DOES A FOCUS ON MATHEMATICAL PRACTICES HAVE AN EFFECT ON GROWTH MINDSET?

by

Amanda Blackwell

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

July, 2017
ABSTRACT
by
Amanda Blackwell

Prior research has investigated relationships between the beliefs of an individual’s mindset and the amount of effort exerted on a task. Growth mindset, the idea that intelligence is not fixed and effort is essential to success, is of interest as a potential factor in mathematics achievement. The purpose of this study was to explore the connection between the Standards for Mathematical Practice and the growth mindset of students.

Participants were given a pre-test to determine their level of growth mindset and were then presented with focused work on the mathematical practices. A post survey was administered to determine change in participant mindset. Results were mixed with significant growth in some aspects of growth mindset, but not others.

While there were several shifts in the data from pre to post survey moving in favor of growth mindset. One of several statements that showed significant shifts were students can do even the hardest work if they try. Results from this statement included 12.3% of students disagreeing with this in the pre-survey and 6.1% in the post survey (none of which strongly disagreed).
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CHAPTER 1
NATURE AND SCOPE OF THE STUDY

Statement of the Problem

For many years, researchers have observed achievement gaps in educational achievement of students, including in mathematics. Many entities have come together to try to close these gaps in variety of ways. While some have helped in certain aspects of these gaps, it can be agreed upon that there are still some significant gains to be made. Some of these efforts have resulted in the development of commonly aligned standards known as the (Common Core State Standards, National Governors Association, 2010).

While not all states have adopted these standards, they have been a great influence to the revision of curriculum standards across the country. Many of these standards revisions have held a great deal of similarities to those of the CCSS. The standards have a complementary piece to them known as the Standards for Mathematical Practices (SMP) that define the proficiencies of successful mathematic students. Because of these developments educators are struggling with the implementation of the practices as well as realizing the connection of the practices to academic achievement and other critical aspects that affect achievement.

As educators have tried for years to close the achievement gap, many factors have been analyzed and discussed. One factor that may play a role in closing this gap is the idea of growth mindset. This idea is centered on the theory that there are two primary mindsets, one that is fixed and one that is malleable. The idea that surrounds the fixed mindset is that the mind does not grow or change. Specifically, one is born with a certain amount of intelligence and there is nothing that can be done to change that. In contrast to that idea is one that believes that the brain is like a muscle and can be developed. This idea has been given the term “growth mindset”. It
has yet to be determined what kind of a role growth mindset may play in closing this achievement gap. However, if there is a connection between the SMPs and growth mindset then a focus on those SMPs could lead to gains in academic achievement.

**Background**

Since the Common Core State Standards (CCSS) have been brought forth there have been a number of questions and thoughts on how teachers can help students master these standards. The CCSS provide the SMP for teachers to refer and apply within classes to assist them in achieving mastery on these standards. In fact, in an article by Michelle L. Stephan (2014), the lack of understanding of the practices is described, “… and CCSSM gives no information on how to help students embody these practices.” (p. 532)

Through research projects such as the one completed by Vanessa Walker (2015) that questions how professional development can help with the implementation of CCSS and the SMPs, there is evidence of a lack of confidence, knowledge, and support on the connection of the SMPs in teaching. One teacher in Walker’s study shared:

I'm just not sure what they expect us to do. The standards have high-expectations for the kids. Kids who may struggle with math have to do multi-steps problems that require so much reading. Those low ones are just going to kind of even fall more behind. They can't even do the math, but then you have to ask them to explain why you are doing this. There is just not enough support for these kids. (p. 56).

In addition to the concerns shared by the teachers, there have also been connections between the SMPs and Carol Dweck’s (2007) concept of growth mindset. The growth mindset idea is the research that intelligence is not a fixed concept but rather one that can change with experiences and training. The brain is described as a muscle that can be strengthened with use.
Dweck’s theory of growth mindset is related to the Common Core's Standards for Mathematical Practice." This connection is made as the SMPs are described as instructional strategies that will exercise the brain by helping move information from the working memory to the long term memory. While connections are stated and made between the SMPs and the growth mindset idea, there is little research that shows how the focus on the SMPs affect the growth mindset or the thoughts that students have in regard to their math classes.

**Purpose of the Study**

The purpose of this study is to investigate if a focus on the SMPs affects the beliefs and thoughts of students when it comes to math.

This study will consist of a survey used in a previous study by Wilkins, (2014) to quantify the students’ answers in a survey to measure their mindset in their math class. Students will then continue their math class with a focus weekly on the SMPs. After one quarter of the academic school year, students will take the same survey that they took at the beginning of the study. The data provided will determine if the focus put on the SMPs will affect the mindset of middle school math students.

**Research Question**

There have been a number of attempts to help close the achievement gap in education over the years resulting in standard revisions. The difference with the previous attempts and that of the recent initiatives is that recently the standards have come with the additional practices for teaching component. The connection between the SMPs to the various components in education could be better understood through further investigation. Therefore, the research question of this study is:

Does a focus on the mathematical practices affect growth mindset?
Significance of the Study

The educational significance of this study is to further the understanding of how the SMPs impact students’ achievement as well as the connection with growth mindset theories. There have been connections made between the concept of the SMPs and the research that has already been conducted with the growth mindset ideas that Carolyn Dweck and other researchers have published. Findings from this study could lead to more schools understanding a need for a specific focus on the practices as well as a push for schools to provide the professional development for effective implementation. With the knowledge and research to better understand the relationship between the SMPs and the students beliefs teachers will be better equipped to help students make academic gains as well as set them on a path for success in such a pivotal moment in their educational careers. Additionally, as Wilkins (2014) describes, “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.” (p. 24)

Organization of the Remaining Chapters

Chapter Two includes a literature review providing a theoretical framework for this study. The development of the CCSS and the SMPs, studies on academic efficacy beliefs, relationship between efficacy and achievement, and the role of professional development and implementation of the standards are discussed in the review of literature. Chapter Three explains the methods, design, and methodology implemented for this study. Chapter Four is a discussion on the results that were identified in this study. Chapter Five includes a discussion on the results including limitations and recommendations of the study.
CHAPTER 2
REVIEW OF LITERATURE

Introduction

As students develop from elementary, through middle, and eventually high school it is important that educators who are responsible for the various components of curriculum writing as well as carrying out the curriculum to respect and incorporate a healthy balance between content understanding and procedural understanding. It is specifically suggested that a great opportunity to engage the practices to the content is when a standard specifically uses the word “understand” (Common Core State Standards Initiative, 2017). There is a danger for relying too much on procedure, and this is particularly highlighted when students lack understanding over a topic.

While the SMPs are mentioned there have been connections made by educators between the practices and the research of the coined term “growth mindset”. While the research between growth mindset has grown, the research between growth mindset and connection of the mathematical practices are limited. There have also been research connections between growth mindset and student efficacy (Wilkins, 2014). Studies support a positive correlation between growth mindset and self-efficacy and academic achievement. Because of this positive correlation, and the lack of research between the practices and growth mindset, it is important to start researching the connection between the two. This will further emphasize the need for teachers and school districts to ensure a focus on the practices as well as the standards. This study will investigate the connection between the focus on the SMPs and growth mindset. This chapter is a review of literature that will provide background information related to the SMPs,
growth mindset, the relationship between efficacy and achievement, and other factors that will provide a base for the investigation.

**Standards of Mathematical Practices**

According to the results from the 2011 National Assessment on Education Progress (NAEP) the average 8th grade score in mathematics increased from 2009 but only by one point. In 2009 the average score of 284 is still considered below proficient even with the various reform initiatives in place to improve scores. One of the commonly known initiatives is the Common Core Initiative [(CCSS), National Governors Association, 2010]. This initiative referred to the CCSS, which eventually served as a model for states to either adopt the standards or use a modified version of the standards. Missouri is one of the states that adopted learning standards that are very similar in nature to the CCSS, but was tailored to the needs of the state. These standards are known as the Missouri Learning Standards which were adopted in 2016 (National Center for Education Assistance 2011).

When the CCSS were developed they were fronted as a guideline for our students to increase the rigor in our classroom which would provide a deeper understanding of the various concepts. The unified goal was to help students obtain college and career ready status as they leave high school. The expectation was that a focus would be on problem solving, critical thinking, and self-evaluation. With the CCSS there were a number of process standards that were adopted with them. These process standards are the guidelines on how to address the standards in class. The practice standards are based on an earlier set of process standards developed by the National Council of Teachers of Mathematics (NCTM). The SMPs include:

1. Make sense of problems and persevere in solving them.

As it is described in the CCSS for Mathematics, students who are proficient in mathematics will have a strategic approach to problem solving rather than
instantaneously jumping into a solution attempt. Strategic approaches may include, but are not limited to, considering problems that are similar, alternative or simpler forms, searching for patterns or trends, and considering how realistic the answer or solution is.

(2) Reason abstractly and quantitatively.

Often there is an emphasis put on making sense of a problem within the context, but students who are proficient in math can also show the ability to pull the information from the context and represent it symbolically. Furthermore, they can handle the representation to fulfill a variety of references. The quantitative piece in this standard involves units and the meanings of those quantities.

(3) Construct viable arguments and critique the reasoning of others.

The students who are mathematically proficient can also defend, analyze, and critique other approaches to problem solving. This is done by using what they have learned and observed from previous problems and using this in combination with logical progressions and statements to test and prove conjectures (whether it is their own or others).

(4) Model with mathematics.

This can be done a variety of ways. It is expected that a mathematically proficient student will be able to model problems. This may be done by simply writing a number sentence or an equation. This could also be a drawing or using hand held manipulatives to model the problem. Another way that this can be done is physically. Some other models may include tables, graphs, charts, formulas, and conceptual maps to show and analyze relationships to interpret meanings.
(5) Use appropriate tools strategically.

This standard could be considered self-explanatory. A student proficient in math will not only be familiar with the variety of tools available, but also take into consideration which tools will aid in solving a problem effectively and efficiently. The tools can be as simple as a pencil and paper. Some examples of tools that students would take into consideration are: models, rulers software, computer systems, calculators, spreadsheets, graphing calculators, or even protractors among others.

(6) Attend to precision.

Precision in this case is not limited to precision in numbers. It can also be communicating precise definitions, clearly identifying and stating the meanings of symbols, and expressing to the correct degree of precision.

(7) Look for and make use of structure.

Students learn early to look for patterns. As they emerge through to mathematical proficiency, they are able to take these patterns and use structure to create conjectures, develop meanings, and enrich critiques and arguments with these patterns.

(8) Look for and express regularity in repeated reasoning.

Mathematically proficient students can identify repeated calculations. They may even take this a step further and find shortcuts to problem solving. Throughout this process the students continuously look for the reasonableness of their solutions or the path that they are on in problem solving (Common Core State Standards Initiative, 2017).
As Susan Jo Russell reinforced in an article published by NCTM, “CCSSM does not tell us how to teach. It offers a framework that must be interpreted and implemented using all the knowledge about children’s varying learning needs and strengths that we, as educators, bring to our work. One way to do this is to take seriously the backbone of CCSSM- the Standards for Mathematical Practice- …” (Russell, 2012, p.56) This is an indication that there is a gap between the expectation in educational mandates and educators’ understanding of the implementation. An educator may wonder how they are expected to implement these practices without guidance on how to implement them.

While some have openly expressed concerns about the SMPs, there have also been articles and action research projects to help assist with some of the expressed concerns. An article written by Victor Mateas, published in Mathematics Teaching in the Middle School (2016), addresses “myths” that have developed around the SMPs and how teachers can address them. The article stemmed from professional development that was tested on 400 educational professionals ranging from teachers to school leaders across seven different states. Throughout these professional development opportunities, some of the same misconceptions surfaced.

The first myth that this article addressed was that all of the SMPs must be included in each and every lesson. While some SMPs do naturally go hand in hand when going through a lesson, like looking for patterns and making sense of problems, forcing all SMPs to be addressed in the same lesson can be distracting and take away from the intended educational objective(s). The suggestion to address this myth is to really analyze which SMPs lend themselves to the students naturally in the planning phase.

The second myth addressed by Mateas was that only one of the SMPs could be focused on at a time by the student. This again is suggested to be addressed in the planning phase. There
are situations where students will naturally address more than one practice at a time. The third myth brought forth in the article is that the math task alone determines what practice will be used. As it has been mentioned, the practices focus on the mathematical thinking that goes with the problem. Because this is done through the students’ thinking process it cannot be 100% identified what practice they may highlight. It is good to try to plan, but it is recommended to plan with flexibility in mind.

The fourth myth deals with the idea that only specialized problems can be used to focus on a practice, but in reality procedural problems can lend themselves to highlight the practices as well. This is where teachers struggle with the SMPs. They have not always been expected to be as flexible and dynamic in the presentation and the learning process. The teachers need the practice in addressing these shortfalls.

The last myth deals with the idea that mathematical practices can be taught separately from the mathematical content. While this study set up a specific time to focus on the practices, it could not have been done without thinking mathematically. Since the main idea of the SMPs is to guide how to think mathematically, you cannot learn how to think mathematically without thinking mathematically about something (Mateas, 2016).

It is evident that the SMPs play an essential role in students deeply engaging into their lessons and mathematical concepts. One can clearly connect the importance of the role of the SMPs with the importance of teachers’ understandings of the SMPs as well.

**Growth Mindset**

In 2006 Carolyn Dweck published a great deal of research that has forever changed educators’ approach in the classroom, especially with student interactions. The research that she published is empowering as she supports that when students develop growth mindset, they
believe that the brain can grow with exercise making intelligence a learned concept. Her research shows that approximately 40% of the students in the United States exhibit a growth mindset. Characteristics of these students include resiliency in the face of failure, enjoyment from challenges, more effective efficacy in learning and working, and more willingness to take academic risks. Additionally, her research also indicates that another 40% work with what is known as a fixed mindset. This contrasting mindset exhibits characteristics such as the belief that your mind is what it is, you are either smart or you are not, more apt to give up, have a fear of failure, avoid challenges, and when you fail or make mistakes you feel that you are just not smart (Dweck, 2006).

Dweck’s studies also indicated that when students go through an intervention to move from fixed to growth mindset they start performing at higher levels right away. This coupled with findings of brain elasticity and response to effort, began a huge movement to how schools not only interacted with students, but also how they grouped students. Dweck’s findings encouraged a number of studies to investigate what impacts growth mindset interventions had on groups of students. It was found that new connections were formed in the brain as effort was introduced. This is something that is directly controlled by the students. As numerous studies replicated it was found that academic achievement was on the rise for these students that had learned growth mindset. In addition to the findings of effects of effort, it was discovered how ability grouping can encourage the idea of a fixed mindset. In the United States these groupings start to naturally take place in the middle school time frame. Students are quick to pick up on these groupings even when it is not told to them. They gain the perception that only the “smart” students go to the advanced classes. Contrastingly, those schools who do not group based on ability send the message that intelligence is learned through effort (Dweck 2006).
Throughout these investigations, another area of interest is the messages that play a role in which mindset a student will embrace. The ability grouping that has been discussed sends the message that a student is smart or they are not. Another message that can affect the student belief is the types of feedback given to students. Certain types of praise can be damaging. This has especially been noted with females. Praise is equated with being “smart” and if they fail or make mistakes the student takes away that they are not smart because of the failure or mistake. Because of this idea they are further damaged and create a fear of failure leading them to naturally stray from challenges (Dweck 2006).

Since the initial burst of research that Dweck has published, she has revisited the ideas of growth mindset and has shared some misconceptions that have naturally surfaced. Some have equated effort with growth mindset. While effort is essential for student achievement, it is cautioned to not solely focus on effort. If students are putting forth effort and not making progress on their learning, there is a problem that has to be addressed. As educators, not learning is something that should not be acceptable. Dweck suggests feedback should show the appreciation for the effort, but also address how to move past the gap and persevere through the challenge. A suggested feedback could be, “Let’s talk about what you’ve tried, and what you can try next.” (Dweck, 2015, p. 20).

Another concern shared by Dweck as she revisited the growth mindset theory is that it has been realized that educators and adults have claimed a growth mindset, but fail to show or act in accordance to growth mindset. One example of this is parents who endorse growth mindset; however, they react to mistakes and failures in a problematic way, which commonly leads to foster that fixed mindset idea of themselves. To keep the false growth-mindset minimum, Dweck suggests we approach the journey to growth mindset as one that is ongoing. It
is also suggested that everyone realize that everyone has a natural mixture of growth mindset and fixed mindset thoughts. It is believed that once the fixed mindset characteristics are acknowledged, they can be addressed and keep those on the path to growth mindset (Dweck 2015).

One may question the role of growth mindset pertaining to mathematics beyond the connections previously mentioned. One researcher that has narrowed the role of growth mindset in the mathematics classroom is Jo Boaler. Boaler describes mathematics as the subjection that is the closest aligned to fixed ability messages. Conversations and practices are the venue in which educators consistently send messages to students about ability and learning (Boaler 2013).

These vital messages that can change the mindset of students are not only given verbally, but also in the messages we send in a number of mediums. Boaler describes how all students can be successful in math, but it is a challenging task to change students’ math mindsets. These messages that we send to students through questions, tasks assigned, feedback, and mistakes made can help shape students’ math mindset and set them on a path of success (Boaler, 2016).

One of the areas of focus is mistakes in mathematics. Specifically, in which ways we react to mistakes. Mistakes in a fixed mindset equate to failure, however, in the growth mindset mistakes are seen as opportunities. When students analyze mistakes to figure out what caused the error there are new connections made and help create growth in the brain. It is suggested that teachers value and celebrate mistakes. Formerly, educators celebrated pages of correct work. However, it is suggested that pages of correct work doesn’t show growth, and the opportunities for growth can be missed (Boaler, 2013).
Relationship Between Efficacy and Achievement

In a study conducted by Wilkens (2014) in regard to efficacy of growth mindset intervention and student achievement, there was a reported relationship between efficacy and achievement. The findings included, “…that when students engage in effective study skills strategies, they are likely to have higher self-efficacy and in turn higher achievement.” (p.168). Wilkens describes the middle school years as those that can be more challenging as there is a greater, “focus on competition, social comparison, and ability self-assessment, as students begin to identify their limits and capabilities” (2014). Blackwell et al., (2007) described this as a point in time where students work through these challenges with greater levels of efforts, while other students pull away from their school experience and show less effort. The path in which students take to adapt to these challenges have shown to have a correlation with their academic success (Blackwell et al., 2007). Because of this, it is important to student success for educators to guide and support them during this critical transition.

As this critical time shapes the academics that follow for students in their education, researchers increased their interest in finding out what made students persevere and put forth greater effort versus students who lack that resiliency. It was also noted that incremental theories focus on learning goals which relate to enhancing one’s ability whereas the entity theorist will tend to focus on performance goals which highlights ability. It was also documented that these incremental theorists put a focus on the utilization of effort rather than the idea of effort being pointless.

Blackwell et al., (2007) completed a series of studies that measured not only the idea that theories had an association with motivational patterns, but also the idea that when enacting a theory, they predicted that there would be a positive motivational outcome in the classroom. The
first study focused on junior high students. Measurements of implicit theories and achievement-related beliefs were assessed through seventh and eighth grade. This study focused on 373 moderately high achieving students in a public school setting. This was a five-year study and was primarily geared towards math. The motivation was assessed in a variety of profiles. One of these used a Likert-type scale to test their theory of intelligence. The lower end of the scale represented more of a fixed mindset (i.e. entity) and the higher end focused more on incremental theory. In this study it was reported to have a mean of 4.45. Another assessment focused on the Learning goals from the Patterns of Adaptive Learning Survey (PALS). Also included in the assessments was an assessment for Effort Beliefs.

In this first study, there was a positive association with positive effort beliefs, learning goals, low helpless attributions, and positive strategies. Throughout this study it was also noted that while there wasn’t a significant difference between students with incremental and entity theories in mathematical achievement scores, the difference increased over the two years of junior high school. This formulated the argument that there is a correlation between the theory of intelligence and motivation. Another notable finding described in this study is that those students who held a strong incremental theory of intelligence at the beginning of the study outperformed those who didn’t nearly two years later. Additionally, these students also had more positive motivational beliefs.

As the first study highlighted an association with the theory of intelligence and the motivational patterns, it was deemed necessary to explore what would happen if students were taught to think of their intelligence as malleable to help them reach the more positive motivation and achievement in the classroom. The second study focused on questions such as, “Do students, having been taught to think of intelligence as malleable, show more positive motivation and
greater effort in the classroom? Do they achieve more highly than their peers who were taught useful skills but were not taught the incremental theory” (Blackwell et al., 2007)?

The second study was conducted in a different school with a smaller sample size. There was also a difference in the achievement of these students as they were relatively low-achieving sixth graders. In the first study only 53 percent were free lunch eligible; whereas the second study had 79 percent of the students eligible for free lunch. The same motivational variables questionnaire was used from the first study for this study. In regard to the interventions for the second study on teaching the students to think more along the ideas of the incremental theory, there were eight 25-minute periods conducted once per week. These groups were smaller in design containing 12-14 students. The groups were randomly assigned to incremental theory training or to the control group. Students were reassessed at the end using the questionnaires (found in Appendix B) which also helped identify whether the students changed in their theory of intelligence.

In the results of Blackwell et al., 2007 study, it was indicated that students in the experimental group showed a change in theory of intelligence as anticipated. However, there was not a significant difference found in the control group. In regard to academic achievement, the experimental group was able to eliminate the decline that is normally shown (also shown in the control group) of students during the junior high school transition. In these findings it was discovered that, “… even a brief targeted intervention, focusing on a key belief; can have a significant effect on motivation and achievement” (Blackwell et al., 2007). However, it is noted that these motivational beliefs may not have an effect until there is a challenging time period where success is difficult.
CHAPTER 3
METHODS

Introduction

Many factors impact the mathematical performance and achievement of our students. The presence or absence of growth mindset is one such factor. This study was designed to investigate the impact that a focus on the SMPs would have on the growth mindset of students.

Setting

This study took place in a rural school located in central Missouri. While the building contains a high school, middle school, and an elementary school, they each have their own specified subdivisions. The school covers a rural area comprised of several small towns. The middle school had a total of 177 students enrolled in the 2016-2017 school year. Additionally, during this school year just over fifty percent of the students were eligible for free or reduced-priced lunch. This study focused on the eighth grade level in the subject of math. Because of the size of the school and the schedule, the course is taught by the same teacher across three sections.

Participants

The participants of the study were students who were enrolled in 8th grade math classes. Because the middle school years have been coined pivotal years that can lead the students down a path of perseverance or a path of giving up, the target eighth grade class was deemed appropriate for this study. These classes did not include students who were enrolled in an advanced math course (Algebra 1). Any student enrolled in the eighth grade math classes during the third quarter of the 2016-2017 school year was invited to partake in the voluntary study provided that they also provided parental consent to participate. There were 49 students involved.
in the study, 28 of them were males and 21 of them were females. The students are ages 13-15 years old. As these observational surveys did not stray from the students daily routines in school, there was no compensation offered to the participants. The only benefit provided for the participants was the unique opportunity to take part in a real life university level educational study that would provide more research in the field, and possibly have a positive impact on teachers and students in the future.

**Measurement Instruments**

The study is comprised of a pre and post survey that combined components including mindset, effort beliefs, student efficacy, and a value component into one survey (See Appendix B). The students completed the survey during their normal class time. The data collection took place using a pencil and paper survey. Once the data was collected from the pencil and paper, it was entered into a spreadsheet program. The survey is a modified version of a survey used in a previous study by Wilkins, P.B.B. (2014) to quantify the students’ answers in order to measure their mindset in their math class. The only change in the survey is in section four where the focus is changed to math class rather than science.

The survey contains five sections that focus on student mindset, effort beliefs, student efficacy, the value component related to the math class, and finally the cognitive and metacognitive strategies rehearsal, elaboration, and organization subscales. This survey contains the students’ thoughts and opinions using subscales to quantify their answers.

**Mindset Assessment Subscale**

The first section of the survey included the Student Mindset Assessment - Theory of Intelligence Scale (Wilkins, 2014). The intention of this scale was to measure the students’ views about intelligence and how they compare to the growth mindset theory. If a student answered the
questions indicating they believed intelligence was set and cannot change, the response leaned
toward the fixed mindset. Conversely, if the students answered in a manner which led to
intelligence not being set, then they were answering towards a growth mindset. The subscale was
set up using a Likert-type scale that listed 1 as Agree Strongly to 6 as Disagree Strongly. The
higher the score for the items showed an agreement with growth mindset ideas.

**Effort Beliefs Subscale**

This portion of the survey focused on the students beliefs of work and effort. Specifically,
it targeted if the student saw value in effort or work (practice). Again, these were taken from
previous studies by Blackwell (2002). This portion of the survey split up the four positive and
five negative items. If the students agreed with the positive items, they would lean more towards
the belief that effort can lead to positive results. Alternatively, students who agreed with the
negative items led to a belief that effort did not have a positive impact on results. As the scale
was arranged, it was set up to have a higher score reflecting effort as a positive impact on the
performance. The items on the scale rated 6 as Strongly Disagree and 1 as Strongly Agree.

**Student Efficacy Subscale**

This portion of the survey uses statements that focus on how the student perceives their
capability to complete their school work. This scale is completed on a 5-point scale with 1 being
Strongly Agree and 5 being Strongly Disagree.

**Task Value Subscale**

This portion of the survey was designed to gain insight on, “students’ beliefs on the
interest, importance, and utility of the science (math in this study) course they were learning.”
(Wilkins, 2014, p. 67). This was also measured on a 5-point Likert-type scale. The score of 1 was
rated as very true of me and the score of 5 was rated as untrue of me. The higher scores for this
portion of the survey indicated low interest, importance, and utility of the math class they were learning.

**Procedures**

The data collected in the study was quantitative in nature due to the responses of the surveys being assigned values. However, there were artifacts that were collected during the class interaction time that are qualitative in nature. While these are not part of the data analysis, they are complementary to the analysis of the results obtained from the surveys. The school provided the details and demographical data of the students in order to keep track and file the consent and assent forms for the study.

The study began in the beginning of the third quarter of the 2016-2017 school year with the students answering the pre survey questions provided by their regular math teacher. Prior to the study, permission was asked and granted by the administration of the school. Each student provided assent and parents provided consent for the students to take part in the study and answer the questions in the pre and post surveys (See Appendix A). Throughout the 42 day quarter, students would participate in activities weekly that emphasized the ideas, meanings, and applications of the SMPs. The activities emphasizing the SMPs included mathematical problem focused in class discussions, small group discussions, journaling, and other methods. At the end of the quarter the students participated in the post survey, which included the same questions as the pre survey to gather their thoughts and opinions in regard to effort and growth mindset in the classroom. The data was analyzed to check for statistical significance through a t-test to compare the change in the students’ thoughts and opinions.
Data Analysis

The questions on the pre survey and the post survey were the same questions to compare the change in the students’ opinions and thoughts. Once the surveys were collected, they were analyzed using t-tests to determine if the results were statistically significant.

Considerations of Ethical Concerns

The surveys did not include any identifying information as they were taken confidentially. As previously mentioned, consent from the parents and assent from the participants were collected prior to conducting the study. The students who did not provide informed consent and/or assent to take part in the study were removed from the data pool. Additionally, the data that was analyzed was done so anonymously. As these surveys were integrated into part of their normal school day and did not require anything additional of the participants, there was no risk associated to the participation in this study. The data that were recorded included the opinions of the students in regard to intelligence, beliefs and opinions about effort, and student efficacy in math class. The consent and data was secured in a locked cabinet and classroom. The destruction of consent and data included the documents being shredded.
CHAPTER 4
RESULTS

Introduction

The SMP described in the CCSS (National Governors, 2010) are related to the idea of growth mindset. Previous research has shown growth mindset has a positive correlation with academic achievement (Dweck, 2007). Because there is limited research on how the SMPs affect the growth mindset of middle school students, it is important to analyze data collected to learn more about the possible connections between the two. Therefore, the purpose of this study was to explore the connection between a focus on the SMPs and students growth mindset and student efficacy. This research is designed to help answer the research question, Does a focus on mathematical practices have an effect on growth mindset?

The results of this exploration are presented in this chapter in three parts outlining the questions from the pre and post surveys that showed significant changes. The first part discusses student mindset using the theory of intelligence scale adapted from Wilkins, (2014). The second part discusses the student responses from the pre and post surveys dealing with effort beliefs adapted from Blackwell (2002). Finally, the significant change for the student efficacy section will be analyzed.

Data Analysis Overview

All of the pre surveys and post surveys were analyzed in terms of means and frequencies as deemed appropriate. Additionally, a t-test was applied to the data to test for significant values of interest for discussion. As the research question, Does a focus on the Standards for Mathematical Practices have an effect on Growth Mindset? is addressed through looking at all of the significant values from the pre and post survey.
Descriptive Statistics

The mean and standard deviation for data from each question on the pre and post surveys were calculated. Table 1 shows this data.

Table 1

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<th>Pretest SD</th>
<th>Posttest M</th>
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</table>

Notes. This table represents the means scores on the pre and post survey responses given to the students prior to and after a focus on the SMPs. The survey questions analyzed student effort beliefs and student efficacy.

Analysis

Data from the pre and post surveys were analyzed to determine if statistically significant differences in mean scores were present. Table 2 shows the result of this analysis.
Table 2

Results of t-tests of survey questions

| Question | Pretest | Posttest |  |  |  |  
|----------|---------|----------|----------|----------|----------|----------|
|          | M      | SD      | N        | M      | SD      | n        | t        | df       |
| 1        | 4.18   | 1.38    | 49       | 4.24   | 1.45    | 49       | -0.214   | 96       |
| 2        | 2.04   | 1.19    | 49       | 1.67   | 0.83    | 49       | 1.175    | 96       |
| 3        | 4.37   | 1.36    | 49       | 4.63   | 1.31    | 49       | -0.979   | 96       |
| 4        | 2.45   | 1.24    | 49       | 2.12   | 1.09    | 49       | 1.382    | 96       |
| 5        | 3.69   | 1.54    | 49       | 4.31   | 1.46    | 49       | -2.016*  | 96       |
| 6        | 2.63   | 1.33    | 49       | 2.04   | 1.06    | 49       | 2.32*    | 96       |
| 7        | 4.04   | 1.29    | 49       | 3.94   | 1.36    | 49       | 0.381    | 96       |
| 8        | 4.55   | 1.39    | 49       | 5.14   | 0.89    | 49       | -2.516*  | 96       |
| 9        | 5.08   | 1.18    | 49       | 4.98   | 1.23    | 49       | 0.417    | 96       |
| 10       | 3.43   | 1.32    | 49       | 4.12   | 1.36    | 49       | -2.556*  | 96       |
| 11       | 3.16   | 1.36    | 49       | 3.69   | 1.40    | 49       | -1.902   | 96       |
| 12       | 2.67   | 1.49    | 49       | 2.53   | 1.26    | 49       | 0.512    | 96       |
| 13       | 2.47   | 1.44    | 49       | 2.41   | 1.38    | 49       | 0.218    | 96       |
| 14       | 1.67   | 0.85    | 49       | 1.92   | 1.22    | 49       | -1.151   | 96       |
| 15       | 2.37   | 1.09    | 49       | 1.92   | 1.17    | 49       | 1.963    | 96       |
| 16       | 2.55   | 0.82    | 49       | 2.24   | 0.99    | 49       | 1.668    | 96       |
| 17       | 2.65   | 0.86    | 49       | 2.37   | 1.03    | 49       | 1.490    | 96       |
| 18       | 1.94   | 0.77    | 49       | 2.02   | 0.88    | 49       | -0.488   | 96       |
| 19       | 1.96   | 0.87    | 49       | 1.84   | 0.90    | 49       | 0.687    | 96       |
| 20       | 2.47   | 1.08    | 49       | 1.96   | 0.89    | 49       | 2.550*   | 96       |

Notes. This table represents the results of the t-test scores on the pre and post survey responses given to the students prior to and after a focus on the SMPs. The survey questions analyzed student effort beliefs and student efficacy. *p<.05

Student Mindset

There were a few statements that showed a great deal of change, but not all of them contained significant change. One of the statements that did show significant change was found in the section of the survey that dealt with student mindset. Question five asked students how likely they agreed with the statement that you can learn new things, but cannot change your basic knowledge. As shown in Figures 1 and 2, 46.9% of students responded that they agreed, agreed a little, or agreed a lot with this statement. However, the post survey indicated that only 30.6% of students agreed, agreed a little, or agreed a lot with this statement. The most significant change from the pre to the post survey results on this question took place with 20.4% of students...
agreeing with the statement in the pre assessment, and only 4.1% agreeing at the end of the study. This would suggest that students feel that you can in fact change your basic intelligence.

As shown in table 2, a t-test of data from this question showed a statistically significant difference from pre to post survey mean scores.

Figure 1. Pre Survey Results for Question 5

![Pre Survey Results for Question 5](image)

*Notes.* This figure represents the responses to the pre survey results for question 5 provided to the students prior to a focus on the SMPs.

Figure 2. Post Survey Results for Question 5

![Post Survey Results for Question 5](image)

*Notes.* This figure represents the responses to the post survey results for question 5 provided to the students after a focus on the SMPs.
Question six focused on how students can “change” their intelligence. As shown in Figures 3 and 4, while the majority of the participants noted that they agreed a little, agreed, or agreed a lot with this statement (a combined 81.6%), there was a notable shift from those who disagreed a little, disagreed, or disagreed a lot with this statement. The combined total percentages of these participants that disagreed with the statement shifted from 18.4% to 8.2%. This is a significant shift of students believing that you cannot change your intelligence to believing that you can change your intelligence. Furthermore, it shows that no students strongly disagreed with the statement in the post survey. As shown in table 2, a t-test indicated the change in mean scores from pre to post survey was statistically significant.

Figure 3. Pre Survey Results for Question 6

Notes. This figure represents the responses to the pre survey results for question 6 provided to the students prior to a focus on the SMPs.
Notes. This figure represents the responses to the pre survey results for question 6 provided to the students after a focus on the SMPs.

**Effort Beliefs**

Question eight shows that significant change was taken from the section of the survey that focused on effort beliefs. As indicated in Figures 5 and 6 below, the statement reads, “It doesn’t matter how hard you work—if you’re not smart, you won’t do well. When looking at the agree side of this statement there were 22.4% of participants selecting one of the agree options. However, when you look at the post survey, the percentage of participants agreeing dropped to 4.1%. This statement also showed 32.7% of participants strongly disagreeing to 42.9% of participants strongly disagreeing. As shown in table 2, a t-test analysis of the results from this question showed a statistically significant change from pre to post survey.
Figure 5. Pre Survey Results for Question 8

Notes. This figure represents the responses to the pre survey results for question 8 provided to the students prior to a focus on the SMPs.

Figure 6. Post Survey Results for Question 8

Notes. This figure represents the responses to the pre survey results for question 8 provided to the students after a focus on the SMPs.
Question ten showed significant change from the pre to the post survey included the idea that if a subject is hard the student will not be able to do really well at it. The results from this question are shown in Figures 7 and 8. A notable change lies in the strongly disagree column. While only 4.1% strongly disagreed with this statement in the pre survey, 20.4% strongly agreed in the post assessment.

Figure 7. Pre Survey Results for Question 10

Notes. This figure represents the responses to the pre survey results for question 10 provided to the students prior to a focus on the SMPs.
Question ten on the survey showed a statistical significance in the mean differences. According to the responses in the pre survey there were 24.5% of the participants who believe if a subject is hard for them they will not do really well at it. As this statement is one that aligns with that of a fixed mindset, it proved to make a favorable shift to only 10.2% of the participants falling into those responses connected to a response related to fixed mindset. Furthermore, the results show the response most connected to the growth mindset idea resulted in 16.3% increase of students selecting the disagree response.
Figure 9. Pre Survey Results for Question 20

Notes. This figure represents the responses to the pre survey results for question 10 provided to the students prior to a focus on the SMPs.

Figure 10. Post Survey Results for Question 20

Notes. This figure represents the responses to the pre survey results for question 10 provided to the students after a focus on the SMPs.
**Student Efficacy**

The last statement that showed a significant change in responses deals with participant’s beliefs surrounding student efficacy. The survey question was, “I can do even the hardest work in this class if I try.” The average mean from the first survey to the post survey showed -.5102 change moving the participants’ responses into the direction of agreeing the hardest work in class is accomplishable given that the student tries. Half of the students who disagreed with this statement in the pre survey, no longer disagreed in the post survey. Additionally, two participants moved from the neither agree nor disagree section.
CHAPTER 5
DISCUSSION

Introduction

The primary goal of this study was to identify if putting a focus on the SMP would have an effect on a student’s growth mindset in middle school. As mentioned previously, there have been connections made between the SMPs and the growth mindset theory. This is described possibly because the SMPs include the descriptions on strategies to achieve understanding of the standards, and these strategies are analogous to the exercises the brain uses to grow. In addition to the goal previously mentioned, it is also a goal to gather more research of the relationship between the SMPs and the thoughts and opinions of students and their mindset. As these sections are discussed they support that students who had a weekly focus on the SMPs moved their thoughts and beliefs to be more supportive of the growth mindset theory.

This chapter will discuss the results and how they address the statement of the problem and the research question. Additionally, there are sections to discuss the limitations and weaknesses of the study, future recommendations, and a conclusion.

Student Mindset Assessment

Based on the results in the previous chapter, there appear to be some positive connections between a focus on the SMPs and growth mindset of middle school students. Students moved from the statements that would suggest a fixed mindset to one more comparable to a growth mindset. These statements suggest a stronger belief that the participants began to see their brains as malleable, and the ability to grow and strengthen the brain. The questions on the survey that specifically addressed student mindset were identified as questions five and six.
As it was previously mentioned, the higher the number used as a response on questions five and six on the first part of the survey showed a greater connection to growth mindset beliefs. As the table indicated, the mean response went up from 3.6939 to 4.3061. This is considered a significant change that is likely not by chance.

As growth mindset has been described as believing that one’s brain is like a muscle and the more one works the muscle the stronger it becomes, participants again showed a shift in their opinions and beliefs as more students believed in a positive correlation with the amount of work and the ability to accomplish tasks. This supports the idea that students began to move more towards a growth mindset versus a fixed mindset. Students also showed this during some of the class activities. Particularly, the journal entries that the students completed showed evidence of their thinking of the brain as a muscle.

One student stated, “Your brain is like a muscle because just like muscles if it is not used it does not develop or grow. When you exercise your muscles are being used and are being broken down and when you rest they grow bigger/stronger than they were before…. ” This quote shows that the student gained the understanding that his brain is not fixed. One question that could have been used to follow up with this conversation is, “How does this idea relate to intelligence?”

The only change from the normal curriculum taught in the classroom was the weekly focus on the SMPs as well as the activities that supported the SMPs. As the students completed journal entries and discussed various questions and problems in the classroom there were comments and discussion points that also supported a growth mindset. One example of the tasks was a journal that the students wrote in response to a prompt. The previously quoted participant was answering a prompt in that quote.
Effort Beliefs

Statement eight and ten showed change in student response from pre to post surveys. This section again was to evaluate the degree to which students saw effort as valuable. It is interesting that the two statements that showed significant values were two of the five negative statements in this section. Statement eight read, “It doesn’t matter how hard you work—if you’re not smart, you won’t do well.” On statement eight, it showed the average response to move from disagree a little to disagree. Comparing the pre to the post survey, the results show students beliefs made a move into the direction that relates more to growth mindset.

Statement ten states, “If a subject is hard for me, it means I probably won’t be able to do really well at it.” The change in the responses from this statement rose by .6939. The significant part of this change is that the responses would have shifted from “agree a little” to “disagree a little”. This shows that there is a change in belief from the beginning of the study. The interesting connection made with this finding relates to one of the next statements of the survey. Student responses in question ten changed to believe that if a subject was hard, it didn’t necessarily mean they won’t do well. At the same time, students supported that same conclusion by moving to agree more with the statement they can do the hardest of work if they try. These connections may suggest that students are willing to persevere through problem solving and are less likely to give up on something because it is hard.

Limitations

The research design had a number of limitations. One of these was the sample size. While the sample size was significant for the number of available eighth grade students in this particular school, a larger sample size could have provided a more accurate account of students’ beliefs and thoughts towards theories surrounding growth mindset.
Another item that limited the analysis on the study is the length of time. One school quarter doesn’t allow for a lot of exposure to the teaching of the practices. While the idea is that the practices are embedded in each lesson that is taught, it could have impacted the study to have it carry over a longer period of time.

The limitation that may have had a significant effect on the outcome was a more standardized approach to which practices were focused on and for what amount of time. With the current approach the benefit was that it led to more math talk discussion that wasn’t directed, however, the standardized approach would have kept the discussions on a defined pathway. While the discussion would vary a little, this defined pathway would have made it easier for the other classes to follow those same talking points. Additionally these discussions and activities could have provided more qualitative data for the study.

Having only one teacher present the information and the focus on the SMPs could be considered a limitation or strength depending on how it is addressed. Having one teacher present the material ensures that the discussions and focus are the same across the classes. However, having only one teacher present the information and conduct the pieces of the study could bring in bias as to which practices are discussed and how the conversation progresses. Perhaps it could also be biased in the sense that the teacher isn’t knowledgeable about certain aspects that should be discussed.

The wording of the statements could have also been misinterpreted by the students causing a variance in the student’s actual beliefs and feelings versus the answers provided. One example is that it can be awkward for a middle school student to answer a negative statement with a negative response.
**Recommendation for Future Research**

When looking back at a study it is a lot easier to see what should have been done to provide clearer findings and more information for the research question. One of the recommendations that could be made is to increase the sample size over a number of teachers and schools. The larger the sample size the more generalizable the data will be. It may also be beneficial to carry the study out over several years.

Another suggestion that could be made is to make sure that the individual carrying out the lessons has professional understanding of growth mindset for themselves as well. Additionally, the teacher carrying out the lessons should be educated on the misunderstanding surrounding growth mindset as well. Educators and leaders need to have a strong understanding of this mindset to be able to teach students these ideas.

It is also recommended that more extensive research is done with the connection of the SMPs and the growth mindset ideas. Since standards based grading is grading focused on achievement and using problem solving skills to go past procedural knowledge to that of deeper understanding of concepts there is a clear connection with that of growth mindset. A major reason for that connection is that they share characteristics such as conceptual understanding, perseverance through problem solving, the idea that the mind grows and understanding for mastery is a growth process, and effort and growth work together. As there can be an interest relating growth mindset and standards based grading, another piece that can be added to the study is comparing two studies: one in a school who has adopted standards based grading, and one who hasn’t made that transition. Additionally, it would be beneficial to add goal setting and achievement to a study involving growth mindset ideas.
A recommendation that can be made to educators is to not only plan well for opportunities to highlight the thinking practices offered through the SMPs, but also discuss them on a professional level to obtain deeper understanding of the SMPs. A published article discusses the benefits of being able to discuss the intricacies of understanding the SMPs. Barlow et. al, 2015 stated, “We encourage readers to engage in their own discussions with colleagues about some of the issues that arise when interpreting the SMPs….In addition work through further examples to deepen your understanding of the intricacies of these SMPs.” (p.344).

**Conclusion**

While the SMPs have intentions of how to teach the standards that so many schools are held accountable for, they are still not understood or focused on nearly enough. Because the data showed a correlation between a focus on the SMPs and growth mindset, it is advisable that districts put more of an emphasis on professional development tailored toward understanding the SMPs. With the middle school grades being the pivotal moment in laying the pathway for student’s educational success or shortfall there must be more attention given to avenues that will help students persevere when the intensity of a struggle increases. Educators must take advantage of the strategies that will help improve higher thinking for our future problem solvers. Math educators already have these strategies that are intended to go hand-in-hand with standard mastery. Not only do they complement the standards but they show a correlation with growth mindset beliefs. If educators can take advantage of the opportunity to teach growth mindset ideas to students hand in hand with the SMPs, then students will be given tools to embrace challenges, persevere through struggles, and find it rewarding to go further than just the solutions.
References


Walker, V. L. (2015). *Implementation of common core state standards & the standards of mathematical practices how can professional development support this process?* (Order

Appendix A

Consent and Assent Forms
Research Consent Form

Identification of Researchers: This research is being done by Amanda Blackwell. We are with the University of Central Missouri.

Purpose of the Study: The purpose of this study is to find out how a focus on the standard mathematical practices affect the beliefs and thoughts of students when it comes to math.

Request for Participation: We are inviting your child to participate in a study on growth mindset. It is up to you whether you would like them to participate. If you decide not to allow them to participate, they will not be penalized in any way. You can also decide to allow them to stop at any time without penalty. If they do not wish to answer any of the questions, they may simply skip them. You may withdraw your child’s data at the end of the study. If you wish to do this, please tell us before they turn in their materials. Once they turn in their materials, we will not know which survey or test is your child’s.

Exclusions: You must be in Amanda Blackwell’s 8th grade classes at Sherwood Middle School to participate in this study.

Description of Research Method: This study involves completing 2 short surveys. The survey will ask you about your beliefs and thoughts on several things in the math classroom.

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

Explanation of Risks: The risks associated with participating in this study are similar to the risks of everyday life.

Explanation of Benefits: You will benefit from participating in this study by getting firsthand experience in educational research. You may also get satisfaction knowing that research is being conducted to help with student confidence and mind strengthening in math.

Questions: If you have any questions about this study, please contact Amanda Blackwell. If you have any questions about your rights as a research participant, please contact the UCM Research Compliance Officer at (660) 543-8562.

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

I have read this letter and agree to allow my child to participate.

Student Name: __________________________

Parent Name: __________________________

Signature: ___________________________

Date: ________________________________

Person obtaining consent: __________________________
Does a Focus on the Standards for Mathematical Practices Have an Affect on the Growth Mindset of 8th Grade Students?

Assent Form

Researcher and Research Topic: My name is Amanda Blackwell. I am trying to learn about students thinking and beliefs related to math instruction because this will help teachers teach students how to exercise their mind and build confidence in the mathematics classroom. If you would like, you can be in my study.

What will happen in this Research? If you decide you want to be in my study, you will take two surveys.

What are the good and bad things that come from you being in the research study? The good thing that could come from this is that this research could show teachers how they can teach math in a way that will help exercise your mind and make you enjoy challenges and feel better about math in general. Also you will get to participate first hand in a research study. The risks will be the same as those risks you would encounter normally on a daily basis.

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

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

Researcher Contact Information: My telephone number is 660-499-2239. You can call me if you have questions about the study or if you decide you don’t want to be in the study any more. I will give you a copy of this form in case you want to ask questions later.

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

Signature of Study Participant

Date

Printed Name of Study Participant

Printed Name of Parent/Guardian

Signature of Researcher

Date
Appendix B

Student Pre and Post Surveys
Section 2: Effort Beliefs (Blackwell, 2002)

Rating Scale:

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