher cognitive processing where the learner is asked to make connections and construct meaning of information (Pintrich & Shunk, 2002). The goal of these of strategies is to help students place new content into long-term memory (Pintrich et al., 1991).

The 15 items on the three original subscales use a rating scale which ranges from 1-*Not at All True of Me* to 7-*Very True of Me.* Certain items were reverse-coded so that higher scores indicated greater use of the assessed strategies. The original reliability for the rehearsal subscale was .69 (Cronbach's alpha) and for the elaboration subscale was .76 (Cronbach's alpha). The reliability for the organizational strategies subscale was .64

(Cronbach's alpha). The Cronbach alpha's for this study were as follows: rehearsal strategies subscale = .76, elaboration strategies subscale = .82, and organizational strategies subscale = .74.

Rehearsal strategies for learning original subscale questions. The items for this subscale were as follows.

- When I study in this class, I practice saying the material to myself over and over.
- When studying for this class, I read my class notes and the course readings over and over again.
- I memorize key words to remind me of important concepts in this class.
- I make lists of important terms for this course and memorize the lists.

Elaboration strategies for learning original subscale questions. The items for this subscale were as follows.

- When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.
- I try to relate ideas in this subject to those in other courses whenever possible.
- When reading for this class, I try to relate the material to what I already know.
- When I study for this course, I write brief summaries of the main ideas from the readings and the concepts from the lectures.
- I try to understand the material in this class by making connections between the readings and the concepts from the lectures.
- I try to apply ideas from course readings and the concepts from the lectures.
- I try to apply ideas from course readings in other class activities such as

lecture and discussion.

Organizational strategies for learning original subscale questions. The items for this subscale were as follows.

- When I study the readings for this course, I outline the material to help me organize my thoughts.
- When I study for this course, I go through the readings and my class notes and try to find the most important ideas.
- I make simple charts, diagrams, or tables to help me organize course material.
- When I study for this course, I go over my class notes and make an outline of important concepts.

As with the MSLQ: Task Value subscale, the author was contacted and permission was granted to adapt the subscale. The purpose of adapting the items on this subscale was to make it more congruent with other items asked in the overall questionnaire. The items were slightly adapted to specifically target student rehearsal, elaboration, and organizational strategy use in science classes. The adapted range used a 6-point scale: 1-*Never,* 2-*Rarely,* 3-*Ocassionally,* 4-*Sometimes,* 5-*Most of the Time,* and 6-*Always*.

Rehearsal strategies for learning original adapted questions. The adapted questions used in the student pre and post survey questionnaire were the following.

- When I study for a test, I practice saying the important facts over and over to myself.
- When I study in science, I read my class notes and the science readings over and over to myself to help me remember.

- I memorize key words to remind me of important concepts in this class.
- I make flash cards and quiz myself with them to help me remember things.

Elaboration strategies for learning adapted questions. The adapted questions used in the student pre and post survey questionnaire were the following.

- When I study, I pull together information from different sources, such as lectures, readings, and discussions.
- When I study, I relate ideas in science to those in other classes whenever possible.
- When reading in science, I try to relate the information I am learning to what I already know.
- When I study, I write brief summaries of the main idea and put those ideas in my own words.
- I try to understand the material in science by making connections between the readings and what the teacher has taught.
- I try to apply ideas from my science readings in other class activities such as classroom discussions.

Organizational strategies for learning adapted questions. The adapted questions used in the student pre and post survey questionnaire were as follows.

- I write outlines for the chapters in my book to help organize my thoughts while studying.
- When I do homework, I look back over my class notes and science readings to remember the most important ideas.
- I make simple charts, diagrams, or tables to help me organize my science

notes.

- When I study for my science class, I go over my class notes and make an outline of important ideas.

Behavior Task-Choice

In order to measure effort in science, a Behavior Task-Choice activity was proposed for this research study. This task was not administered due to fear of participant drop-out. This behavior choice activity was modeled after Mueller and Dweck's (1998) protocol and was developed to measure a student's behavior on two dimensions: effort investment and challenge-seeking. In their science classes, students were introduced to a science task through a short, challenging pre-test on which they would not be able to answer most of the questions. The task was a coded list of names for different types of scientists along with clues describing what they do (Trimpe, 1999) (See Appendix D). Each letter in the word corresponded to a symbol which represented a letter (e.g., a black square, a black circle, a half circle, a rectangular bar). Students were then given a decoder chart that mapped the codes to the letters of the alphabet. Most students were only able to complete one to two of the five problems in the initial 5-minute task. For the purpose of this activity and measurement of the two dimensions, the following would have been measured if the behavior-task choice activity was administered.

- Challenge-seeking: Students were asked how many problems they would like to try to solve in a 15 minute set: 0-150. Students were told that if they picked a smaller number of problems, they could be sure to finish all of them; but if they picked a larger number, they would get better at decoding and also learn about different science careers. Students were also asked to write a short explanation of why they chose this number of problems. The average number of problems that students chose to attempt represented challenge-seeking, and coding of students' explanations assessed the degree to which their choice was driven by a desire to learn, to perform well, or to avoid expending effort.

- Effort Investment: Students were subsequently told that they would have 15 minutes before they tried the problems again and that they could use this time to practice if they wished. During this time, they could review a list of names and definitions of science careers (thus giving them the chance to learn about them and be better prepared for the challenge), and they could practice with the code list. They were also asked to report how much time they wished to spend practicing (0-15 minutes) and to write a brief explanation of why they chose to spend that amount of time in practice. The amount of time that a student chose to practice the challenging task represented effort investment, and the coding of students' explanations assessed the degree to which their choices were driven by a desire to learn, to perform well, or to avoid expending effort (See Appendix D).

In addition to the student measures, a series of measurements were administered to teachers. These measures served to review teachers' mindsets, effort beliefs, and personal teaching self-efficacy as confounding variables which may impact student beliefs—positively or negatively. Teachers were asked to rate student levels of observable behavioral characteristics in the classroom.

Teacher Ratings of Student Motivational Behavior

Teachers were asked to evaluate student behavior during participation in the study. These ratings were completed for both the control and experimental groups. The researcher randomly selected 35 students from all students who submitted student assent and parental consents. These students were selected from any of the seventh-grade science courses taught by an individual teacher.

The student behavior observation rating scale consisted of 10 items, each rated on a 6-point scale ranging from 1-*Very Often* to 6-*Never* for the degree to which teachers observed behavior for that student. Reliability had not been established for this instrument prior to its use in this study. Reliability for this study was assessed with Cronbach's alpha and found to be .87. This instrument was adapted from Stipek (2002) *Identifying Motivational Problems* and *Teacher Ratings of Student Helplessness* (See Appendix E).

The teachers were asked to rate student behavior by characterizing the types of behaviors and identifying the behaviors in which students experienced increases/decreases. These behaviors included participation and enthusiasm, sleeping in class, motivation and willingness to learn, persistence to work on a task that may be initially difficult, and intrinsic motivation to try tasks that are not required.

Teacher Mindset

The Teacher Mindset Assessment—Theory of Intelligence was administered to teachers as a pre and post questionnaire. This subscale is identical to the Student Mindset Assessment—Theory of Intelligence subscale, and score ratings determine if a teacher has more of a growth or fixed mindset. This subscale consists of a 6-point Likert-type rating scale that ranges from 1-*Agree Strongly* to 6-*Disagree strongly*. All items were reverse-coded so that a higher score on this scale reflected agreement with a growth mindset. Levy et al. (1998) used this subscale to measure adult theory of intelligence in order to determine adults' perceptions about their own abilities. No reliability for this research element is provided for this study, as the teacher sample size was not large enough.

Teacher Effort Beliefs

Just as students' effort beliefs were measured, measuring teachers' beliefs about effort helped the researcher identify the types of beliefs teachers held about improvement and effort. The effort beliefs subscale was also included in the overall teacher pre and post questionnaire. The subscale for teachers was identical to the student efforts belief subscale. The eight items on this subscale were rated from 1-*Disagree Strongly* to 6-*Agree Strongly* and were reverse-coded so that a higher score on this scale reflected a more positive belief that effort could improve student achievement. No reliability for this research element is provided for this study, as the teacher sample size was not large enough.

Personal Teaching Efficacy

The Patterns of Adaptive Learning Scales (PALS) teacher self-efficacy subscale was used to assess teacher efficacy. This subscale examined how much a teacher believed they could significantly contribute to the academic progress of their students (Midley, 2000). This scale also assessed if a teacher believed they could effectively teach all students (Midley, 2000). The seven items of this subscale were rated using a 5-point scale. Items on the student subscale were anchored at 1-*Not at All True*, 3-*Somewhat True*, and 5-*Very True*.

Items from the Teacher Efficacy subscale of the PALS that were used as a part of the teacher pre and post survey questionnaire items were as follows.

- If I try really hard, I can get through to even the most difficult student.

- Factors beyond my control have a greater influence on my students' achievement than I do.
- I am good at helping all the students in my classes make significant improvement.
- Some students are not going to make a lot of progress this year, no matter what I do.
- I am certain that I am making a difference in the lives of my students.
- There is little I can do to ensure that all my students make significant progress this year.
- I can deal with almost any learning problem.

This subscale was used by researchers from Michigan State University in a 1997 study that assessed teacher perceptions of the goal structure of the school, teachers' goal-related approaches to instruction, and personal teaching efficacy (Midley, 2000). Study results showed a significant relationship between personal teaching efficacy and teachers' goal-related approaches to instruction. The reliability of this subscale was reported by Midley (2000) as .74 (Cronbach's alpha). No reliability for this research element is provided for this study, as the teacher sample size was not large enough.

Procedures

In September 2011, the researcher contacted Mindset Works to inquire about opportunities to participate in research about the growth mindset involving the Brainology© curriculum. The researcher was interested in an opportunity to develop a study centered on self-efficacy and mindset. In order to identify schools that might be interested in participating in this type of research study, the researcher developed a presentation about the potential research.

In December of 2011, a presentation about the Brainology© intervention was made to all middle school principals in this school district to ascertain interest in participating in the study. Of the 15 schools, 10 were originally interested in participation. From this 10, three withdrew from participation leaving seven participating schools. These seven schools wrote to Mindset Works, indicating their interest in participating in this research project. Prior to any additional participant recruitment efforts and any implementation of the study's procedures, the research proposal was submitted to the Institutional Review Board for Gardner-Webb University and the Research and Evaluation Department of the school district for approval. Approval was received on August 1, 2012.

In early August, principals of the seven schools were asked to confirm interest in volunteering their schools to participate in a study on the impact of the Brainology© intervention on a variety of student factors. Principals were given information about the expectations of the research study and were informed that this request to participate could provide teachers in their schools with the Brainology© curriculum and lesson resource materials for reinforcing the strategies and information about the growth mindset. These materials would be provided to teachers in the experimental group to conduct with all students in their classrooms. Timelines for this research study were disseminated (See Appendix F). Having this information assisted participants in deciding if the research study was a commitment they were willing to make. Principals were given a school participation consent form (See Appendix G). This form was used to provide verification of intention of the principal's desire for his/her school to participate in this study. The rationale was that the researcher desired to promote fidelity of implementation of the research design by ensuring participants understood the expectations and investments required by the study.

In addition to principals signing school consent forms, the school district Assistant Superintendent also signed a letter of support for those middle schools to participate in this research. Principals were reminded that participation in the study was voluntary and they could withdraw from participation at any time. At the overview session, principals were provided informed consent forms for classroom teachers to complete (See Appendix H). Principals were asked to distribute these consent forms when teachers returned from the summer break on August 20, 2012, and to return those consent forms to the researcher by August 31, 2012.

After teachers signed the Teacher Informed Consent letter, they were randomly assigned to either the experimental (Brainology©) or control group. After random assignments were complete in early September, teachers attended an orientation overview session about the research study. During this session, teachers received timelines for the research study, expectations for participation in the study, and the researcher's contact information for questions and concerns during the research project. Teachers responded to the Teacher pre-survey questionnaire during the research orientation overview session. The decision to collect this data during the orientation information session was to ensure that baseline data on teacher mindset, efficacy, and effort beliefs would be collected.

During the orientation meeting, teachers from both the control and experimental groups were informed of the small incentives they would be eligible to receive, upon completion of the study, for their time investment and participation. Teachers were informed that they would need to complete all study components of the research project (student pre- and post-assessments, Brainology© units and quizzes, classroom growth mindset exercises, teacher pre- and post-assessments, and student motivation evaluations), to receive incentives. Every teacher received a $25 Amazon gift card upon completion of all required components of the study. Also, grand prize drawings for an I-pad and/or an Amazon Kindle occurred for every 10-15 teachers participating in the study. The number of grand prizes was contingent upon having enough classes for the study (See Appendix I).

The teachers selected for the Brainology© online curriculum intervention received a curriculum handbook for instituting the intervention and were given a web link to access and view a 90-minute online orientation video which explained the Brainology© Program and research about the growth mindset. This orientation served as teachers' professional development activities to support them with teaching the ancillary growth mindset lessons which accompanied the Brainology© curriculum. The purpose of this professional development video was to provide foundational knowledge for teachers about the growth mindset and how it could be utilized in their classrooms to facilitate teaching and learning (Blackwell, 2011). The online tutorial served as a go-to implementation guide and orientation of the expectations for the Brainology© curriculum (Mindset Works, 2011). Teachers were expected to complete the online orientation session prior to students beginning the Brainology© intervention.

The video guided teachers through four sections of the Brainology© curriculum. These sections provided the following: an overview, purpose, and structure of the Brainology© curriculum; tools and tips for planning and supporting the teachings in the Brainology© curriculum; instructions on how to implement the program; and tips and guides for teaching the growth mindset in the classroom (Mindset Works, 2011).

All teachers in the study conducted an evaluation of a sample of 35 students randomly selected from their classrooms. These evaluation ratings occurred at the mid-point and at the conclusion of the study. The purpose of these evaluation ratings was to measure any student behavioral or motivational changes during the course of the study.

During the first week of September, over 3,000 seventh-grade students in participating schools were sent informed assent forms and were asked to sign those assent forms to show if they were willing to participate in the research project (See Appendix J). Teachers were asked to allow the students to read the assent forms silently while teachers read aloud to ensure that all information was orally read to the students. Additionally, all students received informed consent letters to deliver to their parents and return to school, indicating whether or not their parents were willing to give permission for their child's data to be used for analysis for this research study (See Appendix K). Students had two weeks to return these assent forms in order for the researcher to cross-reference the names and identification numbers of the students participating in the study. In addition to parents receiving the informed consent letter, they also received an Alert Now phone and email message to inform them that these consent forms were sent home for their review. The messages alerted parents that an informed consent had been sent home with their children and that they should determine if their child could participate in the research study; if they agreed that their child might participate, the consent form should be returned. These messages were sent one to two times prior to the due date as reminders to parents to submit informed consent forms prior to the third week of September. Students and parents were informed of their right to withdraw from the study or request their data be excluded from the data analysis at any point during the research study. As informed consents were received, students were recorded as control or experimental group, based on their teacher's randomized assignment.

Both student groups took a series of pre-assessment measures to gain a baseline of their academic self-efficacy, mindset beliefs (implicit theories of intelligence), effort beliefs, study skills strategies, and interest and engagement in science. Both groups were administered the same post assessment at the end of the study. The pre assessment was administered by early November 2012, and the post assessment was administered at the conclusion of the study in March 2013.

Students' math and science achievement data in the form of quarterly grades for the first three quarters (October, January, and March) were collected, along with math benchmark (first-quarter and third-quarter) assessment scores.

At the end of the study, focus groups were conducted with a small sample of students and all teachers in the experimental group. The purpose was to gather additional information about the impact of the Brainology© curriculum intervention. Participants from each of the four schools in the experimental group were asked questions about (a) the impact of the study on them as participants, (b) how the program impacted their beliefs and views related to motivation and (c) the benefits of using the Brainology© Program Intervention.

These focus-group interviews consisted of a series of questions for teachers and students (See Appendices L and M). For students, the questions focused on how the program impacted them, their learning, and beliefs on how the information in the program was useful or could be improved. For teachers, the focus group questions centered on how the program impacted them as teachers and their classrooms.

Though participants signed original consent and assent forms to participate in this study, the focus group interview session included a participant sign-in sheet that had a brief statement to indicate that participants were assenting/consenting to participate in the focus group interviews (See Appendix N).

These focus groups provided qualitative data that revealed students' attitudes about academic challenges and/or their abilities, and their perceptions of and benefits from the Brainology© program. These interviews allowed participants to provide feedback about the study and how it was beneficial or might be improved.

Another goal of the focus groups was to gain teacher feedback about the impact of the intervention on the classroom environment, student responses, and use of strategies or concepts learned in the curriculum. The teacher component of the focus groups asked teachers to provide feedback about the program quality and their perceptions about how the program could be improved or modified.

Data Collection

Quantitative and qualitative data were collected during the study. Quantitative data collection began in July 2012. A data request was submitted to the school district for the names of all seventh-grade students in the seven participating schools. The data request included a request for the student's name, school, identification number, classroom teacher's name, and parental contact information. This data was used to record and track signed informed consent letters. Students who did not have signed informed consent letters were removed from the data file. Future data requests included information for only students with informed consents on file.

Once consent forms were signed and returned, a second data request was made to the school district. This request was for basic demographic information including race/ethnicity, gender, age, and educational status with regards to regular, special, gifted or limited English proficiency. Sixth grade reading and math End Of Grade (EOG) exam scores were also requested.

Data collection for pre/post assessments on students and teachers was completed online via a survey data collection tool. Students selected their responses to each of the questions in the pre and post assessment. The researcher downloaded the responses from the surveys to analyze the data. These responses were given a score that correlated to the Likert-type scales used for the assessments. The codes enabled analysis of the data from the pre- and post-test assessments. Some items from the various subscales were reverse-coded as needed, and each subscale was scored according to specific directions from the authors of the subscales. Identical procedures were used for the collection of post surveys for students and teachers.

Student achievement score data was collected through a data request to the school district for students' quarterly grades for quarters 1, 2, and 3 in math and science. In addition to the collection of quarter grades, a data request was made for student interim assessment grades for math for two benchmark assessments—quarter 1 and end of quarter 3.

As referenced previously, a Behavior Task Choice Assignment was to be piloted in this research study. The behavior task choice was intended to measure students' behavior on two dimensions: effort investment and challenge-seeking. Due to new mandates and expectations on teachers to learn the new science curriculum and due to fear of participant drop out, it was discussed that this measure should be omitted from this research study. After reflection about the challenges of implementing a new curriculum (training, alignment of resources, assessment development), the decision was made to omit this measure from the research study.

Data Analysis

Frequencies, means, and standard deviations, as appropriate, were calculated on all demographic variables and all pre-assessment subscales to describe and to compare the two randomly-assigned groups. In addition, two sample t-tests and chi-squares analyses, as appropriate, were used to demonstrate the equality of the experimental and control groups. A Bonferroni correction was applied to correct for experiment-wise error given the multiple comparisons (Keppel, 1982). Correlations were run among the various subscales to explore relationships among the subscales.

The following describes how each research question in this study was addressed. Research Question 1 focused on the effects of the Brainology© intervention on eight student measures by asking, "How does the use of the Brainology© intervention affect students' (a) mindset beliefs, (b) effort beliefs, (c) academic self-efficacy, (d) interest and engagement in science, (e) effort in the science classroom, (f) motivation in the science classroom, and (g) student use of three study skills strategies?" To address this research question, a series of analyses of covariance (ANCOVAs) were run with group as the independent variable, gain scores on each of the measures as the dependent variables, and the pre-test scores as the covariates. A Bonferroni correction was used to control for experiment-wise error given seven ANCOVAs.

To answer Research Question 2, "What is the relationship between student academic self-efficacy and student science and math achievement?" a correlation was computed between the student pretest PALS Academic Efficacy subscale and the students' first math benchmark scores.

To address Research Question 3, "How does student achievement in science and math change over the course of the school year for students who participated in the Brainology© intervention compared with students who did not participate in the Brainology© intervention?" a two-factor, repeated measures analysis of variance was run with quarter science grades as the dependent variable. Independent variables were group and quarter (first, second, third). This analysis was repeated for the two benchmark achievement assessments in math.

To answer Research Question 4, "Does student mindset predict student efficacy and, in turn, student achievement?" three different path analyses, which used two-stage least squares regressions, were used. For path analysis model #1, in the first stage, student mindset at pretest was used to predict pretest student academic self-efficacy. In the second stage, predicted self-efficacy scores from the first stage were used to predict student math achievement as measured by the first benchmark assessment. For path analysis model #2, this analysis was repeated using gain scores to determine if changes in mindset produced changes in efficacy and, in turn, changes in achievement. For path analysis model #3, this analysis was repeated using post-test scores to determine if post-test scores predicted changes in spring student achievement.

Limitations

There were several limitations involved in the study design. The first limitation involved the actual Brainology© curriculum. There were quiz assessments imbedded in the program that were not utilized in this study. These quizzes are normally taken by participants in a paper and pencil format. These quizzes were not utilized because they could not be taken electronically by students and were short response items. The time to analyze data from these responses would have required time beyond the time frame allotted for this study.

Because the unit of assignment was at the teacher level, there was some risk that control group teachers might learn about the program from colleagues assigned to the Brainology© condition. To reduce the likelihood that teachers would subsequently communicate about the programs to their colleagues, the researcher collaborated with school leaders about how to frame the project as a pilot to assess the efficacy of the program and to impress on their teachers the importance of their roles in helping to test the different models. In school visits and interviews with school staff, instances of contamination were noted. In our data analysis, we examined whether control teachers exhibited familiarity with or use of Mindset concepts in their practice.

Limitations regarding the measures involved the scale anchor and item adjustments made to several instruments. Also, the teacher observation rating measure of student behavior used in this study did not have established reliability.

Other limitations of this study involved the actual achievement measures used for the study design. The researcher did not have access to achievement measures for seventh-grade science classes involved in the study. The school district only provided math achievement benchmark (interim) assessments. Math data were collected because of the direct link between math and science and because math also has a standardized measure, including the interim benchmarks that measure all participants' achievement with a standardized achievement measure. Also, quarterly grades were collected as a proxy for achievement. This is a limitation because teachers do not grade students based on the same scales or weights. The differences in the grading of individual teachers could greatly impact the students' abilities to improve their grades over the course of the study and could also reflect inflation of grades by teachers with non-academic related grades such as grades for returning signed reports from parents.

Chapter 4: Results

Introduction

This study tested the efficacy of the Brainology© program intervention by determining if the use of this intervention positively impacted psychological variables related to students' perceptions of their academic abilities and increased their academic achievement in math and science. Seventh-grade science classrooms across seven middle schools in a large urban school district in the Piedmont Triad Region of North Carolina consented to participate in this research intervention.

This study used a series of measures to test various constructs. Students took a pre questionnaire at the beginning of this research study and an identical post questionnaire at the conclusion of the study. The questionnaires measured students' mindset (theory of intelligence), effort beliefs, academic self-efficacy, task value (interest and engagement) in science, behavioral motivation, and use of study strategies for learning. Students' mindsets were measured by the Theory of Intelligence subscale. Effort beliefs were measured by the Effort Beliefs subscale. Academic self-efficacy was measured by the Patterns of Adaptive Learning Styles (PALS) Academic Efficacy subscale. Interest and motivation in science was measured by the Motivation Strategies for Learning (MSLQ) Task Value subscale, and student use of study strategies for learning was measured by the MSLQ: rehearsal, elaboration, and organization subscales.

In addition to the measurements of the above listed constructs, teachers' mindsets, efficacy, and effort beliefs were measured. Teachers also completed observation ratings of a random sample of students' motivational behaviors to determine the frequency and use of specific observable behaviors in class. Students' math benchmark assessment scores and science and math quarter grades were also used as measures of student achievement. Lastly, focus groups were conducted with students and teachers from the experimental group to gain feedback and insight on the helpfulness and utility of the Brainology© program. This chapter presents the data and research findings from quantitative measures and focus groups.

Tests for Initial Differences in Sample

This study randomly assigned teachers to various treatment or control groups after consent was received for participation in the study. After the initial pre-test questionnaire was completed, tests for initial differences were performed on several demographic variables as well as the instruments in the questionnaire. Tests for initial differences were run for the following areas: basic demographic features (gender, ethnicity, Limited English Proficiency, Academically Gifted Status, Exceptional Children, and free-reduced lunch status), prior year end-of-grade (EOG) test performance (Grade 6 reading and math level and scale scores), fall teacher observation rating scores, and pre-assessment scales (mindset, effort beliefs, academic efficacy, science task value perceptions, and use of strategies for learning--rehearsal, elaboration, and organization).

As indicated in the research methodology, basic frequencies, means, and standard deviations were calculated for all demographic variables. T-test and chi-squares analyses were performed on select variables to ensure there were no statistical differences among participant groups at the onset of the research study. Results for tests for initial differences and overall means are provided within this section.

Prior to running the basic t-tests and chai squares, the overall sample size was reviewed for the study sample. These numbers were reviewed for the following areas: gender, ethnicity, Limited English Proficiency, Academically Gifted Status, Exceptional Children, and free-reduced lunch status. There were slightly higher percentages of females who consented to study participation. Almost half of the student sample was eligible for Free and Reduced Lunch (FRL).

Since school ethnic breakdown was provided for the collective schools in Chapter 1 of this study, total ethnic breakdown of the actual participants is provided to ensure that participant ethnic make-up is comparative to the respective school's ethnic make-up. Table 12 shows the percent and sample size breakdown for overall demographic variables measured.

Table 12

Demographic Variables for Sample

Demographic Variable	N	Percent
Gender		
Female	460	57.07
Male	346	42.93
Ethnicity		
White	376	46.65
Black	203	25.19
Hispanic	182	22.58
Other	45	5.58
Limited English Proficient	71	8.81
Academically Gifted	113	14.02
Exceptional Children Status	53	6.58
Free and Reduced Lunch Status	410	50.87

Two sample t-tests for and chi-squares were performed on the demographic variables and other pre-data to assess if there were initial differences between the treatment and control groups. The overall family-wise error rate was set at $\alpha = 0.10$ to ensure that no differences between groups were missed. To maintain this family-wise error rate of 0.10, $\alpha = 0.006$ was used for the 18 individual tests for differences. Table 13 displays the results of the t-tests and chi-squares for basic demographic characteristics, prior end-of-grade scores, teacher observation ratings of students, and student pre-test assessments.

Table 13

Tests for Initial Differences of Brainology© and Control Group

Variable	Test	Test Statistic	p
Basic Characteristics			
Gender	Chi-Square	0.23	0.6327
Ethnicity	Chi-Square	5.79	0.1222
Limited English Proficiency (LEP) Status	Chi-Square	2.54	0.1108
Academically Gifted Status	Chi-Square	4.90	0.0269
Exceptional Child Status	Chi-Square	1.98	0.1598
Free-Reduced Lunch Status	Chi-Square	0.17	0.6807
Prior Year (6^{th} Grade) EOG Results			
Grade 6 EOG Reading Level	Chi-Square	3.99	0.2621
Grade 6 EOG Reading Scale Score	t-test	-0.75	0.4512
Grade 6 EOG Math Level	Chi-Square	1.71	0.6342
Grade 6 EOG Math Scale Score	t-test	0.11	0.9107
Teacher Observations			
Fall Teacher Behavior Rating	t-test	1.20	0.2299
Student Pre-Assessment Subscales			
Theory of Implicit Intelligence Subscale	t-test	0.61	0.5402
PALS Academic Efficacy Subscale	t-test	1.40	0.1626
Effort Beliefs	t-test	0.92	0.3574
Science Self-Perceptions and Task Values	t-test	-0.52	0.6024
MSLQ – Rehearsal	t-test	1.62	0.1053
MSLQ – Elaboration	t-test	1.50	0.1340
MSLQ – Organization	t-test	0.65	0.5147

Note. To maintain family-wise error rate of 0.10, $\alpha = 0.006$ was used for the 18 individual tests.

Results showed that the two groups were relatively similar in all areas, that is, there were no statistically significant group differences at the beginning of this research study. Though there was no statistical significance between groups, there was a trend towards significance for slightly more Academically Gifted (AG) students in the Brainology© group than the control group.

Means were also calculated for both groups on pre-test measures: teacher observation ratings, mindset, effort beliefs, academic self-efficacy, interest and engagement in science, and use of strategies for learning. On all measures on the pre-test, means were in the mid-high range and were similar for both groups, with average anchor ratings on subscales and measures ranging from 2.0 to 4.4 for the control group and 2.1 to 4.4 for the Brainology© group. Anchor ratings for most subscales ranged from 1- to 6- with a rating of 6- indicating higher agreement with a construct. Table 14 shows the means on Pre-Test subscales by group.

Table 14

Means on Pretest Subscales by Group

	Group			
	Control N=149		Brainology© N= 539	
Subscale	Mean	SD	Mean	SD
Theory of Implicit IQ Subscale: Pre	4.4	0.9	4.4	0.9
Effort Beliefs Scale: Pre	4.4	0.8	4.4	0.8
PALS Academic Efficacy Subscale: Pre	4.1	0.7	4.0	0.7
Science Self-Perceptions/Task Values: Pre	2.0	0.8	2.1	0.9
MSLQ Strategies - Rehearsal: Pre	4.1	1.0	4.0	1.1
MSLQ Strategies - Elaboration: Pre	3.8	0.9	3.6	1.0
MSLQ Strategies - Organization: Pre	3.7	1.1	3.6	1.1

The means on subscales for the pre-test on the student questionnaires were similar for both the control and the experimental group. Participant numbers within the sample varied as the control group had a sample size of N=149 and the Brainology© groups sample size was N=539. The averages on the subscales and the test for initial differences indicated that student responses about mindset, effort beliefs, academic efficacy, interest and engagement in science, and use of study strategies were relatively the same between both groups.

Means were also calculated for the teacher observation ratings of student motivational behavior. Teachers were asked to complete observational ratings for 35 of their students who were randomly selected from among all their classes. The sample size for this measure is lower than the collective sample size for this study because the observation ratings were not completed on all student participants in the groups.

The tests for initial differences on the teachers' ratings of student motivational behavior showed no statistically significant differences between the control and experimental groups. The number of teachers who submitted the observation ratings of student motivational behavior was greater for the experimental group than the control group. Table 15 provides the means for the teacher observation ratings.

Table 15

Pretest Means for Teacher Observation Ratings

Measure	Group			
	Control N=140		Brainology© N=345	
	Mean	SD	Mean	SD
Teacher Observation Rating-Pre	4.6	1.0	4.5	1.1

Correlational Analysis of Subscales at Pretest

Correlations were calculated on the pretest subscales to see if any relationship existed among the subscales measured in the study. Because several of the constructs measured were similar, it was expected that some subscales would have relationships.

Previous research had illustrated relationships among student theories of intelligence, effort beliefs, perceptions of academic efficacy, and task value (Blackwell, et, al. 2007; Midgley et al., 2000; Pintrich & De Groot, 1990). In several of these studies, it was found that when student mindset was high, then student efficacy was also high and vice-versa. Table 16 shows the correlations among subscales.

Table 16

Pretest Correlations Among Subscales

Pearson Correlation Coefficients							
	Mind-set	Effort Beliefs	Efficacy	Task Value	Rehearsal	Elaboration	Organization
Mindset-Theory of Implicit Intelligence		0.46	0.32	-0.22	0.22	0.13	0.10
Effort Beliefs			0.56	-0.45	0.41	0.36	0.34
Academic Efficacy-PALS				-0.43	0.37	0.38	0.36
Science Interest MSLQ-Task Value					-0.35	-0.41	-0.36
Rehearsal MSLQ S – Rehearsal						0.66	0.69
Elaboration MSLQ – Elaboration							0.75
Organization-MSLQ – Organization							

Note. A correlation of 0 to 0.3 (+/-) was considered to have no relationship among subscales. A moderate relationship among subscales ranged from .3 to .7 (+/-), and a strong correlation between subscales was measured with a correlational coefficient of .7 (+/-) or greater.

Correlations for mindset. A moderately positive relationship existed between student mindset and effort beliefs, $r = 0.46$ and student mindset and academic self-efficacy $r = 0.32$. When students had a growth mindset, they had a greater willingness to put forth effort and relatively higher beliefs in their capabilities to be successful (academic self-efficacy). No relationship existed between student mindset and interest and engagement in science, $r = -0.22$. There was also no relationship found between mindset and student use of any study strategies for learning for rehearsal strategies for learning, $r = 0.22$; for elaboration strategies for learning, $r = 0.13$; and for organizational strategies for learning, $r = 0.10$.

Correlations with effort beliefs. A moderately positive relationship existed between student effort beliefs and academic efficacy, $r = 0.56$; and between effort beliefs and use of rehearsal ($r = 0.41$); elaboration ($r = 0.36$); and organizational ($r = 0.34$) study skills strategies. If a student had positive effort beliefs, they also had relatively high academic self-efficacy and moderately greater use of rehearsal, elaboration, or organizational strategies for learning. The relationship between student effort beliefs and interest and engagement in science (Task Value) was moderately negative, $r = -0.45$, indicating when student efficacy was relatively high, students tended to have relatively lower interest in science and vice versa.

Correlations with academic self-efficacy. There was a moderately negative relationship between student academic efficacy and science task value, $r = -0.43$. When student academic efficacy was relatively high, students tended to have less desire to engage in learning science and vice versa. There was a moderately positive relationship between student academic self-efficacy and the use of rehearsal ($r = 0.37$); elaboration ($r = 0.38$); and organizational ($r = 0.36$) study skill strategies. When student efficacy was high, student use of study skill strategies tended to be moderately high.

Correlations with task-value. There was a moderately negative relationship between student interest and engagement in science and student use of strategies for learning rehearsal ($r = -0.35$); elaboration ($r = -0.41$): and organizational strategies ($r = -0.36$). Students who were interested and motivated to participate in science were not as likely to employ the use of study strategies for learning. Additionally this relationship showed that students who employ study strategies for learning are less likely to have relatively high interest in learning science.

Correlations with strategies for learning. A moderate to strong positive relationship existed between student use of rehearsal strategies and elaboration (r =0.66) and between student use of rehearsal and organizational (r = 0.69) strategies for learning. Students who tended to use one of the strategies for learning also tended to employ the use of the other study strategies for learning as well. A strong positive relationship existed between a student's use of elaboration and organizational strategies (r = 0.75). Students who tended to use elaboration study strategies for learning also employed the use of organizational strategies. This is supported by the fact that both of these types of study strategies require higher cognitive demands than rehearsal strategies.

Fidelity of Research Implementation

Since the approval of this research study, several core elements of data collection and analysis were modified due to adjustments in participant numbers and data availability. During study implementation, several factors impacted the Brainology© experimental group implementation. These factors were out of the researcher's control but must be accounted for and discussed to provide insight as to why implementation and analysis of measures were modified.

Changes in analysis and scales. The use of the seventh-grade science benchmark test scores were expected to serve as a measure of student achievement. At the beginning of the 2012-2013 school year, the school district made a decision not to administer interim benchmark assessments in seventh-grade science. To analyze student achievement for this research study, math and science quarterly grades along with math benchmark assessment scores were used.

Since the data from the surveys and questionnaires were input from an outside provider, there was an instance where a question was omitted from a subscale. This information is provided in Chapter 3.

Teacher Pre-and Post-Survey Questionnaires were to be used to determine if teacher mindsets, effort beliefs, and efficacy changed over time and if they were confounding variables of students' mindsets, effort beliefs, and efficacy. Due to the limited sample size of teachers and non-random drop-out of research participants, these analyses were omitted from this research study.

Brainology© implementation. Several students in the Brainology© intervention group completed computer modules and participated in classroom curriculum lessons and discussions designed to reinforce the teaching of the growth mindset. The Brainolgy© curriculum took about 45 minutes of class time per unit. All Brainology© course modules were to be completed by mid to late March. Student usage was reviewed at the completion of the study to determine the levels of treatment received by participants during the intervention. Table 17 provides usage data on the Brainology© program student completion of units. To finish the Brainology© curriculum, students had to have completed all four units of the program.

Table 17

Student Completion Levels of Brainology© Intervention

Levels of Progress	N	Percent
Has Not Started	426	33.81
Introduction	1	0.08
Introduction Completed	7	0.56
Unit 1	34	2.70
Unit 1 Completed	43	3.41
Unit 2	129	10.24
Unit 2 Completed	15	1.19
Unit 3	108	8.57
Unit 3 Completed	8	0.63
Unit 4	137	10.87
Unit 4 Completed	352	27.94

Note. Student usage data retrieved on April 14, 2013.

It is evident is that many students did not begin participation in the Brainology© intervention and some students did not complete the entire Brainology© curriculum program. Because many students failed to complete the program in its entirety, the researcher believed it necessary to create a rubric to measure the fidelity of implementation and usage of the Brainology© program. These group configurations were developed based on the student level of usage and completion of the Brainology© intervention. Categories and usage levels for the fidelity of completion rubric can be found in Table 18. The creation of this rubric for fidelity of completion created a total of 5 treatment groups: control, no implementation, minimal implementation, partial implementation, and full implementation groups. The levels of treatment groups developed based on the implementation rubric assisted in the categorization and analysis of intervention groups for research questions posed in this study.

Table 18

Brainology© Program Fidelity of Completion Rubric

Program Units Completed	Implementation Level
Did not begin program or only 1 unit completed	No Implementation
> than 2 units completed	Minimal Implementation
≤ 3 units completed	Partial Implementation
4 units completed	Full Implementation

After the experimental treatment group was re-configured, means were calculated to reflect the new treatment groups. Table 19 shows the number and percent of participants in each treatment group and the percent of the sample of the research sample.

Table 19

Treatment Group Sample Size

Treatment	N	Percent
Control	194	24.7
No Implementation	178	22.7
Minimal Implementation	73	9.3
Partial Implementation	82	10.5
Full Implementation	257	32.8

The largest treatment group was the No Implementation group. This group was randomly assigned to the Brainology© intervention but did not participate in the research program. The smaller numbers of group participants in treatment groups were the minimal, partial, and control groups.

Analysis of Means by Treatment Levels

Since the number of treatment groups increased from two groups to five groups due to the creation of four implementation levels of the Brainology© treatment group, means were re-run for the groups based on the group implementation level. The averages of means among the five groups show similar means in relation to previous research studies in which these subscales were used.

Each of the subscales had varying means for this research study. Table 20 displays the subscale means on the pre-assessment measures for the five treatment groups.

Table 20

Pre-Test Means on Subscales by Treatment Group

Construct Measured by Subscale	Control *N= 149*		No Treatment *N= 168*		Minimal Treatment *N=69*		Partial I Treatment *N= 78*		Full Treatment *N= 220*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mindset: Pre	4.4	0.9	4.3	0.9	4.3	0.9	4.2	0.9	4.5	0.9
Effort Beliefs: Pre	4.4	0.8	4.3	0.8	4.3	0.7	4.4	0.7	4.4	0.7
PALS Academic Efficacy: Pre	4.1	0.7	4.0	0.7	4.0	0.8	3.8	0.7	4.0	0.7
Science Task Values: Pre	2.0	0.8	2.0	0.8	1.9	0.8	2.1	0.9	2.2	0.9
MSLQ – Rehearsal: Pre	4.1	1.0	4.0	1.1	4.0	1.1	3.8	1.0	4.0	1.2
MSLQ – Elaboration: Pre	3.8	0.9	3.7	1.0	3.4	1.1	3.5	1.0	3.6	1.0
MSLQ – Organization Pre	3.7	1.1	3.7	1.1	3.6	1.0	3.5	1.0	3.7	1.2

The research of Dweck (1999) found an average mean for the mindset (Theory of

Intelligence) subscale between 4.45 and 4.47. The means for the mindset subscale for this research sample ranged from 4.2 (partial implementation) to 4.5 (full implementation group). Means for this research study were similar to means in previous studies.

Previous means on the effort belief subscale indicate an average score among participants toward positive effort beliefs is 4.6. Means for the effort beliefs subscale were also similar in the Blackwell et al. (2007) research study. The mean for this study was $\bar{x}$ = 4.66 and std. deviation =.89. The range of means for this research study were $\bar{x}$ =4.3 (no and minimal implementation groups) to $\bar{x}$ =4.4 (control, partial, and full implantation groups). These means are similar to previous studies.

The means for the academic self-efficacy subscale of Midgley et al. (2000) research study found $\bar{x}$ = 4.20 and std. deviation =0.71. For this research study, $\bar{x}$ =3.8 for the partial implementation group; $\bar{x}$ =4.0 for the full, minimal, and no implementation groups; and $\bar{x}$ =4.1 for the control group. The means for the academic self-efficacy subscale in this study were somewhat lower than previous studies.

On the task value subscale, Pintrich and De Groot (1990) reported the following results: $\bar{x}$ =5.54 and std. deviation= 1.25. The means for this study were 1.9 for the minimal implementation group; $\bar{x}$ = 2.0 for the no implementation and control group; $\bar{x}$ = 2.1 for the partial implementation group; and $\bar{x}$ = 2.2 for the full implementation group. The means for this study were lower than the means reported by Pintrich and De Groot.

For the rehearsal strategies subscale, Pintrich and De Groot (1990) reported $\bar{x}$ = 4.53, std. deviation =1.35. The means for this study were $\bar{x}$ =3.8 for the partial implementation group, $\bar{x}$ = 4.0 for the no implementation, minimal, and full implementation groups, and $\bar{x}$ = 4.1 for the control group. The means for this study were lower than the means reported by Pintrich and De Groot.

Pintrich and De Groot (1990) reported $\bar{x}$ = 4.91, std. deviation =1.08 for the elaboration strategies subscale. The means for this study were $\bar{x}$ =3.4 (minimal implementation group), $\bar{x}$ = 3.7 (no implementation group), $\bar{x}$ = 3.8 (control and partial implementation group), and 4.0 (full implementation group). The means for this study were lower than the means in Pintrich and De Groot.

The organizational strategies subscale used in Pintrich and De Groot (1990) had $\bar{x}$ = 4.14, std. deviation =1.33. The means for this study were $\bar{x}$ =3.5 (partial implementation group), $\bar{x}$ = 3.6 (minimal implementation group), $\bar{x}$ = 3.7 (control, no implementation, and full implementation groups). The means for this study were lower than the means of Pintrich and De Groot.

Means were also calculated for the post-test subscales for the implementation groups for all eight measures. Table 21 provides the post-test means for all five treatment groups.

Table 21

Post-Test Means on Subscales by Treatment Group

Construct Measured by Subscale	Control N= 107		No Treatment N= 65		Minimal Treatment N=39		Partial Treatment N=47		Full Treatment N=150	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mindset: Post	4.4	0.9	4.2	0.8	4.4	0.9	4.3	0.8	4.5	0.9
Effort Beliefs: Post	4.3	0.8	4.2	0.7	4.2	0.6	4.1	0.9	4.4	0.8
PALS Academic Efficacy: Post	4.1	0.6	4.0	0.7	3.9	0.6	3.8	0.7	4.1	0.8
Science Task Values: Post	2.08	0.80	2.29	0.80	2.27	0.83	2.37	0.88	2.35	0.93
MSLQ - Rehearsal: Post	3.98	1.11	3.77	1.09	3.79	0.89	3.31	1.19	3.96	1.13
MSLQ-Elaboration: Post	3.69	1.06	3.58	1.09	3.54	1.04	3.35	1.02	3.62	1.03
MSLQ-Organization: Post	3.68	1.17	3.40	1.11	3.49	0.86	3.29	1.22	3.55	1.07

Means for difference scores between the pre-and post-test on each subscale were calculated for all five treatment groups. The average difference scores on scales ranged from -0.07 to 0.8. Table 22 shows the mean gain scores across implementation groups.

Table 22

Mean Gain Scores Among Treatment Groups on Subscales

Construct Measured by Subscale	Control N= 107		No Treatment N= 65		Minimal Treatment N=39		Partial Treatment N=47		Full Treatment N=150	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mindset: Diff	-0.1	0.9	-0.2	0.8	0.1	1.0	0.1	0.8	0.1	1.0
Effort Beliefs: Diff	-0.1	0.8	-0.1	0.6	0.0	0.5	-0.2	0.8	0.00	0.6
PALS Academic Efficacy: Diff	-0.00	0.7	0.00	0.7	0.0	0.6	0.1	0.8	-0.0	0.7
Science Task Values: Diff	-0.01	0.90	0.29	0.69	0.41	0.70	0.27	0.73	0.17	0.95
MSLQ - Rehearsal: Diff	-0.07	1.20	-0.22	0.95	-0.08	0.94	-0.39	0.99	-0.12	1.10
MSLQ - Elaboration: Diff	-0.04	1.07	-0.12	0.88	0.32	1.04	-0.09	0.98	-0.01	1.05
MSLQ - Organization: Diff	0.07	1.12	-0.32	0.95	0.12	0.97	0.06	1.12	-0.14	1.21

Means were also calculated on the initial teacher observation ratings of student behavior. The behavior observation ratings were conducted to determine the degree of positive student behavior changes during the research study. A small sample of students of each teacher was randomly selected to complete the observation ratings. Table 23 shows the pretest means for the observation behavior student ratings. Average ratings for all groups were similar among the five treatment levels. These behavior ratings ranged from 4.29 to 4.59. The control group had slightly higher average ratings.

Table 23

Pre-Test Means by Treatment Group on Behavior Ratings

	Control N= 140		No Treatment N= 98		Minimal Treatment N=39		Partial Treatment N=45		Full Treatment N=161	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Teacher Observation Rating #1: Pre-	4.59	0.96	4.29	1.14	4.85	1.02	4.47	1.22	4.52	1.13

Means were calculated on the post-observation ratings. Table 24 shows the post teacher behavior observation ratings of students. These ratings show that all treatment groups' behavior ratings on average ranged between 4.05 and 4.77. The highest average ratings were for the full implementation and control treatment groups.

Table 24

Post-Test Means by Treatment Group on Behavior Ratings

	Control N= 137		No Treatment N= 68		Minimal Treatment N=23		Partial Treatment N=31		Full Treatment N=147	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Teacher Observation Rating #2	4.76	1.13	4.05	1.07	4.75	1.33	4.21	1.58	4.77	1.19

Gains in observation ratings of motivational behavior were also calculated for the 5 treatment groups. Difference means for the groups ranged from -0.19 to 0.19, with the highest observation rating gains seen with the full implementation and control treatment groups. Table 25 provides the mean gains for teacher observation ratings of student behavior for this research study.

Table 25

Mean Gains in Behavior Ratings

	Control N= 137		No Treatment N= 68		Minimal Treatment N=23		Partial Treatment N=31		Full Treatment N=147	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Teacher Observation Rating: Diff	0.17	0.86	-0.14	0.66	-0.16	0.96	-0.19	0.88	0.19	0.68

Analysis of Variance on Measures

Research Question 1, "How does the use of the Brainology© intervention affect students' (a) mindset beliefs; (b) effort beliefs; (c) academic self-efficacy; (d) interest and engagement in science; (e) effort in science; (f) motivation in the science classroom; and (g) use of effective study skills?" was addressed with a series of analysis of the covariance (ANCOVA).

For the analysis of covariance, the pretest for each specific measure served as the covariate with gain scores for each measure as the dependent variable. The treatment group was the independent variable. Significance level was set to .006 for each of the eight ANCOVAs to maintain family-wise error at 0.05. Additionally, adjusted means were assessed for significant changes from pre- to post-test.

Mindset. The ANCOVA for the implicit theories of intelligence subscale did not show statistical significance for treatment group. Table 26 shows the ANCOVA for the Mindset subscale.

Table 26

ANCOVA for Mindset Theory of Intelligence Subscale

Source	df	Sum of Squares	Mean Square	F	p
Mindset Pretest (Covariate)	1	100.55	100.55	162.27	<.0001
Treatment	4	4.10	1.02	1.65	0.1603
Error	402	249.10	0.62		
Total	407	354.99			

After the ANCOVAs for mindset were calculated, adjusted means were run. None of the five treatment groups demonstrated any significant change from pre- to post-test. Adjusted means for the five treatment groups can be seen in Table 27.

Table 27

Theory of Intelligence Adjusted Means

Treatment Group	Adjusted Mean Gain	Standard Error	Pr > |t|
Control	-0.005	0.076	0.950
Full Implementation	0.098	0.064	0.127
Minimal Implementation	0.052	0.126	0.680
No Implementation	-0.196	0.097	0.046
Partial Implementation	-0.033	0.115	0.774

Effort beliefs. Effort Beliefs as a construct measured a student's beliefs about work and effort—whether they believed that effort or practice was worth the investment. The ANCOVA for effort beliefs was not statistically significant (see Table 28).

Table 28

ANCOVA for Effort Beliefs Subscale

Source	df	Sum of Squares	Mean Square	F	p
Effort Beliefs Pretest (Covariate)	1	30.93	30.93	79.01	<.0001
Treatment	4	2.87	0.72	1.83	0.1219
Error	402	157.39	0.39		
Total	407	191.18			

Adjusted means for the five treatment groups can be found in Table 29. There were no significant differences among groups. Only the partial implementation group showed significant change from pre- to post-test, a significant decrease.

Table 29

Effort Beliefs Adjusted Means

Treatment Group	Adjusted Mean Gain	Standard Error	Pr > |t|
Control	-0.111	0.061	0.0699
Full Implementation	0.020	0.051	0.6963
Minimal Implementation	-0.074	0.101	0.4599
No Implementation	-0.120	0.078	0.1215
Partial Implementation	-0.238	0.091	0.0095

Student academic self-efficacy. The PALS Academic Self-Efficacy subscale measured student's perceptions of their capabilities related to academic performance. The ANCOVA for self-efficacy was not statistically significant (see Table 30).

Table 30

ANCOVA for Academic Self-Efficacy Subscale

Source	df	Sum of Squares	Mean Square	F	p
Academic Self-Efficacy Pretest (Covariate)	1	45.32	45.32	113.50	<.0001
Treatment	4	0.65	0.16	0.41	0.801
Error	402	160.53	9.09		
Total	407	205.99			

Adjusted means were also calculated for the academic self-efficacy ANCOVA and are presented in Table 31.

Table 31

Academic Self-Efficacy Adjusted Means

Treatment Group	Adjusted Mean Gain	Standard Error	Pr > |t|
Control	0.043	0.061	0.4815
Full Implementation	0.025	0.052	0.6257
Minimal Implementation	-0.051	0.101	0.6172
No Implementation	-0.013	0.078	0.8665
Partial Implementation	-0.076	0.093	0.4147

Student science perceptions and task value. The Task Value subscale of the MSLQ measured a student's motivation, interest, and engagement in science. The subscale focuses on gaining a better understanding of students' value, interest, engagement, importance, and utility of learning science. Task value refers to the student's evaluation of how interesting, important, and useful learning science is to them.

The ANCOVA on the Task Value subscale showed a trend towards significance (see Table 32).

Table 32

ANCOVA Student Self-Perceptions and Task Value

Source	Df	Sum of Squares	Mean Square	F	p
Science Task Value Pretest (covariate)	1	64.67	64.67	114.02	<.0001
Treatment	4	5.24	1.31	2.31	0.0570
Error	401	227.47	0.57		
Total	406	299.15			

Table 33 displays adjusted mean gain scores for the five groups on student perceptions/motivation in science and task value. The control group showed a decrease in interest in science while the full treatment group showed statistically significantly gains in science interest over the other four groups.

Table 33

Adjusted Means for Task Value

Treatment Group	Adjusted Mean Gain	Standard Error	Pr > |t|
Control	-0.007	0.07	0.9144
Full Treatment	0.214	0.06	0.0006
Minimal Treatment	0.299	0.12	0.0138
No Treatment	0.253	0.09	0.0070
Partial Treatment	0.273	0.11	0.0143

This analysis showed that all groups, except for the control group, showed a positive increase in science task value perception from the pre- to post-tests. The full implementation group had significant improvement from the pre- to post-test. There was a trend toward significant improvement for the other three Brainology© groups.

Rehearsal strategies for learning. Rehearsal strategies are study strategies that help students remember facts and basic information such as recitation, use of flash cards, etc. Rehearsal strategies are used for studying/memorizing simple bits of information (Pintrich et al., 1991). These strategies are believed to involve low metacognitive usage but are beneficial in helping students gain understanding of definitions and knowledge application of content. The ANCOVA demonstrated a statistical trend towards significance for treatment group (see Table 34).

Table 34

ANCOVA for Rehearsal Strategies Subscale

Source	Df	Sum of Squares	Mean Square	F	P
Rehearsal Strategies Pretest (covariate)	1	105.50	105.50	116.10	<.0001
Treatment	4	8.95	2.24	2.46	0.0447
Error	401	364.37	0.91		
Total	406	473.94			

Table 35 presents the adjusted mean gain scores of each group. The partial implementation group had a significant decrease from pre- to post-test; this decrease was significantly lower than the decreases of either the control or full implementation groups.

Table 35

Adjusted Means for Rehearsal Strategies

Treatment Groups	Adjusted Mean Gain	Standard Error	Pr > |t|
Control	-0.047	0.092	0.6115
Full Treatment	-0.080	0.078	0.3028
Minimal Treatment	-0.136	0.153	0.3753
No Treatment	-0.226	0.119	0.0587
Partial Treatment	-0.530	0.140	0.0002

Elaboration strategies for learning. Elaboration Strategies require students to use higher metacognitive skills than rehearsal strategies. Elaboration study skill strategies provide an opportunity for one to make connections with content by paraphrasing, summarizing, creating analogies, or use of various types of note-taking techniques. The ANCOVA for elaboration strategies can be found in Table 36. The analysis of variance for elaboration strategies was not statistically significant.

Table 36

ANCOVA for Elaboration Strategies Subscale

Source	Df	Sum of Squares	Mean Square	F	P
Elaboration Strategies Pretest (Covariate)	1	80.80	80.80	95.75	<.0001
Treatment Group	4	2.35	0.59	0.70	0.5945
Error	401	338.40	0.84		
Total	406	424.60			

There were no statistically significant differences among the treatment groups and no groups demonstrated significant change in student usage of elaboration strategies. Adjusted means for all five groups can be seen in Table 37.

Table 37

Elaboration Strategies Adjusted Means

Treatment Groups	Adjusted Mean Gain	Standard Error	Pr > |t|
Control	0.015	0.089	0.8685
Full Treatment	0.001	0.075	0.9895
Minimal Treatment	0.140	0.148	0.3454
No Treatment	-0.074	0.115	0.5186
Partial Treatment	-0.165	0.134	0.2188

Organizational strategies for learning. Organizational strategies for learning help students arrange content for meaning by doing things such as creating timelines, outlines, or re-writing content in the student’s own words. This level of study strategies for learning require higher cognitive processing because the learner makes connections and constructs meaning of information (Pintrich & Shunk, 2002) The ANCOVA for organizational strategies was not statistically significant (see Table 38).

Table 38

ANCOVA for Organizational Strategies Subscale

Source	df	Sum of Squares	Mean Square	F	p
Elaboration Strategies Pretest (Covariate)	1	119.32	119.32	125.27	<.0001
Treatment Group	4	4.90	1.22	1.28	0.275
Error	401	381.95	0.95		
Total	406	510.15			

Adjusted means are presented in Table 39. There were no statistically significant differences among the treatment groups; the no implementation group had a statistical trend for a significant decrease from pre- to post-test.

Table 39

Organizational Strategies Adjusted Means

Treatment Groups	Adjusted Mean Gain	Standard Error	Pr > |t|
Control	0.082	0.094	0.3836
Full Treatment	-0.086	0.080	0.2794
Minimal Treatment	0.008	0.157	0.9583
No Treatment	-0.248	0.122	0.0430
Partial Treatment	-0.123	0.143	0.3905

Teacher observation ratings. Teachers were asked to rate student classroom behavior during participation in the study (e.g., talks inappropriately, participates with enthusiasm, persists rather than gives up, etc.). These observation ratings were completed in the fall and spring of this research study. Each teacher was asked to complete 35 observation ratings for randomly selected students. The ANCOVAs on teacher observation ratings yielded statistical significance for treatment group (see Table 40).

Table 40

ANCOVA for Teacher Observation Ratings

Source	df	Sum of Squares	Mean Square	F	p
Behavior Rating Pretest (covariate)	1	6.07	6.07	10.31	0.0014
Treatment	4	11.35	2.84	4.81	0.0008
Error	400	235.65	0.59		
Total	405	251.69			

Table 41 provides the adjusted means for behavior ratings for all treatment groups. The control and full implementation groups had significant positive gains from pre- to post-test, which were significantly different from the no implementation and partial implementation groups.

Table 41

Adjusted Means for Teacher Observation Ratings

Treatment Group	Adjusted Mean Gains	Standard Error	Pr > |t|
Control	0.182	0.066	0.0059
Full Treatment	0.201	0.063	0.0016
Minimal Treatment	-0.111	0.161	0.4883
No Treatment	-0.177	0.094	0.0599
Partial Treatment	-0.207	0.138	0.1340

The control and full implementation groups had significant increases in observational rating scores; these gains were significantly different from the no and partial implementation groups.

Correlation Between Academic Self-Efficacy and Achievement

To analyze the data for research question #2, what is the relationship between student academic self-efficacy and student science and math achievement, a Pearson Correlation Coefficient test was calculated. Since there was no science benchmark data for seventh-grade students during the 2012-2013 school year, only the correlation between academic self-efficacy and math benchmark scores was used. The correlation test of $\underline{r} = 0.16$ shows no relationship between student academic self-efficacy and math benchmark achievement.

Change in Student Achievement

To analyze data for Research Question 3, "How does student achievement in science and math change over the course of the school year for students who participated in the Brainology© intervention compared with students not participating in the

Brainology© intervention?" required a closer look at changes in grades in math and science and math benchmark scores. A two-factor, repeated measure analysis of variance (ANOVA) was completed on each of the three dependent variables: quarter math and science grades and math benchmark scores. Treatment group and academic quarter (first, second, or third) served as the independent variables. The effect of interest for all analysis was the interaction between treatment groups and quarter. To maintain experiment-wise error of 0.05, alpha was set at 0.017 for each of the three ANOVAs.

Math quarter grades. Table 42 provides the student math mean scores and standard deviations for all three quarters for students in the various treatment groups.

Table 42

Quarterly Math Grades by Treatment Group

Treatment	Quarter	Numerical Grade		
		Sample Size	Mean	SD
Control	1st -- 9 weeks	182	86.67	8.62
	2nd -- 9 weeks	184	88.05	9.85
	3rd -- 9 weeks	185	86.24	9.80
No Treatment	1st -- 9 weeks	151	84.04	8.07
	2nd -- 9 weeks	151	84.79	8.82
	3rd -- 9 weeks	152	82.82	9.04
Minimal Treatment	1st -- 9 weeks	57	83.99	7.58
	2nd -- 9 weeks	57	86.10	8.05
	3rd -- 9 weeks	58	83.69	9.40
Partial Treatment	1st -- 9 weeks	68	84.13	8.21
	2nd -- 9 weeks	68	83.02	10.22
	3rd -- 9 weeks	68	82.37	9.70
Full Treatment	1st -- 9 weeks	197	87.39	8.68
	2nd -- 9 weeks	198	87.68	9.66
	3rd -- 9 weeks	198	86.02	10.28

Based on the student grading scale, a numerical grade of 85% to 92% indicated that a student was performing at the above-average range or at an alpha grade performance of "B" while a numeric grade of 77% to 84% indicated the student was performing at the average range or at an alpha grade performance of "C". Among all treatment groups of this sample, student performance ranged from average to above-average.

The results from the two-factor, repeated measures analysis of variance on quarterly math grades indicated no interaction effect between treatment group by quarter. This means there was no statistically significant difference in student math grades by treatment groups over the three quarters. Table 43 shows the repeated measures analysis on math grades.

Table 43

Repeated Measures on Math Grades

Source	Df	SS	Mean Square	F	p
Treatment Group	4	5179.23	1294.81	6.37	<.0001
SS within Treatment	656	133426.34	203.39		
Quarter	2	586.01	293.00	11.61	<.0001
Treatment * Quarter	8	249.11	31.14	1.23	0.2752
Error	1303	32882.54	25.24		
Total	1973	172535.32			

Note. SS= Sum of Squares.

An illustration was created to show the interaction among groups based on each treatment group's quarterly grades (see Figure 3). .

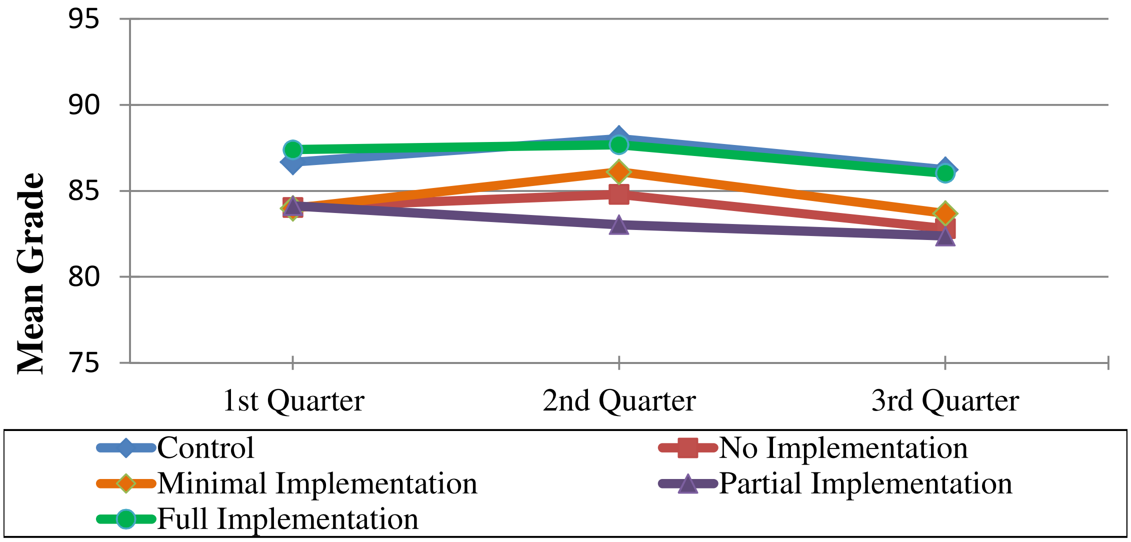

Figure 3. 2012-2013—Seventh-Grade Math Quarterly Grades By Treatment Group. This graphic shows no interaction between or among groups for math quarterly grades.

All five groups show no significant change patterns over the three quarters, only slight difference changes.

Science quarter grades. Science grades by group show a slightly different pattern than math grades. Table 44 shows the means and standard deviations for science grades over the three-quarters measured in this study.

Table 44

Quarterly Science Grades by Treatment Group

Treatment Group	Quarter	Numerical Grade		
		Sample Size	Mean	SD
Control	YL - 1st 9 weeks	150	83.53	19.23
	YL - 2nd 9 weeks	184	86.84	10.35
	YL - 3rd 9 weeks	185	86.36	11.90
No Treatment	YL - 1st 9 weeks	151	88.05	10.58
	YL - 2nd 9 weeks	151	83.58	12.81
	YL - 3rd 9 weeks	152	84.71	13.25
Minimal Treatment	YL - 1st 9 weeks	57	87.71	9.67
	YL - 2nd 9 weeks	57	83.04	9.29
	YL - 3rd 9 weeks	58	86.44	12.67
Partial Treatment	YL - 1st 9 weeks	68	87.38	9.87
	YL - 2nd 9 weeks	68	84.02	9.67
	YL - 3rd 9 weeks	68	87.63	8.06
Full Treatment	YL - 1st 9 weeks	197	92.28	9.26
	YL - 2nd 9 weeks	198	88.76	11.04
	YL - 3rd 9 weeks	198	88.95	8.19

Among all treatment groups of this sample, average performance ranged from the average “C” level to the well above-average “A” performance level. The two-factor, repeated measures ANOVA on science grades found a statistically significant group interaction (see Table 45).

Table 45

Repeated Measures on Science Grades

Source	df	SS	Mean Square	F	p
Treatment group	4	8252.69	2063.17	6.76	<.0001
SS within Treatment	656	200120.60	305.06		
Quarter	2	1718.27	859.14	18.51	<.0001
Treatment * Quarter	8	4037.83	504.73	10.88	<.0001
Error	1271	58985.61	46.41		
Total	1941	272150.08			

There were significant differences in science grade patterns over time between the treatment groups. During quarter 1, the full implementation group had significantly higher science grades than the control and no implementation groups. The control group had significantly lower grades than the no implementation group. During quarter 2, the full implementation group had significantly higher grades than the no implementation, minimal implementation, and partial implementation groups. During quarter 3 the full implementation group had significantly higher grades than the no implementation group. The interaction of student's science grades among treatment groups over time can be found in Figure 4.

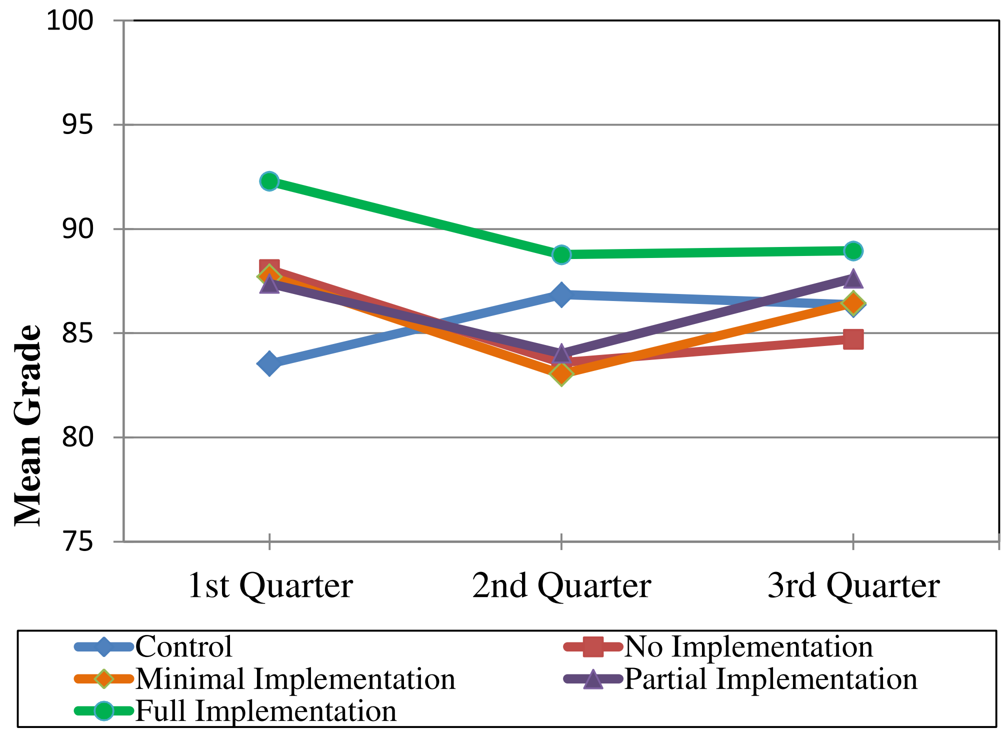

Figure 4. Seventh-Grade Science Quarterly Grades By Treatment Group Over Time. This graphic shows changes among treatment groups related to science grades during the research study.

There were significant differences within each treatment group over the three quarters. Grades for the control group were significantly higher during quarter 2 and 3 than they were in quarter 1. The no implementation and the full implementation groups had significantly higher science grades in quarter 1 than in quarter 2 or 3. The minimal and partial implementation groups had significantly lower grades in the 2nd quarter than in the 1st or 3rd quarters.

Math benchmark scores. Math Benchmark assessments were administered in fall 2012 and spring 2013. These assessments measure cumulative knowledge of student mastery of specific concepts understood at various points in the math curriculum. Means and standard deviations were calculated for math benchmark assessments for fall and spring (see Table 46). Mean scores are relatively low with average scores ranging from roughly 15% to 19% of items answered correctly from these assessments. It is helpful to remember that the math curriculum was changed from curriculum taught in previous years. Because the standards were new, both teachers and students were learning the course curriculum simultaneously.

Table 46

2012-2013 Fall and Spring Grade 7 Math Benchmark Scores

Treatment Group	Benchmark Period	Benchmark Score		
		Sample Size	Mean	SD
Control	Fall 2012	176	18.77	6.46
	Spring 2013	176	19.49	5.40
No Implementation	Fall 2012	548	18.01	6.62
	Spring 2013	510	18.54	5.82
Minimal Implementation	Fall 2012	121	15.93	5.84
	Spring 2013	106	17.10	5.22
Partial Implementation	Fall 2012	140	16.26	6.50
	Spring 2013	127	17.20	5.21
Full Implementation	Fall 2012	341	17.43	6.15
	Spring 2013	281	18.05	5.12

The two factor, repeated measures ANOVA demonstrated no statistically significant interaction between treatment group and time (see Table 47).

Table 47

Repeated Measures on Math Benchmarks

Source	Df	SS	Mean Square	F	p
Treatment group	4	1036.08	259.02	4.32	<.0001
SS within Treatment	1352	81006.13	59.92		
Benchmark	1	175.81	175.81	22.44	<.0001
Treatment * Quarter	4	38.76	9.69	1.24	0.2934
Error	1164	9118.97	7.83416		
Corrected Total	2525	91973.64			

The change in patterns of student scores for all treatment groups on the math benchmark for fall 2012 and spring 2013 increased similarly (see Figure 5).

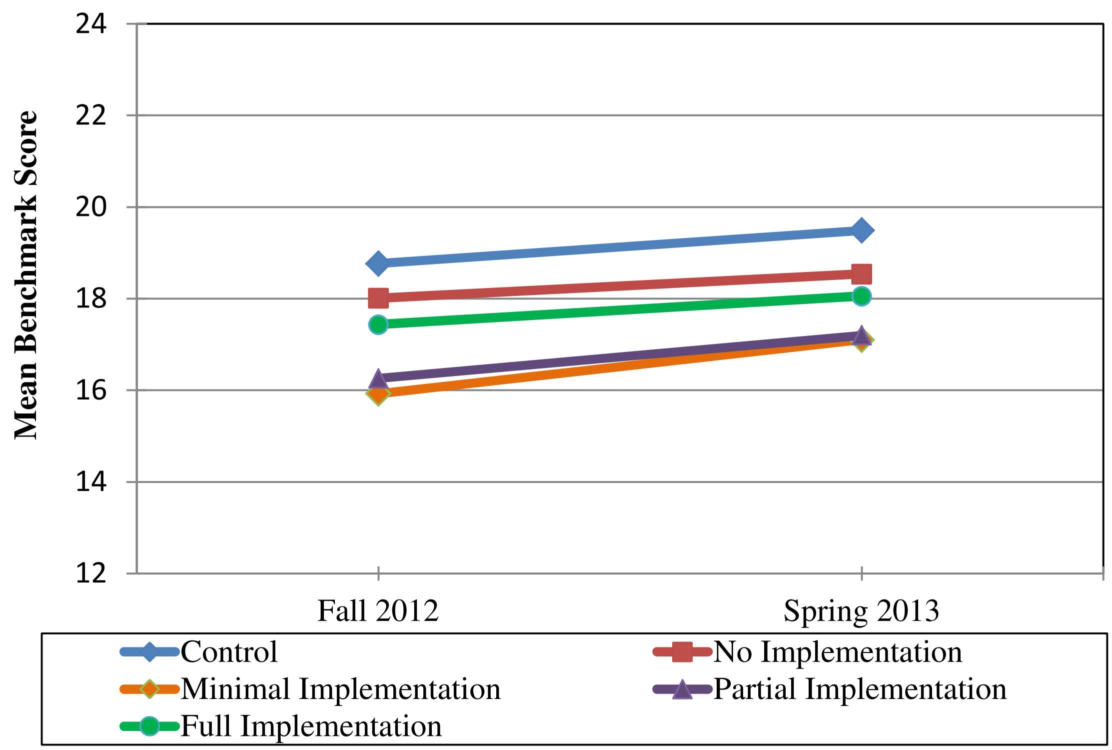

Figure 5. Seventh-Grade Math Benchmark Scores by Treatment Group Over Time. This shows figure shows no difference in student math benchmark scores.

Path Analysis Predictions

To analyze data for Research Question 4, "Does student mindset predict student academic efficacy and, in turn, student achievement?" two path analyses were performed using two-stage, least squares regression.

Path analysis #1. The first path analysis was performed on pretest scores while the second path model used change scores. For path analysis #1, the first stage, student mindset at pretest was used to predict pretest student academic self-efficacy. In the second stage, predicted self-efficacy scores from the first stage were used to predict math achievement, as measured by fall 2012 math benchmark assessment. Since there were no science benchmark assessments for seventh grade in 2012-2013, no data was available to complete the path analysis for science achievement data. Figure 6 shows the results of the path analysis model #1.

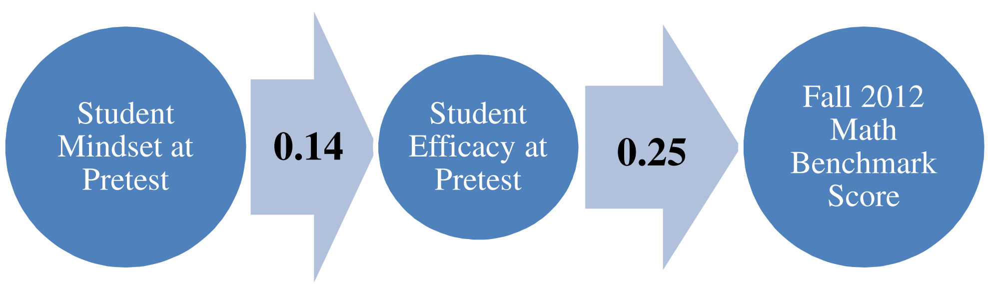

Figure 6. Path Analysis Model #1. This prediction model shows significance during both stages.

The results from path analysis stage one yielded a significant path coefficient of 0.14 in predicting pretest student efficacy ($p = 0.0002$). The results of stage two produced a significant path coefficient of $p < 0.0001$.

Path analysis #2. For path analysis #2, stage one used change scores in student mindset to predict changes in efficacy. In stage two, predicted change scores from student efficacy were used to predict change in math benchmark scores. Figure 7 shows path model #2.

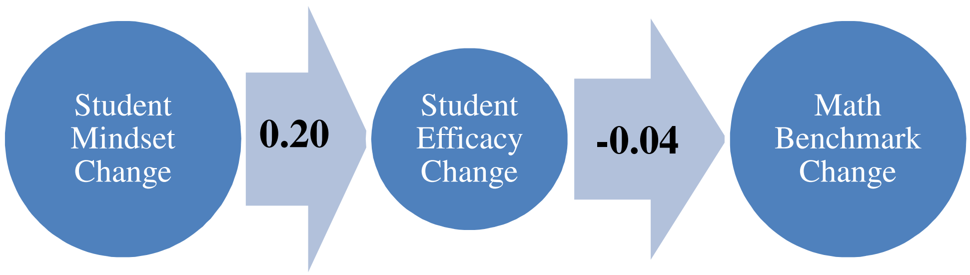

Figure 7. Path Analysis Model #2. This prediction model shows significance stage one but not during stage two.

The results of stage one demonstrated a significant path coefficient of 0.20 ($p < .0001$). The results of stage two of path analysis #2 yielded a path coefficient of -0.04 ($p = .04469$), which was not statistically significant. Student efficacy change does not predict math benchmark change.

Path analysis #3. Though only two path analyses were originally proposed in this study, the researcher felt it important to propose a third path analysis of the data. This third path analysis provides insight about the predictability of student post-test scores, serving as a predictor of student achievement at post-test.

For path analysis #3, in stage one, student mindset post-test scores were used to predict student efficacy post-test scores. In stage two, predicted efficacy post-test scores were used to predict student spring 2013 math benchmark scores. Figure 8 shows path model #3.

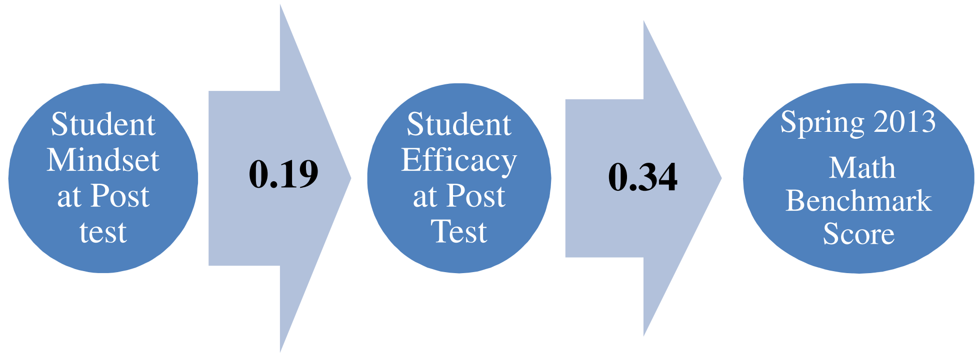

Figure 8. Path Analysis Model #3. This prediction model was the best path model of the three path analysis models computed.

The results of path analysis #3 show a significant path coefficient of 0.19 ($p = 0.0001$). Student mindset at post-test is a significant predictor of student efficacy at post-test. The results of stage two revealed a significant path coefficient of .34 ($p < 0.001$). Student post-test efficacy predicted spring 2013 math benchmark scores. This model was the best model proposed for predicting increases in student achievement.

Qualitative Data

Focus groups were conducted to gain feedback from participants about the quality of the intervention and insight on how the Brainology© program could be adjusted or improved. Both students and teachers participated in focus groups. These focus groups provided descriptive data that elicited students' attitudes about academic challenges, their abilities, and their perceptions of the Brainology© program. Specific research questions were used to ascertain participants' understanding of intervention concepts as well as their thoughts about the total treatment implementation. The Brainology© program intervention included both a computer program through which students participated in four units in order to complete the entire program *(Brain Basics, Brain Behavior, Brain Building, and Brain Boosters*) and classroom lesson activities facilitated by their classroom teachers. The online units provided instruction about the following: the growth mindset, how the brain works/functions, how to build/grow our brains, and strategies that support continuous learning and development of the brain. The classroom lesson activities facilitated by the classroom teachers served to reinforce principles taught in the online curriculum.

The fidelity of implementation groups proposed for the quantitative data analysis was not used to select participants for the student focus groups. The rationale for this was that the fidelity of implementation groups was developed after the completion of the research study. Participants in the student focus groups were a part of any of the four intervention implementation groups (no implementation, minimal implementation, partial implementation, or full implementation).

Data collected from participants during the focus groups were audio recorded and notes were taken during each focus group discussion. Full transcriptions were made from audio recordings of each focus group. After transcriptions were created, each comment was read to create a short summary of responses to help develop a coding system for categorizing responses. These short summaries of responses were considered brief coding or an open-ended coding analysis system. This approach was used for the actual dialogue during the focus groups, and for the note-cards, students responded at the beginning of the student focus group. The researcher did not review data prior to beginning the coding process of creating categorical themes. Not reviewing the responses helped to eliminate some researcher bias. The categories were derived after scheme patterns were identified from the coding. From the development of categorical themes, three coding methods for data analysis were created.

The first coding method involved taking each response and placing responses into specific categories. Related categories were collapsed so that similar concepts were categorized under the same area; for instance, when one student stated, "I liked I could go back to a unit at any time" and another student responded, "You can hover over a definition and find the meaning of a word," those responses were coded as "user-friendly." It is important to understand that codes could go under multiple categories and codes were placed based on the best fit determined by the researcher.

The second layer of coding involved aligning responses to constructs measured in the research study. Participant responses were reviewed to gain an understanding of the relationship between responses and core constructs measured in this research study. These analyses involved reviewing participant comments and then aligning comments with the constructs measured during the pre and post questionnaires. For students, this involved aligning student responses to the transfer of the growth mindset, positive effort beliefs, positive academic self-efficacy, interest and engagement in science, and use of study strategies for learning (rehearsal, elaboration, and organization). For teachers, this coding involved aligning the teacher comments with the constructs measured in the teacher pre-test: mindset, effort beliefs, and personal teaching efficacy. This layer of coding involved matching exact participant responses to constructs.

The last layer of coding involved comparing student and teacher responses into three major themes that were exhibited from the focus group data from teachers and students: benefits of the Brainology© program, barriers to program implementation, and recommendations for improving program implementation.

Student Focus Group Analysis

Small groups of 15 students were randomly selected from the entire Brainology© experimental group and invited to participate in focus groups. Each of the four middle schools had focus group participants. The goal in the random selection of 15 participants was to have a minimum of 8 participants and a maximum of 15 participants in each focus group.

Upon student entrance into each focus group, students were provided a notecard and a pen by the researcher.. Students were then provided a brief statement reminding them that responses from the focus group were confidential. Students were then instructed to answer the following question, "What were the three things you liked most about the Brainology© Program and what three things you think could have been improved about the program?" Students were given approximately 5 minutes to respond to this question. Students wrote their responses on the notecards to the question raised at the beginning of the focus group interviews. The notecards were not collected until the end of the focus group so that students might use them in responding to questions raised during the focus group. The goal of providing students with the notecard and asking this initial question was to ensure that each participant had an opportunity to respond with feedback about the program, regardless if they chose to provide oral responses to questions during the focus group dialogue. What is understood, especially with adolescent students, is that they may be fearful of speaking in an open group session for a myriad of reasons: judgment, trust issues, etc. Because students were not directly involved with the researcher during the study, providing notecards was a non-threatening way for participants to freely express their thoughts related to the intervention. When notecards were given, students were asked not to include their name on the notecards when responding to the initial question.

Once the focus groups began, students were asked questions about the impact of the study on them as participants and how the program impacted their beliefs and views related to motivation. Students were also asked to provide a benefit analysis of the overall Brainology© Program intervention. The five formal questions asked during the student focus group session were as follows:

- What parts of the Brainology© program were most helpful to you as a student? Why was this information helpful?
- What was something new you learned by participating in the Brainology© program?
- What advice might you give other students about the Brainology© program or about the growth mindset?
- What are ways the Brainology© program could be improved?
- Is there any additional information you would like to share with me about the Brainology© program or how it has impacted you?

These five questions were asked of each participant in each focus group. A couple of additional questions were also asked to gain a better understand of the intervention quality and implementation. These questions were spontaneously developed in response to information provided by research participants about the intervention. These questions were added during the first and second student focus groups. These questions were included to gain additional insight about program fidelity and utility. The researcher made it a goal to ensure as much consistency in the focus group protocol; however, participant responses in some cases elicited insight about additional information to be collected. The additional focus group questions in this research study were as follows:

- What were your thoughts about the growth and fixed mindset?

- Which was more beneficial to your learning and understanding, the Brainology© computer program or the classroom lessons?
- Did you complete the study guide and was it helpful?

A summary of the student responses to the focus group questions indicated that students thought learning about the brain (through the computer games, puzzles, and activities) was the most exciting and helpful component of the Brainology© intervention. Students also thought that the visuals, graphics, and diagrams aided in understanding and learning the materials in the program. Students liked that the program was computer-based and self-paced. As far as the new learning gained from the program, student responses indicated that information on the functions, workings, processes, and usages of the brain was newly-learned information. Getting a better understanding of how long-term versus short-term memory was created was also cited by students. Students advised that other students should not use the skip function in the program because when they arrived at the check-in quizzes, they would not understand or know the responses to the questions posed. Students also advised that the program could eliminate lots of unnecessary wordiness, additional jokes, or conversations irrelevant to the learning of the program content. Students indicated that the program could be improved by shortening the program, increasing the games/activities, making information most relevant to the school curriculum, and adapting the program to help support learning in other academic core subjects. One additional area students said could be improved was teacher support and guidance during program implementation. Many students noted that teachers just gave a password at the beginning of the program initiation or did not implement classroom lessons. Students also noted that without teacher facilitation, it was harder for students to gain an understanding of the clear purpose of the program. One student indicated, “I think that it [Brainology©] was very interesting and that you learned about the brain, but if you are not going to have any classroom discussions that are mandatory or have work that goes with it, then you’re going to lose the whole point of it and be sitting there like, I am supposed to do what with this, exactly?”

In addition to reviewing student responses to focus group questions posed, student comments were reviewed to determine alignment and transfer of the growth mindset, positive effort beliefs, positive academic self-efficacy, interest and engagement in science, and use of study strategies for learning (rehearsal, elaboration, and organization). When students where asked about their thoughts about the growth versus fixed mindset during the discussion, four of the five student focus groups had no initial response. Students where provided with base-level information about the difference in the two mindset theories before they were able provide a response to this question. Student responses about the growth mindset included comments such as, “better than the fixed mindset,” “accept challenges,” and “persevere when learning is hard.” As it related to positive effort beliefs, some student groups provided instances where they indicated the use of “more work at something,” and “brain grows through practice and learning”.

Relating to academic self-efficacy, one participant noted that the use of the program made them want to use their brain, indicating they believed that they could and wanted to learn new things. An additional student indicated a decrease of test fear and that, as a result of program participation, they were more confident in their abilities to be successful on tests. Table 48 provides student information from the focus groups and aligns this with the constructs measured in the pre and post questionnaires.

Table 48

Alignment of Brainology© Program to Measured Constructs- Students

Construct	Alignment	Student Comment(s)
Mindset	Attitude toward challenge	"It helped me persevere because in some subjects they are harder than others"
	Comparison of Mindset Types	"The growth mindset is better than the fixed mindset. The growth mindset takes on challenges."
	Malleability of Brain	"I learned how I can grow my brain and get smarter."
Effort Beliefs	Effort= Improvement	"The more you work on something the bigger your brain gets, the more you learn."
	Brain Expansion due to learning	"…it was talking about how you can make your brain grow by practicing and learning stuff."
Academic Efficacy	Desire to learn	"It made me want to use my brain more."
	Grade Improvement	"I went from like a "C" but now I know that I can get better."
	Increased confidence	"…it talked about test fears and it helped me to take test better now."
Science Interest/ Engagement	Brain functions	"I learned different parts of the neuron like dendrites, and how it sends messages to other parts"
	Brain functions	"It helped me extend my knowledge about science and how my brain works"
Strategies for Learning	General Strategies	"It teaches how I get smarter and not be the same."
	Rehearsal Strategies	"A strategy that was helpful was using the index cards. They helped me study."
	Rehearsal Strategies	"Practice things by saying them over and over and go over them a lot."
	Rehearsal Strategies	"I use repetition to memorize things."

Note. Brief coding of participant responses served as alignment component to constructs.

Relating to interest and engagement in science, no student directly mentioned liking or enjoying science more as a result of participation in the Brainology©

intervention; however, participants from every focus group highlighted their enjoyment with learning the functioning of the brain and how that information helped them see clearly how the brain works and processes information, which is a science curricular goal.

As it relates to strategies for learning, students did not mention any examples or information related to the use of elaboration or organizational strategies for learning. These are the strategies that require a higher level of cognitive demand than recitation or memorization techniques than are employed by rehearsal strategies. The indication from students across all focus groups was that students used rehearsal strategies and general effective strategies for positive outcomes. Students stated they employed the use of notecards, saying things repeatedly, memorizing key facts, and thinking positively.

Teacher Focus Group Analysis

The intention of the focus groups was also to gain teacher feedback about the impact of the intervention on the classroom environment, student behavior, student use of strategies for learning, and the impact of the program on their instruction. Like the student focus groups, teachers were asked to provide feedback about the program quality and their perceptions of how the program could be improved or modified.

The teacher focus group questions were as follows:

- What impact has Brainology© had on your classroom as a whole?
- Were there specific students who showed observable evidence of the growth mindset during the institution of Brainology©? Please cite the most frequent observable characteristics.
- Talk to me about how the Brainology© program was helpful to you as a

teacher.

- Was there any new learning for you as a result of your participation in the Brainology© intervention?
- What are ways the Brainology© program could be improved?
- What was difficult or a hindrance to implement the Brainology© Program?

All teacher participants remaining in the Brainology© intervention group participated in the focus groups. There were nine teachers across all four schools that participated in the focus groups. Two additional questions were raised for teacher response. These questions were also created as a result of the initial focus group respondent feedback. The additional questions were:

- Do you believe students received more benefit from the computer program or classroom lessons?
- Did students complete the study guide component at the completion of the online Brainology© program?

When teachers' were asked if the program impacted the classroom climate, teachers had little input as to how the program impacted their classrooms, directly. More wait time was provided for this question. Four teachers directly stated the program had no impact on their classrooms while five teachers noted limited impact. When teachers were asked what changes they saw in student effort or achievement as a result of program participation, three teachers were able to site specific changes in a student(s) during the program implementation. Those teachers referenced how the program impacted the *low* student. When teachers were asked if they had any new learning as a result of the program or how the Brainology© program impacted them, many indicated that the information presented in the program was not new to them but made them consider how they might support students in practicing the principles presented in the program. The majority of teachers also noted that the program had little to no impact on them as the teacher but believed it was important to have training and professional development on the Brainology© program in order to implement the program well. Two of the nine teachers commented on how the use of the program helped them reflect on their teaching and how they reflected on student abilities. One teacher stated, “It [Brainology©] really made me think . . . change, I need to get out of those stereotypes, this child makes a ‘level 4’ and this one makes a ‘level 3’ and this is how we are going to group them. Moving forward from Brainology© I have a different perspective and I would like to change the climate so that we can stop grouping children just by a standardized test.” Another teacher stated, “This made me reflect on my teaching methods and how I explain things in class and use discussion.”

As far as areas of improvement of the program, teachers indicated that having a way to get consistent updates about student progress, more alignment with the current science curriculum—outside of the alignment with teaching of body systems and improved access to technology—would greatly improve the implementation of the Brainology© program. Teacher comments illustrated a high level of awareness that they did not implement the program with fidelity. Teachers provided such comments as, “We needed more time to implement the lessons,” “I could not give this the time it needs because of the tests,” or “I am sorry; I did not do that part.” The pressure of new curriculum standards where noted as the number one reason that teachers did not implement the program as prescribed.

Just as with the student focus groups, teacher focus groups were reviewed to determine alignment between teacher pre- and post-questionnaire variables and the focus group responses. Though teacher questionnaire data could not be analyzed due to low sample size, the three teacher constructs measured in the pre and post questionnaires were teacher mindset, effort beliefs, and personal teaching efficacy. Teachers' responses noted mixed perceptions and alignment with the three constructs.

Regarding agreement with the growth mindset, the majority of teachers repeatedly made comments about low versus high students. Several teachers indicated comments such as "some kids care and others don't" while some teachers indicated alignment of the growth mindset in their responses to students. As a part of the classroom lesson for Unit 1, of the Brainology© lesson curriculum, an article, "You Can Grow Your Intelligence" was provided to students and teachers for reading, responding, and discussing. In response to the use of this article and teacher reflection, a teacher stated, "It is okay if you have not done well in the past; that doesn't mean that you can't move forward and do better in the future."

Regarding effort beliefs, the majority of teachers were clear in statements to students who hard work and effort lead to progress; however, it was noted by six teachers that this program should be targeted for *lower* students versus *bright* students. In interviews, many of the teachers indicated that the bright students already understood things that were taught in the program.

Relating to personal teaching efficacy, there were some teachers that made statements that alluded to the use of effort for improvement. One teacher stated, "I feel motivated to help students understand; they can grow their brains." Other teachers indicated that they were limited in the amount of motivation they could provide to help students be successful with the program or in a course if there was no accountability or grade tied to the completion of the program. One teacher stated, “If there is no grade, they won’t complete it.” This speaks to teaching efficacy because teachers that believe they can positively impact student learning reinforce the principles of the growth mindset and positive effort beliefs. Table 49 provides a summary of the alignment of teacher questionnaire constructs to participant comments.

Table 49

Alignment of Brainology© Program to Measured Constructs- Teacher

Construct	Alignment	Teacher Comment
Mindset	Teacher Reflection on Practice	“It really made me think…change, I need to get out of those stereotypes, this child makes a “level 4” and this one makes a “level 3” and this is how we are going to group them. Moving forward from Brainology© I have a different perspective and I would like to change the climate so that we can stop grouping children just by a standardized test.”
	Fixed Mindset	“The high ones get higher but the low ones stay low”
Effort Beliefs	Effort = Improvement	“I gave them examples like an athlete if he does not exercise and use those muscles he can’t be in the NFL. I want to believe that can help someone.”
	Reflection on Effort	One of my low kids…was trying to answer something and he was like forget it and threw his pencil down…If you could apply yourself more. I said read it again…. he was able to give a response. I said, some effort is better than none.”
	Persistence to Improve	“I noticed he doesn’t give up as often.”
	Positive Effort Belief	“It will take work but you can do it.”
	Reflection on Effort	“I think . . . they can sit back and look at what did I just do and why did I just do it, that’s higher level thinking.”
Teaching Efficacy	Reflection on Practice	“ I am much more conscious that I need to help them, growth their brains… I feel more obligated!”
	Reflection on Practice	“It [Brainology©] had me think about how I write out stuff. It has helped me reflect as a teacher and remind myself to ask students, what did they learn and accomplish.”

Benefits of Brainology© Program

Another way the focus group data was analyzed was by reviewing the comments from both students and teachers to compare and contrast the overall feedback of both groups. Analysis of this data included responses from student focus group questions, student responses on note cards from the beginning of student focus groups, and teacher responses during the focus groups. Overarching themes were given to categorize information. The categories developed for this analysis are as follows: Benefits of Brainology© Treatment, Barriers to Brainology© Intervention, Recommendations for Program Improvement, and Brainology© Implementation Fidelity.

There were several benefits indicated by both teachers and students. Both groups felt that the Brainology© program was very informative and provided valuable material. Teachers believed information from the program was transferrable to students in school and in life. Students enjoyed that the program allowed them to re-read portions at their own pace and go back to different parts when things were not clear. Students also enjoyed the games, puzzles, and activities used in the program and stated that the graphic animations helped them better understand the information presented. Students stated the program helped them reflect on their learning while a couple of teachers indicated the program helped them reflect on their teaching styles. Table 50 provides a summary of information gained about the benefits of the Brainology© Program from both groups.

Table 50

Benefits of the Brainology© Intervention

Students	Teachers
• Informational—learn about brain	• Informative—study skills and brain functions
• Interactive—Promotes hands-on learning and how to study	• Alignment to course curriculum about Body systems
• Self-Paced	• Promotes Student Reflection
• Reflect on Learning	• Universal Transfer
• Fun brain games/challenges	• Supported class discussions
• Good visuals—simulations, pictures, graphics	• Reflect on classroom instructional delivery

Barriers to the Brainology© Implementation

Along with the program benefits, there were also barriers to the program implementation. Some barriers were specifically related to the design of the Brainology© program while others were instructional or cultural. Some of the key Brainology© program infrastructure barriers were its length and ambiguity related to student progress, program features, and instructions. Students indicated the program was too long, had too much talking, had some irrelevant information, and that the characters at times spoke too quickly. Teachers and students provided insight regarding program navigation issues.

Teachers indicated there was difficulty knowing which unit, activity, or place students were to continue and that teachers did not have an easy way to know where the students were in the program. Teachers noted that the program had no way to require students to remain attentive, and the program was loosely tied to the Grade 7 science curriculum, aside from being aligned with the teaching of body systems—nervous systems, etc. Students indicated that jokes where "cheesy" or unneeded and that sometimes the jokes were a stretch and just made the program longer. A teacher stated, regarding the cartoons, "Because we assume that things like cartoons are going to hold kids interest and I am not so sure that was correct with this age group." A summary of the Brainology© program-related barriers are listed in table 51.

Table 51

Barriers to Brainology© Program Implementation

Students	Teachers
• Program was too long • Characters talked too much/too fast • Unnecessary information • Skip Feature overused • Need feedback on progress • Cheesy Jokes	• Program does not require student attentiveness • Limited alignment to other parts of curriculum • Unclear program instructions • Skip feature overused

The Brainology© program barriers raise additional concerns about program implementation quality. The program quality or fidelity of implementation issues were expressed by teachers and students, as having an impact on the overall program implementation. These fidelity issues do not necessarily align with actual components related to the program but relate to the cultural issues (classroom environmental needs, student motivation, attentiveness, etc.) or instructional issues (curricular constraints—classroom pacing, time, transitions, etc.) with the implementation of the program affected by actions of participants.

Time is often a mediating factor impacting fidelity of any program implementation. In this particular research study, teacher participants were implementing a new curriculum for the first year and had limited time to learn any additional information outside of understanding the new curricular content standards. The lack of time had a possible impact on teacher buy-in. In focus groups, it was not evident if teachers bought into teaching the concepts supported by the Brainology© program. None of the teachers actually completed training about the online curriculum or classroom lessons involved in the Brainology© treatment, aside from the initial program overview about the program. Students noted that they did not understand the purpose or intent of the program and this may be largely due to lack of teacher buy-in to program principles.

Peer pressure could have served as a rationale as to why students did not see the value in program participation. As stated by one student, “I was going at my own pace and saw I was slower than everybody, and then I got competitive and hit skip, skip, skip.” This supports why the program may not have obtained optimal implementation fidelity from students because they failed to see the purpose of the program and were influenced by both their peers and teachers to withdraw engagement in program participation.

Teachers, on the other hand, cited different rationales for fidelity implementation issues of the program. These fidelity issues were most closely related to the lack of technology—limited access to computer labs, working laptops, or headphones. The lack of resources impacted when students were able to use the technology and its functionality during usage. Table 52 provides a summary of the Fidelity of Implementation issues.

Table 52

Brainology© Intervention Fidelity of Implementation

Students	Teachers
• Did not see purpose/value • Bored with program • Lack of teacher support for implementation • Peer Pressure	• Limited Time • Mandates/Pacing for Implementation of New curriculum • Student grade not tied to program completion • Working Technology/internet • Lack of technology access (computers, headsets, labs) • Lack of student progress tracking about completion • Lack of teacher buy-in and concept reinforcement • Students were inattentive to program during participation (bored, • Material availability--handouts • Progress updates not given to teacher • Peer Pressure

The inability to track student progress and receive handouts at the beginning of the program was another reason cited for implementation fidelity issues. Each teacher was provided with a program log-in that enabled them to view student usage of the Brainology© Program. Teachers were not reminded of their access capabilities of this feature by the researcher during the study for fear that an additional request may cause study participant drop-out. Also, resource materials were provided before each unit was taught. Some teachers paced themselves within the program quicker than the researcher had intended, and these teachers did not have handouts until the time when the next unit was expected to be taught.

Recommendations for Implementation Improvement

In response to the program barriers, teachers and students provided recommendations for improving the quality of the program intervention. Both teachers and students agreed they would like to see the program implemented in new subject areas. Students indicated other core academic subject areas while teachers recommended the program be implemented in special classes like alternative learning, summer school, elementary school, or study skills courses. Students proposed that the program have less talking, be shorter in duration, and have less jokes. Students also proposed that the program have more games and activities that allow for interaction and even requested that the program allow for more opportunities for collaboration so that they could work with one another and learn about others ideas. Students also indicated that the questions on the quizzes should be more difficult and require more thought, and that the program designers should remove or limit the skip feature so that students must pay attention to the program information when presented. Teachers also agreed that the skip feature should be limited and wished there were easier navigation features. They also indicated that they desired a better way to track student progress within the program. Table 53 provides a summary of program improvement recommendations by teachers and students.

Table 53

Recommendations for Improvement of the Brainology© Program Implementation

Students	Teachers
• Put in other subjects (math, social studies, language arts) • Allow students to complete program in groups • Shorten dialogue • Remove unneeded information • Make navigation easier • More activities/games • Less "Cheesy"--Consider format other than cartoons, jokes, animations • Don't allow students to skip videos • Make questions more challenging	• Align to more parts of curriculum (other than body systems) • Implement program in specific classrooms (ALC, study skills, summer school) • Make district requirement for program implementation • Use program in non-core classes (World languages, PE, Early Elementary courses) • Implement Program at Beginning of Year • Shorten program duration for online • Allow more time for classroom lesson implementation • Require minimal journal • Easier navigation function for tracking progress

Teachers also believed that the program should be implemented at the start of school to set the tone for the year and to begin student buy-in to the growth mindset principles. Teachers felt that minimal writing in journal entries should be required for students to advance within the program. Teachers also felt more time should be allotted to implement the classroom lessons. Though more time was needed for classroom lesson implementation, teachers felt this would be difficult as the teaching requirements of current curriculum content makes additional classroom time scarce.

Chapter 5: Discussion

Introduction

The purpose of this study was to determine whether an intervention designed to help influence student development of the growth mindset, positive effort beliefs, high academic self- efficacy, increased interest engagement in science, and strategies for learning (rehearsal, elaboration, and organization) would increase student achievement in math and science. In addition to measuring the above mentioned constructs and student achievement, student motivational behavior in class was rated by teachers to capture the level at which selected students exhibited positive or negative behavioral changes. Finally, student focus groups were conducted in order to determine the benefits and impact of the Brainology© treatment intervention.

Student change in mindset was assessed by the theory of intelligence subscale; change in effort beliefs was assessed via the effort beliefs subscale; efficacy beliefs were measured by the Patterns of Adaptive Learning Styles questionnaire; and students' interest and perceptions of task value in science was measured by the task value subscale of the Motivational Styles Learning Questionnaire (MSLQ). Student use of learning strategies was assessed by the MSLQ rehearsal, elaboration, and organizational subscales. This chapter will draw conclusions about the meaning of data presented in this study and discuss implications, limitations, and recommendations for educators and future research.

Discussion

This chapter will use the data from chapter four to answer each of the research questions posed. This study sought to answer four specific research questions.

1. How does the use of the Brainology© intervention affect students' (a) mindset

beliefs, (b) effort beliefs, (c) academic self-efficacy, (d) interest and engagement in science, (e) effort in the science classroom, (f) motivation in the science classroom, and (g) use of effective study skills strategies?

2. What is the relationship between student academic self-efficacy and student science and math achievement?

3. How does student achievement in science and math change over the course of the school year for students who participated in the Brainology© intervention compared with students not participating in the Brainology© intervention?

4. Does student mindset predict student academic efficacy and, in turn, student achievement?

Data from this study provides information about the quality and impact of the Brainology© intervention on student mindset, effort beliefs, academic self-efficacy, interest and engagement in science, use of study skills strategies, motivational behavior, and achievement in math and science.

Mindset

Research Question 1: How does the Brainology© intervention affect students' mindsets? The Brainology© intervention was designed to teach students how learning changes the brain and how learning and development improvement occurs (Dweck, 2008). Blackwell et al. (2007) showed positive results from this type of intervention. This indicated that this type of intervention can be beneficial in fostering students' understanding and belief in the growth mindset.

The initial hypothesis was that there would be in an increase in student perceptions of growth mindset as measured by Theories of Intelligence subscale of the Student Mindset Assessment after the use of the Brainology© intervention. In this research study, the quantitative results show that there was no significant increase or decrease in student mindset during the intervention. Since none of these values showed statistical significance among groups, it cannot be concluded that the Brainology© program supported a positive increase in growth mindset by students in the intervention group. It is important to note that during the student focus groups, only one of the five student groups could provide a definition or clear insight about the growth mindset without being given a definition by the researcher about the construct during the focus groups. This indicates that students did not have a good understanding of the teachings about the Growth Mindset during the Brainology© online program nor did transfer occur during the classroom lessons conducted by teachers.

The lack of change towards a growth mindset could be the result of the lack of teacher and program fidelity of implementation. As noted in Chapter 4, a large number of student participants in the Brainology© intervention group did not complete all four units of the program intervention; therefore, analysis of data of treatment groups was broken down into implementation levels (full, partial, minimal, no implementation, and control group). These implementation groups were created because of the researcher's review of data of student program usage and information received from focus groups from teachers. Breaking groups down by treatment levels was believed to be a more accurate way to analyze data. These factors could have been key variables in the research finding of no statistically significant different changes in mindset of any of the participant implementation level groups.

Effort Beliefs

Research Question 1: How does the Brainology© intervention affect students' effort beliefs? Student effort beliefs were expected to change as a result of Brainology©

participation. The program focused on how attention, repetition, and focus create pathways to enhance dendrite growth (Mindset Works, 2011). Previous researchers have found that students who believe their intelligence can be developed are more likely to push through when learning gets difficult and seek support when they do not understand or need clarification (Dunning, 1995; Hong et al., 1999; Nussbaum & Dweck, 2008).

The original hypothesis was that student responses about their abilities, after the completion of the Brainology© intervention, would show an increase in positive effort beliefs as measured by efforts beliefs subset scale. The ANCOVA run on the student effort belief subscale showed no statistically significant increases or decreases of any group related to their effort beliefs. Since none of these values show statistical significance among groups, it cannot be concluded that the Brainology© program supported a positive increase in student effort beliefs.

During the focus groups, a limited number of students (less than 5 students) brought up words like perseverance, hard work, and effort. The limited number of students who referred to these statements illustrates a loose understanding of the role effort plays in improvement and achievement. It can also be concluded that if teachers did not discuss or reinforce the teaching of positive effort beliefs, then it is highly unlikely this idea would transfer. Four of the nine teachers in the focus groups often stated that the low students are encouraged to put forth more effort while the bright students have the ability, skills, and knowledge to succeed. This type of thinking is highly aligned with the *fixed mindset*, which puts students into categories that are pre-determined or static. If teachers did not take on the disposition that everyone must put forth effort in order to improve or grow, then it is highly unlikely that students would be willing or motivated to put forth effort and perseverance when learning concepts became challenging.

Academic Self-Efficacy

Research Question 1: How does the Brainology© intervention affect a student's academic self-efficacy? The Brainology© program is intended to expand students' perceptions of capability. Zimmerman (1995) indicated that judgment of personal knowledge, skills, and strategies interact to help form efficacy beliefs. The Brainology© program addresses the formulation of positive self-efficacy beliefs by emphasizing how the understanding of brain and neural connections coupled with study strategies can improve one's abilities (Mindset Works, 2011).

The original hypothesis for this portion of the research question was that there would be an increase in student academic self-efficacy as measured by the Academic Efficacy subscale of the PALS after the use of the Brainology© intervention. The results of this study showed that no statistically significant increase in student academic efficacy as a result of participation in the Brainology© intervention existed. Student focus groups did not provide a strong alignment of student understanding about individual capabilities. Some students brought up comments like, "I went for a 'C' but I know I can get better." This student comment indicated some understanding of the ability to improve in class in spite of prior performance. There were no clear connections that provided the researcher with insight that collective groups of students had increased their academic self-efficacy. It can be concluded that the Brainology© intervention had no impact in positively increasing student self-efficacy beliefs. There are other reasons that can help explain why students did not show an increase in academic efficacy beliefs. According to Pajares (2006) these factors include grades in other classes, social comparisons, and mastery experiences. Because this research study did not measure these other variables, it is hard to determine what impact, if any, they had on student academic efficacy beliefs.

Student Interest and Engagement in Science

Research Question 1: How does the Brainology© intervention affect a student's interest and engagement in science? The hypothesis for this research study was that the Brainology© intervention would increase student interest and engagement in science as measured by the Motivation Strategies for Learning (MSLQ) task value subscale. The results from the ANCOVAs on science task value showed a trend towards significance. This trend does indicate a statistical difference among the groups. The analysis of adjusted means showed that the full implementation group displayed statistically significant increases in gains in their interest and engagement in science while there was a trend towards significance for the no implementation group as well. The student focus groups highlighted that learning about the brain, workings, functions, and processes was the number one value of the Brainology© intervention program for students. All five of the student focus groups commented about how it was fun to learn about the brain in the Brainology© program. Because learning the functions of body systems is most closely aligned to learning science, it can be concluded that the full implementation group significantly increased their interest in science, which may have been partially the result of the information learned in the Brainology© intervention program and the science-based activities used within the classroom lessons; however, because the no implementation group also saw an increase in science interest and engagement, it cannot strictly be assumed that the Brainology© program intervention was the reason for increased student science engagement. This may be in part due to the way teachers taught in the classroom in general, science activities used to teach the curriculum, or outside experiences in which students participated of which the researcher was unaware.

Effort in Science

Research Question 1: How does the Brainology© intervention affect student effort in the science classroom? The hypothesis was that there would be an increase of student effort in science as measured by the Behavioral Task Choice measure. As mentioned in Chapter 4, this analysis was not completed due to fear of participant drop out and due to the use of several other measures available for the research study. This measure was to be a pilot measure for this study. The initial research implementation timeline was delayed because of the time it took to gain access to student consents and the time to get all students enrolled in the Brainology© program. Also, it was understood that the 2012-2013 school year was the first year for implementation for the new seventh-grade science curriculum. As a result of these factors, it was decided that this measure be removed from this research study. No data existed related to student effort in science; therefore, no results or conclusions could be drawn from this portion of Research Question 1.

Motivation in Science

Research Question 1: How does the Brainology© intervention affect student motivation in science? The original hypothesis for this research question was that students' behavioral motivation in their science classes would show an increase in positive motivational behaviors as measured by Teacher Ratings of observable motivational behavior of students. The data shows that there was a statistically significant difference between the ratings on student motivational behavior among groups. The control and full implementation groups saw gains in positive motivational behavior, which included the following behaviors: participating with enthusiasm, asking relevant questions, engaging in activities that were not required, and striving to improve skills. The full implementation group had significantly higher gains in motivational behavior than the no implementation group, which means that student participation in the entire Brainology© program is more likely to produce higher increases in positive student motivational behavior. The control groups also showed increases in observable student motivational behavior but not as much as the full implementation group. The minimal, partial, and no implementation groups had negative gains in student motivational behavior, which illustrated that students in these groups participated in negative motivational behaviors such as talking inappropriately in class, joking around, acting confrontational, not asking for help, or getting easily discouraged at errors.

It can be concluded that because these groups failed to complete all four curricular units of the Brainology© online program intervention, they were unable to receive enough of the program instruction to positively impact their classroom behavior. During the student focus groups, only a few students mentioned one of the positive behavioral characteristics of the eight rated by teachers on this measure (see Appendix E). The positive motivational behaviors mentioned by the students were things like persisting when things were challenging, improving, and studying more.

Strategies for Learning Usage

Research Question 1: How does the Brainology© intervention affect a student's use of strategies for learning? In Pintrich and De Groot (1990), seventh-grade students were assessed on their motivational orientation and their use of various learning strategies to determine the level of effect these variables had on their grades. The researchers contended that students' motivation and learning strategies were mediators for student achievement. This study found that students with higher levels of self-efficacy have high use of complex cognitive strategies that positively correlate with higher academic performance.

The original hypothesis was that the use of the Brainology© intervention would increase students' use of study skills strategies as measured by MSLQ Strategies for Learning: rehearsal, elaboration, and organizational subscales. The results show a statistically significant trend in the use of rehearsal strategies by the various treatment groups. There were differences in increases and decreases in use of rehearsal strategies by students in various treatment groups.

The adjusted means show no change in student use of rehearsal strategies for the control, full implementation, minimal implementation, or no implementation groups; however, the partial implementation group employed significantly less use of rehearsal strategies as measured by the student questionnaires. It is unclear why the partial implementation group employed less use of rehearsal strategies during the intervention. Focus groups provided insight that 3 out of the 5 student groups employed memorization techniques like the use of flashcards and repeating information over and over as a learning strategy.

As it relates to the use of elaboration strategies, there was no change in the use of elaboration strategies by students in any treatment group. It can be reasoned that because one must understand content in order to paraphrase or summarize it, it would be difficult for any student to use elaboration strategies if they do not understand foundational concepts. No focus groups mentioned the use of summarization techniques as a method for studying.

There was also no change in student use of organizational strategies. Just as with elaboration strategies, organizational strategies require that one understand content to create an outline to illustrate key concepts and ideas. There was no statistically significant difference in the usage of elaboration strategies by the treatment groups. In the student focus groups, no students provided insight about the use of organizational techniques for learning content or studying information. In order for students to show an increase in achievement and academic self-efficacy they must engage in higher cognitive study strategies like the use of elaboration, organization, or critical thinking (Pintrich & De Groot, 1990).

Relationship Between Efficacy and Achievement

Research Question 2: What is the relationship between student academic self-efficacy and math achievement? The research of (Bouffard-Bouchards, 1994) showed a modest increase in student self-efficacy when coupled with the teaching of study skills strategies. This means that when students engage in effective study skills strategies, they are more likely to have higher self-efficacy and in turn higher achievement.

The original hypothesis was that there would be a positive relationship between student self-efficacy as measured by the Academic Efficacy subscale of the PALS and science student achievement as measured by the seventh-grade science benchmark tests. There was no science benchmark, as stated in Chapter 4, the section on deleted measures. Math achievement data from student benchmarks were used since there was no student science achievement data. There was no statistically significant relationship between student academic self-efficacy and math achievement.

Student focus groups provided minimal information about student academic self-efficacy. It is questionable if students clearly understood the meaning of academic self-efficacy. Reflecting on the focus group questions, no single question was created in a way to determine if students believed they were capable of being successful in math and science. This question was directly asked on the pre- and post-student questionnaires.

Because students did not show a change in the use of strategies for learning, it could be argued that there would be no relationship between efficacy and achievement because students did not employ strategies to help them increase their academic achievement.

Change in Math/Science Achievement

Research Question 3: How does student achievement in science and math change over the course of the school year for students who participated in the Brainology© intervention compared with students not participating in the Brainology© intervention? The original hypothesis was that students involved in the Brainology© intervention would show an increase on the mean score on the seventh-grade math and science benchmark exams compared to students not involved in the Brainology© intervention. Since there were no science benchmarks to answer this question, student math and science quarterly grades and student math benchmark scores were used to answer this question.

As it relates to math quarter grades, there was no statistical difference between the treatment groups and quarterly math grades. There was a statistically significant difference in the change in pattern across all groups in student math grades by each quarter. This pattern shows both increases and decreases in grades over the three quarters. This could be explained by several factors such as level of study, tutoring, support, or interventions students received to improve. These results cannot be attributed to the Brainology© program intervention.

Results from analysis of the science quarter grades show statistical differences between student science grades by quarter and the treatment group: The control group had significantly higher grades in the 2nd and 3rd quarters than the 1st quarter; the no implementation group had significantly higher grades in the 1st quarter than in the 2nd and 3rd quarters in science; the minimal and partial implementation group had significantly lower grades in the 2nd quarter than in the 1st and 3rd quarters; and the full implementation group had significantly higher grades during the 1st quarter than in 2nd and 3rd quarters. This change in grades by students cannot be attributed to the use of the Brainology© intervention. For example, the full implementation group's grades dropped during the duration of the intervention, and the minimal and partial implementation group had lower grades by quarter 2. Because the Brainology© program was implemented during these times, it can be concluded that the Brainology© intervention had no impact on student increase in science grades.

As it relates to math quarter benchmarks, there was no statistical difference between the treatment groups and benchmark assessments (fall or spring). There was a statistically significant increase among all groups from the fall to the spring benchmark. Students scored higher on the spring 2013 math benchmark for all treatment groups. This could be attributed to the increase in student knowledge and understanding of the curriculum since the beginning of the school year. Reflecting on the grades collectively by groups per quarter, the full implementation group had significantly higher grades overall than the control and no implementation groups while the control group had significantly lower grades than the full and no implementation groups. This might be explained by the t-test run on the original groups at the pre-test. This test showed a trend of more academically gifted students in the Brainology© group. This trend of more academically advanced students might provide information as to why the grades for the full implementation group where statistically higher than the control groups. No information from the focus groups was provided by students about their grades and the increase or decrease in their grades during the program. One student did mention that he had recently improved from being a “C” student.

Path Analysis

Research Question 4: Does student mindset predict student academic efficacy and, in turn, student achievement? The hypothesis for this question was that student mindsets, as measured by the mindset subscales of the student mindset assessment and teacher mindsets as measured by the motivational goals and beliefs survey of the Teacher Mindset Survey, would be positive predictors of student efficacy, which in turn would be positive predictors of student achievement, as measured by the seventh-grade science benchmark tests. Because there were not enough teachers who participated in responding to the pre- and post-survey questionnaires, teachers’ mindsets were not used for this analysis.

Path analysis #1 used the student pre-test mindset score as a predictor of pre-test efficacy, and the pre-test efficacy score was then used to determine if it would predict student achievement on the fall 2012 benchmark. This model showed that the score on the student mindset pre-test is a reliable predictor of student efficacy and fall 2012 math achievement.

Path analysis model #2 showed that student mindset change was a predictor in student efficacy, but it did not predict a change in student achievement from fall to spring 2013. This model is not a robust predictor of the path models proposed.

Path analysis model #3 shows the highest predictability in that student post-test mindset scores can predict student post-test efficacy scores, and those student post-test efficacy scores are a reliable predictor of student spring 2013 math achievement. Path analysis #3 was the most statistically significant prediction model of all three models.

This information aligns with the math achievement data in Research Question 3.

Student scores on the spring benchmark were significantly higher than the student fall 2012 benchmark scores. This can explain why path model #3 is the best prediction model. If students have increased mindset scores during the post-test and have a prediction of increased efficacy scores at the post-test time, then it is believed that students will show an increase in achievement scores on the spring math benchmark assessment.

Qualitative Data

The information gleaned from focus groups illustrated that students did not have a good understanding of the core constructs taught in the Brainology© program intervention or an understanding of the guiding principles of the classroom lessons. Students indicated that they spent little time in the program and that teachers offered limited to no support during the program implementation. Students cited that the program was beneficial in learning about the brain and that the games and activities were interesting.

Teacher responses to focus group questions illustrated that teachers saw a minimal effect of the Brainology© intervention on students within their classrooms or on them as teachers. It was interesting to note that five of the nine teacher participants did not notice an impact of the program on students who exhibited high achievement. In response to teacher comments about bright versus low students, this type of thinking supports the idea that effort is only needed for a specific type of student and is not a universal expectation for all students. This belief is also congruent with the fixed mindset. Many teachers noted that this program is a good fit for the low students, seeing that only a certain type of student needs motivational reinforcement. Teachers also provided insight about the lack of implementation fidelity because they were consumed with teaching the core curriculum. All teachers noted that the use of the Brainology© program began to be less important when the program curriculum no longer directly tied into the instructional curriculum. All teachers provided insight that the program was a great fit for teaching students about the body system; but after that instructional unit had concluded, it was a struggle to keep students engaged in participating in the program and to continue themselves to remain committed to implement the program.

Summary of Brainology© Impact

Based on the quantitative and qualitative results for this research study, it can be concluded that the Brainology© intervention had minimal impact on the treatment group. Positive statistical differences and increases were found in the areas of student motivational behavior, science quarter grades, and math benchmark performance from fall 2012 to spring 2013. Additionally, a robust prediction could be used for predicting student mindset, efficacy, and achievement at the conclusion of the research study. The full implementation group saw a significant increase in science interest and engagement (task value) during the course of the research study. Both the full implementation and control groups saw an increase in positive motivational behaviors in science. All other areas measured within this study showed a statistically insignificant impact.

This study does not provide strong evidence that teaching students about the malleability of intelligence produces uniform positive effects on student motivational beliefs or academic achievement. The results of this study are in contrast to the results provided by Cury, Elliot, Da Fonseca & Moller (2006) and Romero & Paunesku (2011) where student pre- and post-test survey responses showed a connection between mindset, academic self-efficacy, and achievement. This study also notes that an increase in student mindset does not always have an accompanying increase in academic self-efficacy. What is unknown is the lasting impact this program will have on an individual student and/or teacher. The impact based on the variables measured does not constitute a high effect.

Limitations

The original design called for the use of a messaging system to elicit parent reminders and to maximize consents received for the research study; those messages were not sent to parents as reminders due to issues with access to the system and accessibility of student data by the researcher. Not sending out these reminders could have inhibited the number of actual informed consents that were received or the amount of participation for the research study.

The research design implementation for this study had several issues. The study originally had a larger sample; but due to participant dropout, the sample size was decreased tremendously from the originally anticipated participant levels. It cannot be assumed that the results of this study can be generalized to any other group. The qualitative analysis has a level of researcher bias as the researcher was the only analyst and coder of participant responses during the focus groups.

The timing of this research study could be seen as poor. The 2012-2013 school year was the implementation of new curriculum standards for all subject areas as well as preparation for new assessments. Due to the curriculum implementation, teachers were required to participate in mandatory content curriculum trainings. The researcher was unable to provide additional training for teachers other than the program overview in August 2012. Additionally, the researcher sent teachers several updates, reminders, and requests for study completion and activities.

Additionally, working with an outside entity to collect and compile data proved to be somewhat of a challenge. The organization graciously supported all efforts of this research, but it was difficult to manage student data and responses when no direct access was provided to the researcher. In the future, it is recommended that the data be stored in a centralized location for researcher accessibility.

Teachers cited that needing to have access to student progress during the program implementation was a barrier. The researcher did not send out information about student program progress per class during the research study. This was monitored by the researcher, but was also available to teachers when they logged in the program. It would have been helpful to provide this information to teachers. The researcher feared overload and pressure upon participants by either providing student progress updates or requesting teachers access this information. The researcher's goal was to minimize teacher stress from program participation as the 2012-2013 school year was full of additional mandated expectations by the school district and teacher participation in this research study was voluntary.

Recommendations for Educators

The Brainology© program has intrinsic value and the ability to assist students in developing a more mastery goal oriented approach to learning (learning for learning sake, putting forth effort to improve). It is also believed that the Brainology© program could help diminish the educational culture focused on extrinsic value (grades, right answers, limited effort investment, etc.). Though the information presented within the program did not translate into widespread changes in student mindset, effort beliefs, academic self-efficacy, interest and engagement in science, motivational behavior in the classroom, use of study skill strategies for learning or large gains in academic achievement within the treatment group, teaching students about how the brain works; explaining about the malleability of intelligence through effort, study, and practice; and imparting effective strategies for learning in school and life are worthwhile academic investments for the educational system. The growth mindset intervention cannot be recommended as an intervention that promotes high gains in student achievement and student positive perceptions of self-based on the results of this research study; nonetheless, it can be stated that this curriculum is a worthwhile investment to help promote and influence growth in perceptual thinking of teachers and students.

Based on the results of this study, it can be argued that further research on teacher mindset, effort beliefs, and efficacy should be studied in order to better understand teachers' perceptions and if these perceptions may impact student self-perceptions or student achievement. Research of Midgley, Feldlaufer, and Eccles (1989) found that the student-teacher relationship was an important factor in adolescent value of mathematics. Meece, Anderman, and Anderman (2006) showed that classroom structures can positively or negatively affect student motivation.

It is recommended that future educators who make use of this intervention should begin first with professional development for teachers. As noted by the teachers, the lack of teacher professional development helps explain why there was a lack of teacher buy-in during program implementation. Students also noted the lack of teacher support and facilitation during program intervention. Allowing for additional opportunities for teachers to reflect on their own views could have a high impact on the quality of positive interactions among teachers and students who develop positive student perceptions of self and ultimately lead to greater gains in student achievement.

It is necessary to provide training for teachers about the malleability of intelligence in order to positively impact changes in students' beliefs. Klassen and Lynch (2007) examined the self-efficacy beliefs of adolescent students and their teachers.

Responses from teachers showed that they "generally viewed the student's lack of academic success as the result of uncontrollable deficits" while the students felt their lack of success was due to the lack of effort (Klassen & Lynch, 2007, p. 11). Therefore, interventions which focus on teacher-efficacy, classroom goals, and beliefs about intelligence might be more successful in influencing student beliefs. To date, Mindset Works, Inc. (developers of the Brainology© curriculum) have developed a program called Brainology© Educators Learning Lab Suite (BELLS™). The purpose of BELLS is to serve as an online professional development program designed to help educators learn about the growth mindset and how to incorporate it into their everyday practice to support students and colleagues in developing a growth mindset (Mindset Works, 2012) This program may be beneficial in its ability to have a greater influence on students by positively influencing the beliefs of educators.

Additionally, scales and measures used for students may need to be re-configured so that questions are asked in a manner which students can clearly provide information about their learning and attitudes. The scales and measures used for the pre- and post-test did not appear to capture the complete picture related to students' attitudes. It is recommended that qualitative interviews be used to provide evidence of student learning and information related to constructs measured for future research studies.

Recommendations for Further Study

Exploring avenues for enhancing students' beliefs in a growth mindset is necessary to increase student academic efficacy. This research study of the growth mindset intervention, Brainology©, did not collectively affect change in this study; however, some slight positive changes were noted by both students and teachers that indicated an understanding and acceptance of constructs measured in this research study.

More extensive studies incorporating the Brainology© program and other supportive materials like videos, games, other interactive mediums (such as films like the *Ben Carson Story*), and the use of the pre-test and post-test are recommended. These studies would clarify whether teaching students about the brain and enhancing a belief in the growth mindset can influence student motivation and achievement.

An idea for incorporation in future studies would include the measurement of other variables such as goal orientation (performance or mastery goal orientation). Gathering insight about student goal orientation could help identify the driving force motiving students (intrinsic or extrinsic motivation). Understanding this could better tailor the intervention program and activities to best develop and promote the teaching of growth mindset principles.

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Appendix A

Crosswalk Between Constructs, Measures, and Research Questions

Construct	Measure	Research Question (s)
Student theory of intelligence (mindset)	Student Mindset Assessment – Theory of Implicit Intelligence subscale	1, 4
Student effort belief	Student Mindset Assessment – Effort Belief subscale	1
Student academic self-efficacy	PALS – Academic Efficacy subscale	1, 2, 4
Student interest and engagement in science	Motivation Strategies for Learning Questionnaire Science Task Value subscale	1
Student effort in the science classroom	Behavior Choice Task	1
Use of effective study skill strategies	Motivation Strategies for Learning Questionnaire(MSLQ) (Rehearsal, Elaboration, and Organizational Strategies)	1
Student motivational behavior in the science classroom	Teacher Ratings of Student Motivational Behavior	1
Student math achievement	seventh-grade math benchmark assessments	2, 3, 4
Student science achievement	seventh-grade science quarter grades for Q1 and Q2	2, 3, 4
Teacher growth mindset	Teacher Mindset Assessment – Mindset and Effort Beliefs subscales	1 Covariant
Teacher efficacy	PALS – Teacher Efficacy subscale	1 Covariant

Appendix B

Student Pre and Post Questionnaire

This is NOT a test! It is an opinion survey. We will be asking you for your thoughts and opinions about school and being a student so that we can learn how to help teachers and students do better in school. There are no right or wrong answers--different people have different ideas about all of these things. It is very important that you give your own opinion, not what someone else told you to think.

Your answers will be kept private, and they will not affect your grades in any way. If you have any questions about anything, feel free to ask for help.

Please take a look at the questions on this page, and ask for help if you have any questions about how to do this.

The first set of questions asks what you think about intelligence. Intelligence is the same thing as smartness. Here are some things people say about intelligence. Tell us how much you agree or disagree. Remember, there is no right or wrong answer -- we are interested in what you think.

<u>Section 1:</u> **Student Mindset Assessment- Theory of Intelligence Scale (Dweck, 1999; Blackwell, 2002)**

Rating Scale:

1	2	3	4	5	6
Agree A Lot	Agree	Agree A Little	Disagree A Little	Disagree	Disagree A Lot

1. You have a certain amount of intelligence, and you really can't do much to change it.

2. You can always change how intelligent you are.

3. Your intelligence is something you can't change very much.

4. No matter who you are, you can change your intelligence a lot.

5. You can learn new things, but you can't really change your basic intelligence.

6. No matter how much intelligence you have, you can always change it a good amount.

<u>Section 2:</u> **Effort Beliefs (Blackwell, 2002)**

Rating Scale:

1	2	3	4	5	6
Agree A Lot	Agree	Agree A Little	Disagree A Little	Disagree	Disagree A Lot

7. To tell the truth, when I work hard at my schoolwork, it makes me feel like I'm not very smart.

8. It doesn't matter how hard you work--if you're not smart, you won't do well.

9. If you're not good at a subject, working hard won't make you good at it.

10. If a subject is hard for me, it means I probably won't be able to do really well at it.

11. If you're not doing well at something, it's better to try something easier.

12. When something is hard, it just makes me want to work more on it, not less.

13. If you don't work hard and put in a lot of effort, you probably won't do well.

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

15. If an assignment is hard, it means I'll probably learn a lot doing it.

Section 3: **Patterns of Adaptive Learning Scales (PALS)- Student Efficacy**

Here are some questions about you as a student in science class. Please select the response that describes what you think.

Rating Scale:

1	2	3	4	5
Strongly Agree	Agree	Neither agree or Disagree	Disagree	Strongly Disagree

16. I'm certain I can master the skills taught in class this year.

17. I'm certain I can figure out how to do the most difficult class work.

18. I can do almost all the work in class if I don't give up.

19. Even if the work is hard, I can learn it.

20. I can do even the hardest work in this class if I try.

Section 4: *Value Component: Task Value subscale of the Motivated Strategies for Learning Questionnaire (Pintrich, P., Smith, D., Garcia, T., and McKeachie, W, 1990)*

These questions will ask you to determine how useful the information in science is to learn and how interested and motivated are you in learning this information.

Rating Scale:

1	2	3	4	5
Very true of me		Somewhat true of me		Untrue of me

21. I think I will be able to use what I learn in science in other classes.

22. It is important for me to learn the information taught in science.

23. I am very interested in learning the information in this science class.

24. I think the information in science class is useful for me to learn.

25. I enjoy learning about science.

26. Understanding the science information in this class is very important to me.

<u>Section 5:</u> Cognitive and Metacognitive Strategies Rehearsal, Elaboration, and Organization subscales *(Pintrich, P., Smith, D., Garcia, T., and McKeachie, W, 1990)*
These questions ask you to determine, how often do you do each of these things when you work on your school work?

Rating Scale:

1	2	3	4	5	6
Never	Rarely	Occasionally	Sometimes	Most of the time	Always

Rehearsal

27. When I study for a test I practice saying the important facts over and over to myself.

28. When I study in science, I read my class notes and the science readings over and over to myself to help me remember.

29. I memorize key words to remind me of important concepts in this class.

30. I make flash cards and quiz myself with them to help me remember things.

Elaboration

31. When I study, I pull together information from different sources, such as lectures, readings, and discussions

32. When I study, I relate ideas in science to those in other classes whenever possible.

33. When reading in science, I try to relate the information I am learning to what I already know.

34. When I study, I write brief summaries of the main idea and put those ideas in my own words.

35. I try to understand the material in science by making connections between the readings and what the teacher has taught.

36. I try to apply ideas from my science readings in other class activities such as classroom discussions.

Organization

37. I write outlines for the chapters in my book to help organize my thoughts while studying.

38. When I do homework, I look back over my class notes and science readings to remember the most important ideas.

39. I make simple charts, diagrams, or tables to help me organize my science notes.

40. When I study for my science class, I go over my class notes and make an outline of important ideas.

Appendix C

Teacher Pre and Post Questionnaire

In the following questions, we ask about your views about intellectual ability, effort and learning, and your beliefs about your ability to teach students. This is NOT an evaluation of your teaching or your beliefs! It is an opinion survey. Opinions differ on these matters and your honest, "gut" response will be most helpful.

<u>Section 1:</u> **Teacher Survey of Mindset Beliefs - Adult Theory of Intelligence Scale (Dweck, 2000)**

Rating Scale:

1	2	3	4	5	6
Agree A Lot	Agree	Agree A Little	Disagree A Little	Disagree	Disagree A Lot

1. You have a certain amount of intelligence, and you really can't do much to change it.

2. You can always substantially change how intelligent you are.

3. To be honest, you can't really change how intelligent you are.

4. No matter how much intelligence you have, you can always change it quite a bit.

5. You can learn new things, but you can't really change your basic intelligence.

6. You can change even your basic intelligence level considerably.

<u>Section 2:</u> **Effort Beliefs (Blackwell, 2002)**

Rating Scale:

1	2	3	4	5
Strongly Agree		Somewhat Agree		Strongly Disagree

7. No matter how hard you work, if you're not smart, you won't do well in life.

8. When I fail at something, I usually put more effort into it the next time I try it.

9. I actually enjoy my work most when it makes me think hardest.

10. To tell the truth, when I have to work hard at something, it makes me feel like I'm not all that intelligent.

11. When it comes to mental tasks, if you're not naturally good at something, hard

work won't make you good at it.

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

13. When something is difficult, it just makes me want to work harder on it.

<u>Section 3:</u> PALS- Personal Teaching Efficacy

Rating Scale:

1	2	3	4	5
Strongly Agree		Somewhat Agree		Strongly Disagree

14. If I try really hard, I can get through to even the most difficult student.

15. Factors beyond my control have a greater influence on my students' achievement than I do.

16. I am good at helping all the students in my classes make significant improvement.

17. Some students are not going to make a lot of progress this year, no matter what I do.

18. I am certain that I am making a difference in the lives of my students.

19. There is little I can do to ensure that all my students make significant progress this year.

20. I can deal with almost any learning problem.

Appendix D

Super Scientist Challenge and Behavior Task Choice

SUPER SCIENTISTS

Name ________________________

1. ❁▲▼❒❏■❏❍❅❒ ________________________
Studies outer space, the solar system, and the objects in it

2. ❂❉❏❍❅❄❉❃❁● ❅■❇❉■❅❅❒ ______________ ______________
Designs and builds body parts and devices

3. ❂❉❏●❏❇❉▲▼ ________________________
Studies all forms of life

4. ❚❏❏●❏❇❉▲▼ ________________________
Studies animal life

5. ❅❃❏●❏❇❉▲▼ ________________________
Studies animals and the way they interact with their environment

6. ❏❒■❉▼❈❏●❏❇❉▲▼ ________________________
Studies birds

7. ❈❅❍❁▼❏●❏❇❉▲▼ ________________________
Studies blood and its diseases

8. ●❅❐❉❄❏❐▼❅❒❉▲▼ ________________________
Studies butterflies and moths

9. ▼❁❘❏■❏❍❉▲▼ ________________________
Studies classification

10. ❐❁●❅❏■▼❏●❏❇❉▲▼ ________________________
Studies dinosaurs and fossils

11. ▲❅❉▲❍❏●❏❇❉▲▼ ________________________
Studies earthquakes

12. ❃❈❅❍❉▲▼ ________________________
Studies elements, atoms, and molecules

13. ❉❃❈▼❈❙❏●❏❇❉▲▼ ________________________
Studies fish

14. ❅■▼❏❍❏●❏❇❉▲▼ ________________________
Studies insects

15. ❍❁❍❍❁●❏❇❉▲▼ ________________________
Studies mammals

16. ❍❉❃❒❏❂❉❏●❏❇❉▲▼ ________________________
Studies microscopic organisms

17. ❍❉■❅❒❁●❏❇❉▲▼ ________________________
Studies minerals

18. ❐❈❙▲❉❃❉▲▼ ________________________
Studies motion, forces, and energy to explain the way things work

19. ❐❁❒❁▲❉▼❏●❏❇❉▲▼ ________________________
Studies parasites

20. ❍❙❃❏●❏❇❉▲▼ ________________________
Studies fungi

CODE:

A	❁
B	❂
C	❃
D	❄
E	❅
F	❆
G	❇
H	❈
I	❉
J	❊
K	❋
L	●
M	❍
N	■
O	❏
P	❐
Q	❑
R	❒
S	▲
T	▼
U	◆
V	❖
W	◗
X	❘
Y	❙
Z	❚

Fold along the line to use the code for the words on the back of this page.

Behavioral Task Choice Survey

[Part 1. Initial Task (challenging pre-test)]

Teacher ________________________ Student ________________ Date ________

Super Scientists Puzzle

Try to solve the puzzle! The names of 5 different kinds of scientists are shown in code, along with clues to what they do. Each symbol represents a different letter of the alphabet. Match the symbols to letters using the chart at the right to decode the words. You will have 5 minutes to solve as many as you can!

[Insert first 5 problems and decoding chart here.]

[Part 2a. Challenge choice]

Here are the correct answers to the puzzles. How many were you able to solve?

[Insert solutions here]

You will get another chance to work on these kinds of puzzles for 15 minutes. You can choose to try to solve as many problems as you want, up to 15.

If you choose a smaller number, you will probably be able to solve all of them with time to spare.

If you choose a larger number, you might not be able to solve them all, but you will learn more about science careers and get better at decoding.

How many puzzles (up to 15) would you like to try in 15 minutes? ____________

Why did you choose that number of puzzles to solve?

[Part 2b. Effort choice]

Now you have 15 minutes before you will start solving the new puzzles. You can use this time to practice if you like: you can review a list of names and definitions for science careers that may be in the puzzles, so you will be better prepared, and you can practice with the code list.

How much time would you like to spend practicing (up to 15 minutes)? ___________

Tell us why you chose that amount of time to practice:

[Part 3. Practice interval: If students elect to practice, they will be given the list and code chart, and will have 15 minutes to practice. Other students will be permitted to read or do other quiet work for 15 min.]

[Part 4. Problem-solving: Then students will be given a sheet with 15 problems and told to work on the number that they selected.]

[Part 5. Post-task survey:]

How many problems did you solve? _____________

Please rate each item on a scale from 1 *(not at all)* to 6 *(very much).*

How much did you like working on these problems?

Not at all	A little			Mostly	Very Much
1	2	3	4	5	6

How much would you like to take these problems home to work on?

Not at all	A little			Mostly	Very Much
1	2	3	4	5	6

How much fun were the problems?

Not at all	A little			Mostly	Very Much
1	2	3	4	5	6

How well do you feel that you did on the problems overall?

Not at all	A little			Mostly	Very Much
1	2	3	4	5	6

Appendix E

Teacher Ratings of Student Motivational Behavior

Adapted from Identifying Motivational Problems and Teacher Ratings of Student Helplessness (Stipek, 2002)

1. Please characterize the student's behavior. He/she:

	very often					almost never
talks inappropriately in class, jokes around/plays the clown.	1	2	3	4	5	6
acts confrontational/rebellious, gets into conflicts with other students.	1	2	3	4	5	6
does nothing/withdraws, acts bored, sleeps in class.	1	2	3	4	5	6
follows directions on tasks, turns assignments in on time, maintains attention until tasks are completed.	1	2	3	4	5	6
participates with enthusiasm, volunteers answers to questions, asks relevant questions about material.	1	2	3	4	5	6
gets upset by initial errors or difficulties; is easily discouraged; doesn't ask for help even when he/she needs it.	1	2	3	4	5	6
engages in learning activities that are not required; strives to improve skills even when performing well relative to classmates.	1	2	3	4	5	6
persists rather than gives up when work is difficult.	1	2	3	4	5	6

Appendix F

Research Project Timeline

Event	Involved Participants	Time Frame
Request School informed consent to Participate in Research	School Principals	July 2012
Data request for names of students and teachers	School district data office	July 2012
Informed Consent distributed	seventh-grade science Teachers	Mid-August 2012
Pre Assessments Administered & Orientation of Brainology© Program	seventh-grade science Teachers	Late August 2012
Informed Consent distributed	Parents and seventh-grade students	Early September 2012
Data request for achievement and demographic data (EOG, EOQ scores, etc.)	School district data office	Late September to early October 2012
Orientation to Brainology© program and pre-assessments	seventh-grade students	Late September 2012
First Administration of Measures (Behavioral Task and Teacher Observation)	seventh-grade students and teachers	September and October 2012
Brainology© modules & Growth Mindset Lessons Administered	seventh-grade science students	Early September 2012 to early February 2013
Post Assessments Administered	seventh-grade science students and seventh-grade teachers	Late February 2013 to early March 2013
Second Administration of Measures (Behavioral Task and Teacher Observation)	seventh-grade students and teachers	February 2013
Focus groups conducted	seventh-grade science students and seventh-grade teachers	Late early to late March 2013
Data request for achievement and demographic data (EOG, EOQ scores, etc.)	School district data office	Late March to early April 2013
Analysis of Research Data and Findings	Researcher	April 2013

Appendix G

Principal Confirmation to Participate in Research Study

Dear Principal,

A research project titled, "Efficacy of a growth mindset intervention," is being developed for seventh grade science classrooms in your school district. This study will test the impact of a neuroscience and study skills program on students' achievement in math and science.

Random Assignment
Teachers' seventh grade science classrooms will be randomly assigned to one of two conditions: a control condition, in which they will continue their normal programs and services; or a Brainology© condition, in which they will Implement the Brainology© program over the 2012-2013 school year along with their regular science curriculum.

Data Collection
We are asking for assistance to collect the appropriate permissions to conduct this research from parents, students, and teachers, and to assist the research team in collection of data during the study period. These data will include student and teacher surveys, to be administered two times during the study period; student and teacher reflections collected during the program Implementation; focus interviews with teachers and students who participate in the program; and collection of pre- and post-program student grades and test scores so that we can assess the impact of the program on achievement.

Time & Resources Needed
Classrooms assigned to the Brainology© condition would spend approximately 12 hours of classroom time over the course of a school term, including 3-4 hours total where students engage in online activities that require access to the internet and computers; and that it would require a minimum of 2 hours of teacher time for professional development activities over the term. In addition, students and teachers in both the Brainology© and control conditions will devote about 1.5 hours over the school year to completing surveys and providing feedback on the program.

Resources & Benefits
Participation will be entirely free for you, with no financial commitment required to receive the products and services described, and that teachers will be compensated for their non-instructional time on the project, including providing data. Furthermore, students who are assigned to the control condition will be entitled to receive the equivalent products and services following the completion of the study period.

Principal Signature:
____________________Date:______________

Principal Name (please print): ____

School Name (please print):
____

Contact Phone #: ________________________________E-Mail: ___________________________

Appendix H

Educator consent to participate in Research Study

Dear Educator,

A research project is being conducted to learn about ways to help teachers and students to be more successful in the classroom. This consent form will give you the information you need to help decide whether or not to participate in the study. Please read it carefully. If you consent to participate, please sign the back of this form and return it to your principal by August 30, 2012. You may contact us with any questions you have about the purpose of this study, how we will conduct the study, what we will do with the information, and anything else that is not clear. This process is called "informed consent."

Purpose of the Study
Our project is looking for ways to help students to do well in school. We are partnering with (School Name) to assess the impact of different programs and resources offered by the school on student achievement. We think these programs and resources can give us important information about ways to help students to become academically successful.

What participation will involve for you
This study will begin in September 2012 and will continue throughout the school year. Teachers will engage in the following activities:

- ***Research Components:*** Teachers will be asked to complete surveys asking them about their beliefs, practices, and experiences as educators, and about their students' motivation and effort. These surveys will take 20-30 minutes to complete and will be given two times during the school year.

Confidentiality
All data, including your responses on the survey, will be kept strictly confidential, and no names will be used when we report on the results of the study. All teachers will use a code number when filling out the surveys, to help protect their privacy. None of their answers will be used in supervisory evaluation in any way.

Benefits
The information that we gain through this study may help us to identify resources that can benefit students' learning and motivation. It may also help teachers to be more effective in the classroom.

For further information
If you have any questions about the study, you may contact Paula Wilkins at 336-399-8117 for further information.

If you consent to participate in this study, please read and fill out the rest of this page, and return it to your principal by August 30, 2012.

HSRC Statement

1. Participation in this research is entirely voluntary. You may refuse to participate or withdraw from the study at any time without consequences.

2. If, during the course of the study, significant new information becomes available which may affect your participation, it will be provided to you.

3. Any information that personally identifies you will not be voluntarily disclosed or released without your separate consent, except as required by law.

4. If at any time you have questions regarding the study or your participation, you may contact Paula Wilkins at [redacted] or via email at [redacted] and she will answer all questions.

I understand the information provided, and I give my consent to be included in this study. I understand that I can ask any questions about the study by calling Paula Wilkins at [redacted]

Educator Signature:
____________________Date:______________

Educator Name (please print):
____

School Name (please print):
____

Contact Phone #: ______________________________E-Mail: __________________________

Appendix I

Mindset Works Research Incentive Support

Confirming support

Thursday, May 10, 2012 9:29 AM

Lisa S. Blackwell

To: 'Wilkins, Paula B.'

Hi Paula,

Just confirming that we can provide the student Brainology© licenses and Educator Kit PD materials for the Brainology© group at no charge for the study. Also, we will provide the following incentives for participation in the research to teachers in both the Brainology© and control conditions:

$25 Amazon gift certificate for each participant
1 iPad3 and 1 Kindle Fire to be raffled off among the teacher participants at the conclusion of the study (end of 2013 school year)*

*Contingent on having at least 30 teachers participating for the full study. We may need to adjust the prize if we go lower.

Cheers,

Lisa
****
Lisa S. Blackwell, Ph.D.
Co-Founder & VP of Design, Implementation & Evaluation
Mindset Works, Inc.
www.mindsetworks.com

Appendix J

Student Assent Form

(To be read aloud as well as provided in writing).

We are developing programs to help teachers and students to do better in school. We are partnering with your school this year to try some programs and study whether they are effective in helping students and teachers to succeed.

As part of this project, your school will have students

1) Fill out some surveys asking about your beliefs, goals, and experiences as students. These surveys will take 20-30 minutes to complete and will be given two times during the school year.

2) Agree to let your school give us information, such as students' grades, so that we can see whether school programs help students to succeed in school.

All information, including your responses on the survey, will be kept strictly confidential, and no names will be used when we report on the results of the study. You will use a code number when filling out the surveys, to help protect your privacy. None of your answers will be used in grading in any way.

Participation in this research is entirely voluntary. You may refuse to participate or withdraw from the study at any time without consequences.

If at any time you have questions regarding the study or your participation, you may Paula Wilkins at [redacted] or by email at [redacted] and she will answer all questions.

You will receive a copy of this page to keep so that you can refer to it in the future.

- ***I understand the information provided, and I agree to participate in this study.***

Student Signature: ____

Date:______________

Student Name (please print):
____

School Name (please print):
____

Appendix K

Parental Consent

Dear Parent/Guardian,

A research project is being conducted at your child's school to learn about ways to help teachers and students to be more successful in the classroom. This consent form will give you the information you need to help decide whether or not to allow your child to participate in the project. Please read it carefully.

If you consent for your child to participate, please fill out and sign the back of this form and return the signed copy to your child's school as instructed by, Friday, September 14. You may contact us with any questions you have about the purpose of this study, how we will conduct the study, what we will do with the information, and anything else that is not clear. This process is called "informed consent."

Purpose of the Study
Our project is looking for ways to help students to do well in school. We are partnering with (school name) to assess the impact of different programs and resources offered by the school on student achievement. We think these programs and resources can give us important information about ways to help students to become academically successful.

What participation will involve for your child
This study will begin in late September 2012 and will continue throughout the school year.

Students will be given surveys, asking them about their perceptions of school and of themselves as students. These surveys will take 20-30 minutes to complete and will be given two times during the school year. In addition, we will collect data on student attendance, end of quarter grades and test scores in math, science, and reading from the school. Your child will be told that he or she may choose not to participate in our study at any time, and may choose not to answer any question on the surveys.

Confidentiality
All data, including your child's responses on the survey, will be kept strictly confidential, and no names will be used when we report on the results of the study. All students will use a code number when filling out the surveys, to help protect their privacy. None of their answers will be used in grading or evaluation in any way.

Benefits
The information that we gain through this study may help us to identify resources that can benefit your child's learning and motivation. It may also help your child's teachers to be more effective in the classroom.

For further information
If you have any questions about the study, you may contact Paula Wilkins at [redacted] or by email at [redacted] for further information.

If you consent to allow your child to participate in this study, please read and fill out the rest of this page, and return it to your child's teacher by___________________

HSRC Statement

1. Participation in this research is entirely voluntary. You or your child may refuse to participate or withdraw from the study at any time without consequences.

2. If, during the course of the study, significant new information becomes available which may affect your participation, it will be provided to you.

3. Any information that personally identifies your child will not be voluntarily disclosed or released without your separate consent, except as required by law.

4. If at any time you have questions regarding the study or your child's participation, you may contact Paula Wilkins at [redacted] or via email at [redacted] and she will answer all questions.

I understand the information provided, and I give my consent for my child to be included in this study. I understand that I can ask any questions about the study by calling Paula Wilkins at [redacted].

Parent/Guardian Name (please print):
____

Street
Address:____

City: ___________________________________ State: _____________________ Zip Code:
______

Student's Name (please print):
____

Contact Phone #: ________________________________E-Mail: ___________________________

Parent/Guardian Signature:
____Date:______________

***IMPORTANT: RETURN THIS FORM BY Friday, September 14, 2012* **

Appendix L

Brainology© Focus Group Interview Protocol for Teachers

As participants arrive they will sign the sign-in sheet to record attendance of the group participating in the focus group.

Introduction script:

You have participated in the Brainology© program for the past several months. In an effort to better understand the impact of the program and its effects, we would like to ask you to respond to a series of questions. We are also interested in understanding the parts of the program that were most helpful to you. This interview should take about 35 minutes.

All responses will be held confidential. No individual participant will be identified in the analysis of this interview. We will be transcribing your responses as well as audio recording this session to guarantee accuracy. You will be given a transcript of your responses and if there are statements that we have inaccurately recorded or information you feel uncomfortable sharing, we will remove it from the research study. To get us started today, please go around and tell me your name.

Script:

During this interview you will respond to7 questions. Some questions refer directly to the Brainology© curriculum while others refer to the impact of this program on you and your students' beliefs about ability and achievement. Please provide as much detail in your responses as possible.

1. What parts of the Brainology© program were most helpful to you as a teacher? Why was this information helpful?
2. What impact has Brainology© had on your classroom as a whole?
3. Where there specific students who showed observable evidence of the growth mindset during the institution of Brainology©? Please cite the most frequent observable characteristics.
4. What was something new you learned by participating in the Brainology© program?
5. Who would you recommend should participate in this program? What advice would you offer another teacher about the Brainology© program or about the growth mindset?
6. What are ways the Brainology© program could be improved?
7. Is there any additional information you would like to share with me about the Brainology© program, the effects it has had on you as an educator or your students?

Appendix M

Brainology© Focus Group Interview Protocol for Students

(As participants arrive they will sign the sign-in sheet to record attendance of the group participating in the focus group.)

Introduction:

You have participated in the Brainology© program for the past several months. In an effort to better understand the impact of the program and its effects, we would like to ask you to respond to a series of questions. We are also interested in understanding the parts of the program that were most helpful to you. This interview should take about 35 minutes.

All responses will be held confidential. No individual participant will be identified in the analysis of this interview. We will be transcribing your responses as well as audio recording this session to guarantee accuracy. You will be given a transcript of your responses and if there are statements that we have inaccurately recorded or information you feel uncomfortable sharing, we will remove it from the research study. To get us started today, please go around and tell me your name.

Script:

During this interview you will respond to7 questions. Some questions refer directly to the Brainology© curriculum while others refer to the impact of this program on you and your beliefs about your ability and achievement. Please provide as much detail in your responses as possible.

1. What parts of the Brainology© program were most helpful to you as a student? Why was this information helpful?
2. What impact has the Brainology© program had on the way you think about your abilities or how you respond to challenges?
3. Where there specific things you do differently as a result of participating in the Brainology© program?
4. What was something new you learned by participating in the Brainology© program?
5. Who would you recommend participate in this program? What advice might you give other students about the Brainology© program or about the growth mindset?
6. What are ways the Brainology© program could be improved?
7. Is there any additional information you would like to share with me about the Brainology© program or how it has impacted you?

Appendix N

Focus Group Consent/Sign-In Form

I understand that feedback is being collected from about my participation experience in the Brainology© program. The purpose of holding this focus group is to gain a better understanding of the impact of the Brainology© program on students and teachers. I also understand that anything I say in this group will remain confidential. My signature below indicates my willingness to participate in this focus group.

Name	**School Location**
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
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