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EMOTIONAL AFFECT IN MATHEMATICS

By

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A REPORT

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

In Applied Science Education

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This report has been approved in partial fulfillment of the requirements for the Degree of
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Abstract

Research indicates that a myriad of possibilities exist for why students perform poorly in mathematics and also suggests strategies that could help students be more proficient in mathematics. The possible factors that hinder performance in mathematics include perception of abilities, motivation and relevance, resilience in challenges, mathematics anxiety, and sense of belonging. These factors all have the underlying feature of emotional affect that hinder mathematical performance and are related to students' emotions. Therefore, increasing emotional affect and forming methods for working through the emotions related to mathematics may help all students do better in mathematics as a whole. This requires identifying what practices educators could implement for increasing emotional affect and positively changing emotions related to mathematics. This research explored the impacts of an intervention that utilized discussing emotions tied to mathematics along with classroom best practices to reduce mathematics anxiety and promote positive student affect towards mathematics. Based on the data analysis and interviews, this research suggests that discussing emotions in mathematics courses about emotional affect connected to mathematics can be beneficial to students. Furthermore, a positive phrase developed by the student through reflection was found to be a helpful motivator and tool to help students.

1 Introduction and Research Question

The Bureau of Labor Statistics projects Science, Technology, Engineering and Mathematics (STEM) related careers to grow by 1 million jobs from 2012 to 2022 (Vilorio, 2014). Although not all STEM fields will grow at the same rates, the demand is high for several fields including engineering, computer science, mathematics, and operational technology (Xue, 2015). The National Governors Association Center for Best Practices and Council of Chief State School Officers' *Common Core State Standards* (CCSS) (2010) and the *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013) indicate that 21st century skills for such STEM jobs require strong foundational understandings in mathematics and science, as well as the ability to problem-solve and think critically. In addition to this, the Institute of Education Sciences' most recent research identified a strong predictive relationship between interest and confidence in STEM and the likelihood of postsecondary STEM success (Hinojosa, Rapaport, Jaciw, LiCalsi, & Zacamy, 2016). In other words, students who do well in mathematics and science in high school are more likely to follow those paths in college and pursue STEM careers. This research also indicated that grades in mathematics and science, high school grade point average, and SAT Reasoning Test or ACT math scores in high school were indicators of STEM success (Hinojosa et al., 2016). Furthermore, Good, Rattan, & Dweck (2012) indicate that students who have a sense of belonging in mathematics and science have a higher chance of pursuing careers within those fields.

Unfortunately, the 2015 National Center for Education Statistics found that only 25% of 12th grade students were at or above proficient levels in mathematics.

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Mathematics proficiency and achievement in Michigan, as illustrated on statewide assessments have typically been better than the national average for the United States. However, they should not be celebrated; the grim fact remains that on Michigan statewide tests in 2015 only 28.5% of 11th grade students and 32.2% of 8th grade students were proficient in mathematics (Michigan Department of Education, 2015). Further, these low levels of proficiency have been relatively consistent over the past several years (Michigan Department of Education, 2017; Michigan Department of Education, 2018). Since mathematics is a field of education in which skills constantly build as students' progress through their K-12 education, poor skills in 8th grade likely lead to poor skills in 11th grade unless some form of intervention takes place for students who are performing poorly.

Research indicates that a myriad of possibilities exist as to why students perform poorly in mathematics and also suggests strategies that could help students be more proficient in mathematics. The possible affective factors that hinder performance in mathematics include perception of abilities (e.g., self-efficacy), motivation and relevance, resilience in challenges, mathematics anxiety, and a sense of belonging (Frenzel, Pekrun, & Goetz, 2007; Githua, 2013; Lubienski, Robinson, Crane, & Ganley, 2013; Yeager, & Dweck, 2012); these factors all have the underlying feature of emotional affect. Additionally, Frenzel et al. (2007) demonstrated that girls are more likely than boys to suffer from the effects of emotions in hindering their abilities to be successful in mathematics.

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Because many factors that hinder mathematical performance are related to students' emotions, increasing emotional affect and developing methods for working through the emotions related to mathematics may help all students do better in mathematics as a whole. This requires identifying what practices educators could implement for increasing emotional affect and positively impacting emotions related to mathematics. Furthermore, it requires understanding how these changes in affect adjust the perceptions of mathematics for the students who experience poor emotional affect to challenges related to mathematics.

This study sought to determine whether creating a positive and supportive learning environment increases emotional affect in mathematics for 7th and 8th grade middle school students. The classroom environment encouraged a positive approach to mathematics where learning is viewed as approachable and attainable. Along with this, classroom discussions and examples highlighted the connectedness of different content throughout different lessons. Students were also given multiple opportunities to master mathematical content through different activities, practice problems, and retesting. In particular, this research explored the impacts on student affect towards mathematics with an intervention that utilized discussing emotions tied to mathematics while classroom best practices were employed throughout instruction.

2 Literature Review

2.1 Emotional Affect

The underlying issue of emotions connected to mathematics performance has been researched thoroughly through lenses of resilience, anxiety, sense of belonging, motivation, and perception of mathematical ability (Clarke, et al., 2014; Hochanadel & Finamore, 2015; Kulkin, 2016). Overall, emotions are defined through multiple levels of the taxonomy of the affective domain written by Krathwohl, Bloom, and Masia (1973). Learners respond to their emotions through varying levels of affect. In the lowest level, known as *receiving*, students are aware of their emotions, beliefs, and attitudes. An example of this would be that students are aware that they have a negative attitude towards mathematics. In the second level, *responding*, students demonstrate a change in emotion, such as expressing a more positive affect in mathematics. In the second level, the students would express a change in emotions, beliefs, and attitudes for a short period of time like a class period or over the course of a few weeks. In the third level of the affective domain, *valuing*, students show a commitment by demonstrating a continued focus on the changed emotions, beliefs, and attitudes than what would be considered responding. This could be seen as a student having a more positive outlook in mathematics throughout an entire semester or school year compared to only during a few lessons in the *responding* level of affect. In the fourth level of the affective domain, *organization*, the student transitions the emotion, belief, or attitude into a priority or goal. In this fourth level, the affect has become part of who the student is as a person. This level reflects that the student has adopted the emotion, belief, or attitude as part of their

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“life philosophy.” In the case of a positive affect in mathematics, the student would make having a positive affect in mathematics part of their overall life point of view. In the final affective domain level, *characterization by value*, the emotion, belief, or attitude has profoundly changed the student. An observable mark of this level of change in positive affect for mathematics would be someone entering a career in mathematics where previously they were deterred from entering the field of mathematics. Further, observation of an impact of a change in emotions, beliefs, and attitudes may take years to be discernable. Therefore, it is even more pertinent to understand and reflect on emotions, beliefs, and attitudes at a young age. By doing so, students develop an understanding of emotions, specifically their own, as well as increasing their emotional reflective skills in their primary schooling years where the foundations are formed in all three domains: cognitive, affective, and psychomotor.

Frenzel and Goetz (2007) describe three reasons why understanding emotions connected to learning and achievement are important. The first reason is that emotions are crucial to well-being and psychological health. The second is the significant impact emotions play in student learning and achievement. Third, cognitive competencies predict academic ability, but emotional variables predict course enrollments and career pursuits. In this, emotions play a large role in what we as humans - and specifically young adults - do and how we do it. In our own personal experiences, we can all find times when we chose to do things we enjoy over things we did not enjoy as much, even if we were good at the task. For example, think of the emotions brought forth when thinking of timed times table quizzes from math. You may be skilled at the times tables, but the thought of

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having to complete the task and the emotions tied to the task may result in avoidance of the task.

A key emotion considered time and again in mathematics education is anxiety. Ruff and Boes (2014) indicate that causes of mathematics anxiety include social, cognitive, and academic factors, which are related to mathematics avoidance. Social factors include societal stereotypes of race and gender, as well as parental expectations. Specifically, the negative social factor that has a large effect is the stereotype that suggests girls are not as good at mathematics as boys (Frenzel, et al., 2007; Spencer, Steele, & Quinn, 1999). Another significant social factor is the parents' beliefs and feelings about mathematics (Ruff & Boes, 2014). For example, if a parent believes in the value of mathematics, then this importance is imprinted on their children. In the opposite effect, if parents have negative beliefs and emotions connected to their mathematical experience, then those may be imprinted on their children.

Cognitive factors that impact mathematics anxiety are related to learning disabilities and stress, as well as level of working memory (Ruff & Boes, 2014). In general, performing mathematics tasks requires higher working memory (Raghubar, Barnes, & Hecht, 2010). Working memory and cognitive factors can be thought of as a desk working space; more open clear space allows for more working room, whereas a small and/or disorganized desk reduces the working space. In considering cognitive factors in this way, it is easier to visualize how more complex tasks like mathematics, which need ample work space, would cause stress if the desk space was small and/or disorganized. We can also visualize the students on the opposite side of the spectrum who

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have a more organized and open space to work and how they would be able to accomplish the same task with less stress, anxiety, and other negative emotions. Finally, academic factors include ineffective teaching styles, teachers who are uncomfortable with mathematics, and traditional mathematics curriculum and practices (Ruff & Boes, 2014). These factors all bring about emotions that can negatively impact a student's desire to complete tasks, specifically mathematics related, and include hopelessness, shame, and anxiety (Frenzel et al., 2007). Overall, research directs educators to openly address emotions related to mathematics anxiety and help students work through them (Kulkin, 2016; Ruff & Boes, 2014). This means teachers should discuss how emotions affect the way students perceive and act in regard to tasks and teach students how to work through emotions.

2.2 Mindset

Along with these factors, helping students understand that intelligence is not fixed and can be changed encourages students to persevere and work through emotions. Yeager and Dweck (2012) have shown that students who perceive intelligence as fixed or unchanging lose motivation to learn once tasks become difficult because they feel they have reached the precipice of their natural ability to complete the task and cannot go any further. However, if the students believe that intelligence can change (i.e., have a growth mindset), they would persist until they could master the task (Yeager & Dweck, 2012). The concept of fixed intelligence brings in related anxieties and stress as the students reach the point in their individual learning where they find themselves challenged and are

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unable to cope with and appropriately address these emotions (Hochanadel & Finamore, 2015; Yeager & Dweck, 2012).

2.3 Instructional Practices

As illustrated above, emotions and other factors therein are complex and multilayered. Therefore, addressing them is just as complex and is sought to be done through interventions, changes and adaptations to classroom instruction, and teaching students how to work through emotions and to understand intelligence. Frenzel et al. (2007) specifically call for research to be done to determine which methods of instruction increase positive emotions while simultaneously reducing negative ones. The methods would also seek to create positive learning environments that demonstrate everyone can learn mathematics and teach students to persist in challenges as well as develop growth mindsets. This is a significant challenge for researchers and educators to accomplish because it may be challenging or impossible for one method or strategy to address all factors. However, multiple strategies and teaching methods working together may be the best approach and is considered a best practice for all learners.

Numerous strategies and methods have been used in research, although not all have been vetted to determine their effect on the aforementioned variables. One strategy seeks to use interventions to teach students that intelligence is not fixed and can be grown through persistence (Hochanadel & Finamore, 2015; Yeager & Dweck, 2012). This research indicates that explicitly teaching students about growth mindset has positive impacts on student outcomes and their persistence to complete tasks. Hochanadel and

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Finamore (2015) indicated having the teacher demonstrate persistence in learning and encourage persistence through challenges via the classroom environment is a strategy for developing those skills within students. Through encouraging persistence within tasks and creating a positive learning environment where taking risks is seen as beneficial, a teacher can create positive affect within their students. Truthfully, the role of a teacher cannot be understated. Teachers have the ability to both create and diminish anxieties, fixed mindsets, and other affective factors (Clarke, Roche, Cheeseman, & Sullivan, 2014).

Researchers have sought for years to determine the best practices that work to reduce anxiety in mathematics. DiMuro (2006) summarized some of these practices and indicated that mathematics should be thought of as a whole with interconnecting parts. DiMuro (2006) summarized best practices to include: (a) comparing and contrasting new and old concepts so students see the relationship of the many parts of mathematics, (b) creating a conducive learning environment using a mix of instructional methods that focus on the utilization of enthusiasm and building confidence in students, (c) challenging students to think beyond rote memorization of material and integrate new information with previous knowledge, (d) encouraging students to write about mathematics, including their struggles and misunderstandings, to help students reflect on their learning development, (e) supporting learning with visual aids to help students connect abstract ideas through concrete representations, and finally (f) providing continuous assessment and prompting feedback so students have a constant understanding of what they know and how they can develop. All of these strategies seek

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to help students see mathematics as a whole and not as a collection of disconnected formulas, charts, and complicated concepts. In utilizing this teaching approach, teachers can reduce anxieties and create positive affect for their students with regard to mathematics.

In connection and support of these methods and strategies, Iossi (2007) also summarized multiple strategies for minimizing anxiety and negative emotions tied to mathematics. The summary concluded with many of the same ideas as Di Muro (2006) and added strategies and methods including retesting, self-paced learning, utilizing technology, and relaxation techniques. The outcomes of these strategies echo those previously stated as they reduce anxieties, increase positive individual perception of mathematics, encourage risk-taking, and build a student ready for any challenge (Iossi, 2007). Singularly, each of these strategies has been proven to work as a best practice, but researchers seek more confirmation as well as new strategies for minimizing anxieties and creating positive affect in mathematics (Di Muro, 2006; Iossi, 2007). The overall hope in utilizing these teaching strategies is that students will be encouraged to learn more mathematical concepts, pursue deeper understandings in mathematics, and persist in the challenges that higher level mathematics and potential STEM careers will give them.

2.4 Summary

Considering these research findings and implications, it is plausible that if a student's emotional responses, perception, and attitude towards mathematics is positively impacted by practice, then the student's willingness to do mathematics will increase. This

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increase in willingness to do mathematics may then result in increased confidence and ability in mathematics. This positive outlook and affect towards mathematics may increase the possibility that the student will pursue a STEM related career. With this in mind, the research study presented here addressed the following research question: *In what ways does directly discussing emotional affect in a middle school mathematics classroom that utilizes best practice impact students' affect towards and within mathematics?*

3 Methodology

3.1 Research Design

This research focused on the way middle school students emotionally think about mathematics. In this study the researcher utilized action research by directly immersing himself into the research as the participants' mathematics teacher. In particular, this research explored the impacts of an intervention that utilized discussing emotions tied to mathematics along with classroom best practices in the hopes of reducing mathematics anxiety and positively impacting student affect towards mathematics.

The research employed a sequential-explanatory mixed methods design (Creswell, Klassen, Plano Clark & Smith, 2011) that utilized both quantitative and qualitative data. Quantitative data were collected via pre and post surveys on students' emotional affect towards mathematics tasks surrounding the intervention. These quantitative data were used to identify participants for focus group interviews. Focus group interviews were conducted after the surveys were analyzed to better understand participants' perspectives related to their emotions tied to mathematics and their thoughts on the intervention.

3.2 Participants

The participants of this study were 53 seventh and eighth grade middle school students from a mixed gender private school in the state of Michigan. Data for this study did not include data from students who missed activities, missed multiple class periods, did not assent, or did not receive parental consent. All students were enrolled in on-page

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courses for middle school. The students within these classes had a mixture of mathematical abilities within their grade level. The choice of participants was a convenience sample because the researcher was the students' mathematics teacher. In the interviews following the post survey, the focus group participants were selected using criterion sampling. In particular, they were selected based on survey results of different changes in affect towards mathematics from pre to post survey: positive change, no change, and negative change. For example, students whose affect towards mathematics shifted to be more positive towards mathematics were grouped together. From the total sample of 53 students, 17 students were interviewed in group settings.

The researcher's own background was a factor in the research so the following information is provided to understand aspects that came into play during the interventions of research. The researcher has degrees in mathematics, physics, and computer aided design which contribute to the depth of knowledge of the researcher and the breadth of examples from areas outside mathematics. The researcher has eight years of teaching experience working with students who struggle with mathematics in grades seven through twelve and has also taught computer programming and physics. The researcher also has previous background knowledge in mathematics anxiety and mindsets to learning from prior professional development and from reading Carol Dweck's book on mindsets, *Mindset: The New Psychology of Success*.

3.3 Intervention

During the course of this study the teacher researcher engaged students in interventions throughout a five week time-frame in addition to the continued use of best

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practices within the classroom to positively influence the emotions of the participants. These best practices were in place as part of common classroom practices prior to the intervention and remained in use during and after the intervention. The best practices, as summarized by Iossi (2007), included creating a positive non-threatening mathematics classroom environment, engaging students in retesting, and making quiz corrections on assessments. Among the best practices, students engaged in think-pair-share, interactive math trivia games (Kahoot), guided notes, class discussions, and real life examples. A key part to the intervention was the teacher researcher explicitly discussing emotions, persistence, and overcoming challenges within mathematics with the students. The students were also active participants in describing their emotions throughout the discussions as well as writing positive affirmations (“positive phrase”) on their assignments and assessments. The intervention started as separate activities from regular instruction but were then integrated into instruction. Content covered over this time period included proportions and similar figures for 7th graders and solving and graphing linear equations for 8th graders. The activities were designed to engage students in the process of understanding and reflecting on their emotions connected to mathematics while also producing visual reminders for the students. An outline of the 5-week intervention is found in Table 3.1. Additional details on each week’s plan is found in the remainder of the chapter under each week’s heading.

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Week	Summary of Intervention Activity
1	Discussion about emotions related to mathematics and student share out of emotions related to mathematics to create class diagram.
2	Students individually started addressing their own emotional affect in mathematics utilizing a graphic organizer led by the teacher. Students each developed their own positive phrase to utilize throughout the remainder of the intervention and school year.
3	Students created a list of emotions they either identify with or want to identify in mathematics and received further support utilizing their positive phrase.
4	Students were given an opportunity to adjust their positive phrase as well as reflected on the intervention up to this point. This week also required that students focus on four positive emotions from the list they created in Week 3.
5	Students were supported in the work they had completed throughout the intervention period by providing students with daily reminders in class to use their positive phrase and to remember their goal emotions

Table 3.1 Outline of five-week intervention.

3.3.1 Week 1

One class period at the beginning of the first week of the intervention, students engaged in a discussion about emotions in mathematics and the reality in which learning mathematics is constantly challenging in its design. Typical mathematics courses teach students new skills each class period which poses a constant challenge of learning new skills on a continuous basis. For some students, this might mean starting to feel good about a concept or just starting to understand it and then the course moves onto the next

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topic and poses another challenge to the student. In this, learners are under the stressors of constantly being introduced to new information which they are expected to master.

The start of the group discussion was teacher researcher driven with the middle and end of discussion being student driven. The teacher spoke in a way to bring up the topic and set the stage for a comfortable sharing experience where all students would feel safe and encouraged to share their thoughts during the next part of the activity. The teacher spoke about math being challenging and how each student gets challenged at different times with different concepts. The teacher also discussed that it is okay to feel negative emotions but we (students and teachers) need to work on balancing the positive and the negative emotions. Additionally, we need to remember everyone can feel different about math and we need to be open to their thoughts. The teacher also briefly spoke about how our own emotions can affect others around us (e.g., test anxiety, stress, etc.). The teacher gave an example of how one student in a class can come into class showing panic about the homework or an assessment and then others in the class start to feel that way or feel they should be more stressed or worried about the homework or assessment. Throughout this discussion, students were asked if they ever felt what was being discussed to engage the students in the discussion and to help prepare them for the prompts that would be asked in the student centered part of the activity of the first week.

After the group discussion, students were presented with several prompts to share out as a class. Students were asked:

- What emotions come to mind when thinking about mathematics?
- How does mathematics class make you feel?

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- How would you like to feel about mathematics and math class?

In answering the prompts, students were led in creating diagrams on the white board at the front of the classroom to summarize the shared positive and negative emotions connected to mathematics. All students had the opportunity to share their own emotions in regard to mathematics. For each emotion added to one diagram, the opposite emotion was added to the other diagram (see Figure 3.1). For example, if a student stated sadness, they would decide to which diagram it would be added, in this case negative, but then the class as a whole came up with an opposite, such as joyfulness, to add to the positive emotions. If the students felt that the antonym for the emotion that was shared was already present on the board then nothing was added to the other diagram. This process of sharing was utilized for both positive and negative emotions and continued until the class had shared all of their emotions towards math and agreed that the diagrams represented their emotions.

In this process of sharing and making diagrams, students were encouraged and instructed to see the connection between the positive and negative emotions to begin their own individual reflections on their emotions connected to mathematics. Students were then asked to further reflect on the prompts and about what other emotions towards mathematics they have individually.

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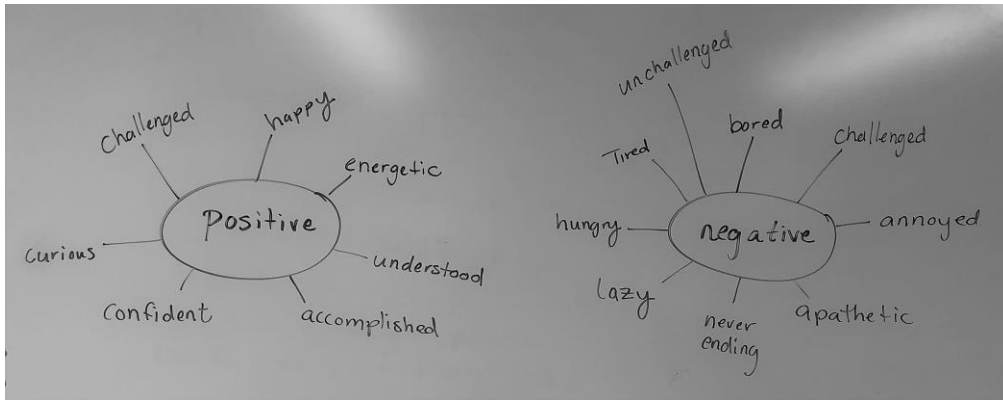


Figure 3.1 Example diagram created from discussion.

3.3.2 Week 2

At the start of the second week of the intervention during one class period, students were reminded of the activity, prompts, and shared emotions that were discussed in Week 1. They were then instructed to reflect on the emotions they identified with while each student was handed a blank graphic organizer, without labels, to use in the class period's activity. An example graphic organizer can be found below. (Figure 3.2).

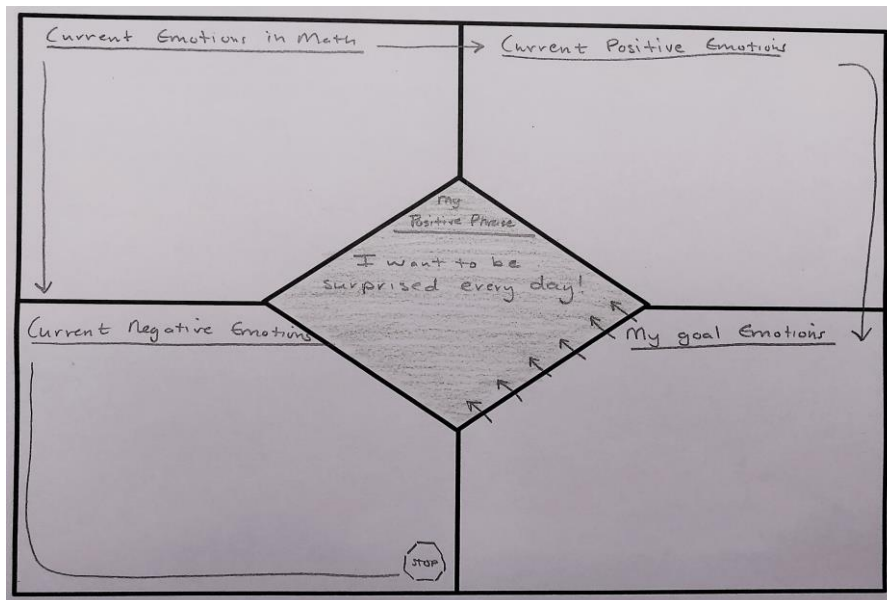


Figure 3.2 Diagram used to by students to work through their individual affect in mathematics.

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In utilizing the graphic organizer, each student individually started addressing their own emotional affect in mathematics. The graphic organizer started off empty and then the students were given the labels for the various sections of the graphic organizer one at a time as well as time to reflect on each section. The teacher walked students through the activity using a document camera for the students to see what sections the teacher was discussing during the activity.

Students were given the label of “Current Emotions in Math” for the top left corner and were instructed to list the emotions they encounter in math class in this section. After allowing the students to complete this task, students were given two more labels for sections of the graphic organizer and instructed to separate the emotions into two categories, “Current Positive Emotions” and “Current Negative Emotions”. They were also instructed to draw arrows from the first section of the graphic organizer to the two newly labeled sections.

After the emotions had been separated, students were instructed to draw an arrow and a stop sign to the “Current Negative Emotions” section while adding an arrow bringing all the positive emotions to the bottom right hand corner labeled “My Goal Emotions.” Students were asked to focus on only the positive emotions they currently had and further identify their goal emotions for mathematics. Students were instructed that goal emotions are the positive emotions they want to strive to have in math courses and the positive emotions they want to have for mathematics in general. Once students were given time to reflect on their goal emotions, each was asked to create their own “positive phrase” to help them remember their goal emotions. The students then colored that

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section their favorite color to help them connect their goal emotions to something they enjoy. Students kept their graphic organizer in their binders/folders and the positive phrase was then written on the top of assignments and assessments for the remainder of the intervention period.

3.3.3 Week 3

In the third week of the intervention, students were again asked to think about their emotional affect in mathematics but this time they were instructed to search online for positive emotions and create a list of their top 9 or 10 they either identify with or want to identify (Figure 3.3). Students were then given time to complete the list and then create a flower where they wrote each emotion from their list on a petal. Students were then given time to color the flower and cut it out for a “surprise” collage. Over the remainder of the week, students were reminded to place their positive phrase from the week before on all notes, assignments, and assessments to integrate the activities into daily lesson activities. At the end of the week, the surprise collage was created out of the students’ individual flowers which spelled out “MATH” (see Figure 3.4).



Figure 3.3 Student samples pulled from collage.

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Figure 3.4 Final collage made from the emotion flowers.

3.3.4 Week 4

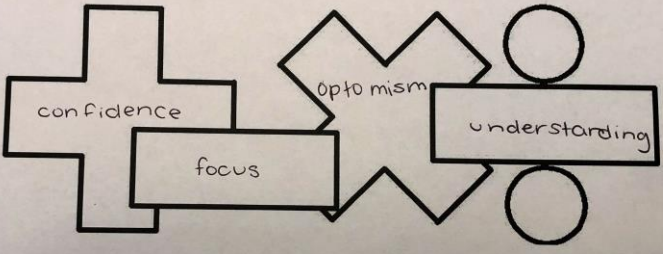
In the fourth week, the students continued utilizing their positive phrase. During a class period in the middle of the week, students were given an opportunity to adjust their positive phrase if they so desired, while further reflecting on the intervention up to this point. Students were encouraged to adjust their positive phrase if they felt it was too long, they had thought of a better positive phrase, or wanted to focus their phrase in a different direction. The Week 4 activity also required that students focus on four positive emotions they individually wanted to work towards from the Week 3 activity. They were then asked to reflect on their positive phrase, the discussions, and their selected four positive emotions (see Figure 3.5). The goal of having students reflect further was to have them continue the process of working through their emotions connected to mathematics while also encouraging them to consider how far they have come within the intervention. Students were also encouraged to reach deeper in their reflection to think about what effect(s) discussions, activities, and positive phrase had on them throughout the intervention time period.

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Math, Emotions, and Me

My Positive Phrase: If you work hard, you will succeed.

Think of the positive emotions that have been discussed in math class. Then, select 4 you wish to focus on to make more present when working with math. Write one positive word in each of the operation symbols below. (Color when completed)



Briefly reflect on how your positive phrase, discussions about emotions/challenges in mathematics, and the positive emotions you are seeking to be more present in mathematics. Share your thoughts and feelings below (in complete sentences).

I liked my positive phrase because it made me think more about trying harder and focusing more in class. when I focus more, I have more positive emotions and I understand the material a lot better.

Figure 3.5 Student sample from activity.

3.3.5 Week 5

The final week focused on supporting the work the students had completed throughout the intervention period by providing students with daily reminders in class at the start of instruction, during homework time, or at the start of an assessment to use their positive phrase and to remember their goal emotions. The teacher researcher also added a line at the top of all assessments for the students to write their positive phrase before taking the assessments.

3.4 Quantitative Data Collection and Analysis

Utilizing the work of Good, Rattan, and Dweck (2012), the researcher used a variation of the Sense of Belonging to Math Scale survey as it is a validated instrument that measures emotional affect in mathematics. The original survey was designed for

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college-age students in advanced mathematics courses. The survey focuses on determining the sense of belonging of an individual in mathematics as a career field as well as the individual's affect towards and within mathematics. The original survey consists of 30 Likert-scale items, which focus on categories of membership, acceptance, affect, trust, and desire to fade as they are related to mathematics. The survey was modified to reflect the focus of this study with middle school students. In particular, the researcher eliminated questions related to membership, acceptance, and trust to focus strictly on the affect tied to mathematics as well as students' emotions connected to their well-being (trust) and participation (desire to fade) in class.

The modified survey of 19 questions uses an assortment of Likert scale and multiple-choice questions (see Appendix A). The questions asked participants to rate their emotions and beliefs related to mathematics. This survey was used to gather data to measure students' mathematics affect at the onset of research prior to the Week 1 intervention. The same survey was given at the end of a five-week intervention period. The surveys utilized de-identification coding system and therefore did not have the names of students on them but a label which correlated to a table identifying the student. This label was strictly used to identify students for the focus groups and the table of names with labels was purged at the end of research. Survey items 3, 5, 8, 13, 16, and 17 use an 8-point Likert scale and were coded as scaled in the survey. Survey items 1, 2, 4, 6, 7, 9, 10, 11, 12, 14, and 15 use an 8-point Likert scale and were reverse-coded due to the nature of the item wording. Survey items 18 and 19, which are a multiple choice scale, were analyzed based on frequency and a conversion to numbers.

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The survey data were analyzed using basic descriptive and inferential statistics to determine how the students' emotions changed over the course of the intervention. Specifically, the researcher calculated averages, conducted paired t-tests, and examined relative frequencies of the data. In addition to performing these analyses for the overall average change in affect, each item was analyzed individually to determine which factors related to emotions were statistically significant between the pre- and post- surveys. The researcher used the average change in emotional affect from pre-to post survey to identify any statistically significant changes in emotional affect for the participants as a whole as well as individually to identify students for qualitative data collection.

An item analysis and statistical significance was determined using paired t-test analysis. The researcher also broke the collected data into four affect sections in the same manner as the original survey taken from Good, Rattan, & Dweck (2012). These four affect sections are membership, participation, trust, and general affect in mathematics. Questions 1 through 5 from the survey asked about membership affect. Questions 6 through 10 from the survey asked about general affect. Questions 11 through 14 from the survey asked about participation affect. Questions 15 through 17 from the survey asked about trust affect. In analyzing the data in this way, the researcher sought to identify which part(s) of affect, if any, may have been impacted the most.

3.5 Qualitative Data Collection and Analysis

At the end of the intervention period, the quantitative survey analysis helped to identify potential student participants for focus group interviews. Students were randomly chosen for interviews based on the changes in their mean affect score from pre- to post-

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survey. Each student's overall mean change in affect was calculated for the pre- and post-survey, matched together and from that the average change in affect score from pre- to post-survey was calculated (e.g. up, down, or stayed the same). The standard deviation of the change in average affect from pre- to post-survey was found to be 0.8. Students were then grouped based on this information into positive change in affect, no change in affect, and negative change in affect based on their individual change from pre- to post-survey being one standard deviation from 0. Meaning any student whose average affect from pre- to post survey was between -0.8 and 0.8 would be considered no change. Then, any participant's change in average affect from pre- to post survey less than -0.8 was grouped into the negative change in average affect group and any participant's change in average affect from pre- to post survey greater than 0.8 was grouped into the positive change in average affect group. From these groups, students were chosen at random to be interviewed. Due to scheduling conflicts, six interview groups were formed from the randomly selected students of each grouped change in emotion affect.

This resulted in three interview groups for positive change (three groups of 3 students), two interview groups for no change (a group of 2 students and a group of 4 students), and one interview group of negative change (2 students). The focus group interviews lasted on average three minutes and participants were not told which change in affect group they belong to and groups were homogeneous in affect change (e.g. all positive change in affect, all no change in affect, or all negative change in affect). Initial questions within the interviews were the same for each group but clarifying questions did arise in some group interviews to better understand student responses. These focus

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groups were used to gain a more detailed insight into the emotional changes that may or may not have occurred for each participant, what may have caused these changes, and why students feel emotionally a certain way about mathematics. These interviews were audio recorded and then selective transcription was utilized for analysis. The focus groups' interview selective transcriptions then went through an inductive coding analysis to look for general codes within the interviews of each change in affect group as well as codes throughout all changes in affect groups.

In addition to the survey results and focus group discussions, the researcher kept a log of the best practices utilized, retesting and quiz corrections offered, and a brief description of discussions held throughout the research to establish a thick description of the environment of the classroom.

3.6 Ethical Considerations

Prior to collecting any data for this research, proper IRB approval was obtained. For example, permission from the participating school as well as the consent of the parents/guardians of the participants was obtained. Student participants were also given the opportunity to opt out of the study at any time. The surveys, interviews, and interventions taking place in the study were designed to not hinder the student in any way and were considered part of normal classroom activities.

The experimenter effect on participants was considered for this research project. In regard to this, the participants' emotional affect in mathematics is hypothesized to be connected to the researcher directly engaging in creating a positive learning environment.

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Meaning, the participants (students) emotional affect is influenced by the emotional affect of the teacher in creating a positive learning environment. Therefore, the positive emotional affect of the teacher, in regards to mathematics, throughout activities and normal classroom instruction is connected to the participants' emotional affect in mathematics. Therefore, the experimenter effect as the students' teacher was being purposely utilized as a variable in research to help understand the effects of a positive environment on emotional affect in mathematics.

4 Results

4.1 Pre-Survey and Post-Survey Comparison

The overall mean for emotional affect in mathematics for the pre-survey was 6.0 with a standard deviation of 1.2. The median was calculated to be 6.4 and the mode was 6.5. The overall calculated mean for the post-survey was 6.5 with a standard deviation of 1.1. The median was calculated to be 6.8 with the mode being 7.4. Therefore, the mean change in affect score was 0.4. A paired t-test showed significant differences between the pre- and post-surveys ($p = 0.00027$ ($T = -3.91$, $df = 52$)). This means the students had relatively positive affect in mathematics to start and also showed an average improvement in affect over the time period of the intervention.

Tables 4.1 and 4.2 summarize the individual questions from the pre- and post-survey to identify which factors were statistically significant by looking at the individual question's mean as well as the paired t-test. Table 4.2 also states an interpretation of each individual question without taking the change in value into consideration. The paired t-test indicates statistical significance by showing that the null hypothesis (paired t-test < 0.05) of each question is unlikely to happen. In other words, the results of those questions with a paired t-test less than 0.05 should be repeatable given the same conditions.

From these data, changes in nine of the seventeen questions were determined to be statistically significant (questions 1, 5, 7, 9, 11, 12, 13, 14, 15). These questions included emotional affect in mathematics in regards to: feeling like an outsider, feeling appreciated, feeling worried, feeling nervous, fading into the background, saying as little

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as possible, being an active participant, being invisible, and proving themselves. For these areas, the changes from pre- to post-survey were statistically significant.

Question #	Affect Phrase	Rev. Code	Paired t-test	t-Stat
1	<i>I feel like an outsider</i>	Y	0.0268	-2.2791
2	<i>I feel ignored</i>	Y	0.5910	0.5407
3	<i>I feel I fit in</i>	N	0.1375	-1.5085
4	<i>I feel unimportant</i>	Y	1	0.0
5	<i>I feel appreciated</i>	N	0.0012	-3.4346
6	<i>I feel unmotivated</i>	Y	0.2339	-1.2044
7	<i>I feel worried</i>	Y	0.0017	-3.3018
8	<i>I feel comfortable</i>	N	0.0885	-1.7359
9	<i>I feel nervous</i>	Y	0.0293	-2.2407
10	<i>I feel fearful</i>	Y	0.3539	-0.9355
11	<i>I wish I could fade into the background and not be noticed</i>	Y	0.0190	-24213
12	<i>I try to say as little as possible</i>	Y	0.0242	-2.3213
13	<i>I enjoy being an active participant</i>	N	0.0027	-3.1564
14	<i>I wish I were invisible</i>	Y	0.0311	-2.2155
15	<i>I feel that I have to prove myself all the time</i>	Y	0.0061	-2.8591
16	<i>I trust my teachers to be committed to helping me learn</i>	N	0.4974	-0.6833
17	<i>Even when I do poorly, I feel my teachers have faith in my potential</i>	N	0.0799	-1.7862

Table 4.1 Summary of itemized statistical analysis (df = 52).

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Question #	Pre-Mean	Post Mean	Meaning of Results
1	6.5	6.9	In general students do not feel like outsiders
2	7.1	7.0	In general students do not feel ignored
3	5.9	6.3	In general students do feel they fit in
4	6.9	6.9	In general students do not feel unimportant
5	5.5	6.3	In general students do feel more appreciated
6	5.2	5.5	In general students motivation falls in the middle of the scale
7	4.8	5.5	In general students feeling of worry falls in the middle of the scale
8	5.5	6.0	In general students do feel somewhat comfortable
9	5.0	5.6	In general students do feel somewhat nervous
10	6.5	6.7	In general students do not feel fearful
11	6.3	6.8	In general students do not wish to fade into the background and go unnoticed
12	6.0	6.6	In general students do not try to say as little as possible
13	5.7	6.2	In general students enjoy being active participants
14	6.9	7.2	In general students do not wish they were invisible
15	4.8	5.7	In general students do somewhat feel they have to prove themselves all the time
16	7.4	7.5	In general students trust that teachers are committed to helping them learn
17	6.6	7.1	In general students feel their teachers have faith in their potential

Table 4.2 Summary of itemized pre- and post means and question meanings.

Based on the questions from the survey, the researcher broke the collected data into four affect sections in the same manner as the original survey taken from Good, Rattan, & Dweck (2012). These four affect sections are membership, participation, trust, and general affect in mathematics. In doing so, the researcher sought to identify which part(s) of affect, if any, may have been impacted the most. This break down indicated that all questions related to participation, questions 11 through 14, showed statistical significance.

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The last two questions of the survey, items 18 and 19, asked students to rate their emotional affect overall as well as their belief of mathematical content knowledge. Question 18 asked students to rate their overall emotional affect as either mostly negative, somewhat negative, neutral, somewhat positive, or mostly positive. Based on frequency and converting the responses to ordinal numbers 1-5 (see Table 4.2), the trending center in the frequency of responses for overall emotional affect shifted from 3.3 to 3.7 but remained centered at “neutral”. Question 19 asked students to rate their mathematical content knowledge as either poor, fair, good, or excellent. Based on frequency and converting the responses to ordinal numbers 1-4 (see Table 4.2), the trending center in the frequency of responses for mathematical content knowledge shifted from 3.0 to 3.2 but remained centered at “good”.

Frequency of Responses					
Question 18			Question 19		
Rating	Pre	Post	Rating	Pre	Post
Mostly Negative (1)	3	3	Poor (1)	1	0
Somewhat Negative (2)	12	4	Fair (2)	9	9
Neutral (3)	17	16	Good (3)	30	27
Somewhat Positive (4)	9	12	Excellent (4)	13	17
Mostly Positive (5)	12	18			

Table 4.3 Relative frequencies of questions 18 and 19.

4.2 Interviews

In the interviews, students were asked what they liked, disliked, or found helpful about the aforementioned activities. They were also asked whether or not they felt their emotions towards mathematics had changed. Students were given opportunities to share

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anything they would like about the activities, their reflections, or discussions.

Specifically, the students were asked the following questions:

1. What did you think about the activities (intervention) related to emotions? Did you find anything helpful? Did you dislike any activity?
2. How do you feel your emotions in mathematics have changed from before the activities (intervention) to now, if they changed at all?
3. What did you think of the timeframe of the activities (shorter/same/longer)? Would you change/add/remove any activities (intervention)?
4. Is there anything else you would like to share about your experience with the activities (intervention)?

At the culmination of the interviews, the recorded interviews were selectively transcribed for analysis and inductive coding was utilized. The codes were developed through repeated listening and selective transcription of the interviews. The codes that were established from inductive coding of the selective transcription were motivation, reflection, positive phrase, and focus. The coding words were not always explicitly stated, but based on the students phrasing and context, the participant's meaning was inferred. For the motivation code, students sometimes stated "motivation" but also stated phrases like "made me want to..." or "felt better about doing...". In identifying the reflection code, some students used "reflection" while others stated phrases like "thought about emotions" or "looked back at how we felt about math". In terms of the positive phrase code, students primarily stated "positive phrase" or "the phrase" but the phrase "the sentence we wrote" was also used. For the focus code, students either stated "focus"

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or stated “pay attention better” implying focus on classwork and the mathematics lesson.

The frequencies of each code can be found in Table 4.4 and Table 4.5.

Interview Group	Participants	Codes			
		Reflection	Motivation	Positive Phrase	Focus
Positive Affect Change	9	8	7	6	3
No Affect Change	6	1	0	0	0
Negative Affect Change	2	2	2	2	0

Table 4.4 Codes from interviews and their frequencies.

Interview Group	Participants	Codes		
		Pos. Affect Change	No Affect Change	Neg. Affect Change
Positive Affect Change	9	8	1	0
No Affect Change	6	1	5	0
Negative Affect Change	2	2	0	0

Table 4.5 Codes from interviews and their frequencies.

4.2.1 Positive Change Group

Students who demonstrated positive change in emotional affect in mathematics indicated in their interviews particular activities they found helpful including the discussions, written reflections, positive flower activities, and positive phrase. Students also indicated that by focusing on the positive emotions, combined with their positive phrase, they felt more motivated and focused in mathematics class. In general, students in this group stated that the activities helped them to identify their emotions, reflect on

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them, and then focus on the positive emotions for mathematics. One student spoke generally about the activities stating, "...the activities made me think about it (emotions) instead of just letting them pass by and me being upset or agitated and not getting anything and I think that the projects (activities) that we did really helped me to actually think about what I can do to improve my opinion and the way I act in class." However, other students spoke about particular activities and stated, "I found the activity where we wrote down the emotions on the flower to be most helpful...it helped me to strive to get those emotions in my mind when I think about math." Whereas another stated, "I liked the positive phrase because it motivated to do what you can do."

Along with this, they felt the activities helped them to make a plan to gain more positive emotions in mathematics. In terms of the length of the interventions, some students felt they only needed further reminders of their goals while others felt they would have gained greater changes in positive emotions from having a chance in class to further the discussion with classmates with similar struggles in mathematics.

4.2.2 No Change Group

Students in the "no change" interview group stated the interventions helped them to identify their emotions in mathematics, but they did not feel an overall change in their emotions when they were asked about how they felt their emotions had changed towards mathematics, if they had changed at all during the interventions. During the open sharing opportunity, these students indicated that they enjoyed mathematics class more this year than previous years with the class projects, interactive games (Kahoot), interacting more in class with activities, and seeing real life examples. One student said, "One of my

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favorite things this year was the time we talked about finding patterns in flowers and in nature everywhere and it made me love math even more.” Students with no change in emotional affect in mathematics also had mixed feelings on whether or not discussing emotions for a longer period of time would be more helpful.

4.2.3 Negative Change Group

Interestingly, students whose survey data showed negative overall trends stated similar themes to those students with a positive overall change. One student stated, “I thought that the positive phrase really helped me because it reminded myself that I could do really well on quizzes and homework.” Later in the same interview when asked about their change in emotional affect in mathematics, another student in the group stated, “I feel like they (emotions) have changed a lot. Before I thought negatively about math but then the activities were really fun and writing the negative things I had to say down, like just getting it (negative thoughts) out, and then saying all the positive things was helpful.” These students, though in the “negative change” group, found the activities helped them to identify their emotions and liked the positive phrase for helping them to focus on positive emotions in mathematics.

5 Discussion, Practical Implications, and Further Study

5.1 Discussion

The overall mean of student's affect was relatively positive on average (6.5 on a scale out of 8 with 8 being positive and 0 being negative) from the start of the intervention to the conclusion. However, the overall student affect did show an increase from pre- to post-survey, demonstrating that the intervention may have worked in increasing emotional affect towards mathematics. Additionally, item analysis revealed that 9 out of 17 questions showed statistically significant changes.

Interviews suggested that for students who showed gains in affect, as determined by change in average affect, the intervention activities were helpful for reflection and motivation to try harder as well as focus in class. One common theme showed up throughout the interviews, the discussions and intervention activities helped the students to recognize and reflect on their emotions connected to mathematics. Furthermore, the positive phrase the students each developed independently was found to be a helpful motivator and tool to help students focus on their goal for each class period. This suggests that if a student has a daily reminder of their individual goals, they may be more motivated and focused throughout their daily coursework. This also indicates that a personal reflection on emotions (in regards to mathematics in this case) and a tool (a positive phrase in this case) could be utilized by students to increase motivation and focus. Interestingly, the question relating to motivation from the survey (#6) did not indicate statistically significant changes. However, all affect questions connected to participation indicated statistical significance which may mean that the motivation from

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the positive phrase was represented through increased affect in participation and that in reflecting on their emotions connected to mathematics, students felt empowered to participate more in mathematics coursework and activities. As well, students in the “no change” group for average affect did not indicate motivation from the positive phrase or discussions and did not feel that their emotions had changed throughout the intervention. This may be due to already having positive affect towards mathematics or a lack of engagement with the activities.

Another curious factor for the interviews was that none of the student participants knew what affect group they were a part of for interviews but answered interview questions in line with the affect group they were statistically placed except for the students which were placed into the negative change in affect group. Interviews with students who had a negative overall change reflected much of the same insight as the students with an overall positive change. The students found the discussions and positive phrase as a good reflection tool and helped the students to work through their emotions. It is possible that other emotional factors may be at play including things happening in student lives, assessments in other classes, relationships with classmates, and other school or societal factors when the students completed the pre- and post-surveys.

This work suggests that explicit discussions in mathematics courses about emotional affect connected to mathematics can be beneficial to students, in particular to emotional affect related to participation. One other factor which has been demonstrated in multiple other studies to have a positive impact on student success and enjoyment in class is the use of best practices. The use of best practices within instruction can be considered

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a constant within the research intervention because the practices were in place before the onset of the research, occurred during the intervention, and continued after the intervention. Taking this into consideration, perhaps the use of best practices helped to further establish an environment where students felt comfortable to engage in the intervention and the activities of the intervention.

5.2 Practical Implications

This research shows promise for teachers to support student's positive affect towards mathematics, but there are practical implications to consider. For one, many teachers may shy away from incorporating such activities into their classrooms due to the time needed to teach the required content for the course. In this study, the intervention occupied approximately 2 hours of class time over the course of 5 weeks with the final week integrated into classroom instruction. The observed gains in student motivation, focus, and positive affect from far and wide made up for time lost in mathematics instruction. Furthermore, the benefit of each student creating a motivating positive statement through reflection helped students maintain a positive attitude, motivation, and focus throughout regular classroom instruction and activities. In addition to these observed benefits, the interviews shined light on how empowered the students felt to know they weren't alone in their feelings and that they could own their feelings in mathematics and strive to make them more positive overall.

A second practical implication is that in order for the intervention to work, the teacher must be invested in discussing emotional affect in mathematics. A teacher

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engaging in this intervention must reflect on their own emotions connected to mathematics and furthermore, should share their own struggles and high points with their students. As in classroom practice, if a teacher is not engaged in their curriculum, it follows that student engagement would be low as well. Likewise, if a teacher shows genuine interest and engagement with the curriculum, then their students may be more likely to do the same. Therefore, a teacher utilizing this intervention must demonstrate engagement and interest in the emotional affect towards mathematics of themselves and their students.

One last practical implication of this intervention is to expect students to be skeptical of the idea of talking about emotions connected to mathematics. Addressing and reflecting on emotions can be a new experience for students. Therefore, engaging in discussion and reflection on emotions, connected to mathematics or not, can be uncomfortable. Moreover, an intervention addressing emotions connected to mathematics while in mathematics class is far from normal classroom instruction. However, as discussions take place about positive and negative emotions, students, especially with encouragement, open up about their own affect in mathematics. Furthermore, the feelings that students share are real and should be addressed. It is especially beneficial for students to see that they are not alone in how they feel in math class whether it be a positive or negative emotion connected to mathematics.

5.3 Further Study

Further study on discussing emotional affect in mathematics with students is highly encouraged. In this research, the participants in this study had relatively positive overall average affect towards mathematics at the beginning of the intervention. Although these results are promising, a longer study over the course of either an entire semester or year of schooling may show greater results as this study took place in the middle of the second semester of the school year. Along with a longer study, studies utilizing the intervention in homogeneous emotional affective groups from the beginning of the intervention may demonstrate the best use of the intervention (ie. low, middle, high emotional affect for mathematics). In homogeneous affective groups, participants may be more willing to share their personal emotions connected to mathematics during the Week 1 discussion of the intervention if they feel others in the group have the same common mathematical affect. To that end, it may have been beneficial to group the students together into their affective groups within this research to have them participate in more small group discussions as a part of the intervention. As one student stated in an interview, “we worked on our self growth and I feel it would be good to see others relate to it. Like just in this interview, I can understand what they (the other participants) are saying and it made me feel that I wasn’t strange or abnormal (in how I feel).” In this particular interview, all of the participants felt that speaking with other classmates about their emotions in regards to mathematics would have been helpful. However, the need to self reflect and identify participants own emotional affect would be beneficial for students to get the greatest benefit from discussing emotional affect in mathematics as a small group.

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The activities could also be more focused on the emotional affect of the participants of the groups by supporting the participants' current emotional affect in mathematics. Meaning, in mixed groups the teacher is meeting the needs of all levels of affect towards mathematics whereas in homogeneous emotional affective groups the teacher can focus on that level of participants' emotional affect towards mathematics.

In addition, while this study focused on middle school students which were on pace with their mathematical development, further studies should look into remedial mathematics courses, ahead of normal pace mathematics courses, and high school mathematics courses. The different levels of courses may require some adaptation to the intervention and its activities to meet the needs of the student participants. Depending on the course and the affect towards mathematics of the students in the course, more activities, discussions, and a longer time frame may be required. In researching the intervention at different course levels as well as with different homogenous affective groups, teachers will be able to identify groups of students who may benefit the most in order to focus their efforts.

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A Survey

In questions 1 – 17, please read each statement carefully and place an **X** in the box of the number that reflects your amount of agreement or disagreement. There are no correct or incorrect answers to any of these statements.

1. When I am in math class or working on math, *I feel like an outsider.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

2. When I am in math class, *I feel ignored.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

3. When I am in math class or working on math, *I feel I fit in.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

4. When I am in math class or working on math, *I feel unimportant.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

5. When I am in math class, *I feel appreciated.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

6. When I am in math class or working on math, *I feel unmotivated.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

EMOTIONAL AFFECT IN MATHEMATICS

7. When I am in math class or working on math, *I feel worried.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

8. When I am in math class or working on math, *I feel comfortable.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

9. When I am in math class or working on math, *I feel nervous.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

10. When I am in math class or working on math, *I feel fearful.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

11. When I am in math class, *I wish I could fade into the background and not be noticed.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

12. When I am in math class, *I try to say as little as possible.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

13. When I am in math class, *I enjoy being an active participant.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

EMOTIONAL AFFECT IN MATHEMATICS

14. When I am in math class, *I wish I were invisible.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

15. When I am in math class or working on math, *I feel that I have to prove myself all the time.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

16. When I am in math class, *I trust my teachers to be committed to helping me learn.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

17. When I am in math class, *even when I do poorly, I feel my teachers have faith in my potential.*

Strongly Disagree				Strongly Agree			
1	2	3	4	5	6	7	8

In questions 18 and 19, circle the letter of your response. There are no correct or incorrect answers to any of these statements.

18. My emotions connected to mathematics are:

- a. Mostly negative
- b. Somewhat negative
- c. Neutral
- d. Somewhat positive
- e. Mostly Positive

19. I believe my current ability less in mathematics is:

- a. Poor – understand few concepts and regularly struggle with completing most homework
- b. Fair – understand some concepts and regularly struggle with completing homework
- c. Good – understand most concepts but struggle occasionally with completing homework
- d. Excellent – understand all concepts and rarely struggle with homework