IMPLEMENTING LITERACY STRATEGIES AND MATH TALK IN THE
SIXTH GRADE MATHEMATICS CLASSROOM

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Abstract

This action-research study examined the observed and reported experiences of sixth-grade mathematics students when literacy strategies and “Math Talk” were implemented in the classroom. Daily routines were introduced with the hopes of increasing student understanding and confidence. These routines included vocabulary identification and usage, collaboration with mathematical conversations, awareness and application of literacy strategies, and written self-reflection.

Data collection methods included student surveys, observations, vocabulary and test score analysis, and most importantly, “Math Recap” documents where students recorded their self-reflections. The data was then analyzed and reflected upon, which led to the creation of theme statements explaining the most relevant outcomes of this study.

The outcomes of this study were significant increases in collaboration, mathematical oral language, identification and use of vocabulary, awareness of literacy strategies, written self-reflection and metacognition, and confidence in mathematical abilities. Many students expressed their experiences as “fun” and enjoyed working together with their peers.
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Researcher Stance

As a child, I was fortunate to grow up in a literacy-rich environment. I have fond memories of visiting the library and narrowing down the stack of books I wanted to borrow to only a few at a time. I maintained a notebook in which I recorded the titles of books I had read and aspired to grow that list as long as possible. I had to specifically limit and keep track of which Dr. Seuss books I checked out, or else I would have taken them all at once! However, by limiting the Dr. Seuss books, I found so many others which delighted and intrigued me along the way. These trips to the library were one of many ways my family instilled in me a love for reading at a very young age.

Throughout elementary and middle school, my love for reading continued to grow. I experienced success and built upon background knowledge and applied strategies I had learned in order to become a stronger reader. I also started to develop a knack for math, skipping Pre-Algebra and diving right into Algebra 1 in middle school. Although I enjoyed math and felt that I was good at it, I find it interesting that my only recollections of using literacy in math have to do with simply explaining each step when solving a problem. Even with little explicit use of literacy strategies in math, I continued to work hard and do well. I graduated near the top of my class from both high school and college, earning a degree in Elementary Education (K-6) and English as a Second Language Program Specialist certification.
After graduating, I had opportunities to experience teaching from several different viewpoints. I started out teaching third grade for the first half of a school year and then kindergarten for the second half. The following year, I accepted a part-time reading assistant position, which would prove to impact my future immensely. In accordance with the Title 1 Program, I worked with small groups of students in kindergarten through fifth grade who needed individualized support in reading and math. I absolutely adored working with these students. I thrived on making literacy fun and exciting in order to dissolve previously hardened and resistant attitudes about reading. I engaged my groups in exciting games and other motivating activities to help students brush up on math skills. I even helped plan and execute school-wide reading initiatives. One of the most rewarding and influential aspects of this position, however, was working directly under the reading specialist, Dr. Cathy Walkovic. The passion that Dr. Walkovic clearly radiated, not only for each student individually, but also as a proponent of planning literacy across content areas and forging essential home-school connections, has yet to be matched by any professional I have ever met. Her hard work and enthusiasm were completely contagious and made me realize that I wanted to be a reading specialist and commit myself to sharing knowledge and practice with other professionals.

While working with Dr. Walkovic, I learned how to analyze test scores in order to provide each student with the support he or she needed in order to
experience success. We worked together planning out all the different grouping options, as well as time considerations within groups to create a seamless flow within the classroom. We progress monitored students to stay up-to-date with their ever-changing needs. She shared the latest research with me, which we then incorporated into our plans to the best of our ability. Finally, one of the most important pieces of this position was sharing all of our knowledge and information with the classroom teachers. The level of collaboration required to truly keep every professional on the same page and fully apprised of the intricate needs of each individual student is, as I discovered, a task requiring impressive organization, knowledge, and communication.

While I cherished the time I spent in this position, taking in all that I possibly could about the day to day life as a reading specialist, I needed to find a full-time teaching position. Throughout the four years that I spent in this part-time position, I went above and beyond and tried to showcase all of my potential to make great things happen in the school district from which I had proudly graduated. However, my efforts were left unrequited year after year and I knew it was time to look elsewhere. The timing of my job search was perfect, and I was offered a position at a different school district where I immediately felt welcomed and appreciated. I began this new chapter of my career in a unique way. I had replaced a retiring teaching in the middle of the school year. Preparing a classroom in the beginning of January is much different than preparing a
classroom at the end of August, especially when there is a blizzard on the one and only day you can move in and set up the classroom! Despite the harried pace and initial stress of acclimating to a new building and a program in full swing, I was deeply gratified by the warmth and acceptance extended to me. I knew I would be able to make a difference here.

At the time of my employment, our school was still tracking students. This meant that all of the learning support and emotional support students were grouped into the lowest track, average-performing students were grouped together in the middle, and the advanced and gifted students were placed together in the highest track. I had the privilege of working with the lowest track, teaching language arts, science and social studies. All of the students in our two classes were reading well below grade level and had been placed in the Read 180 reading intervention program. They were also receiving the Math 180 intervention program, a program which was terminated by the district the following year. I learned a lot of valuable lessons in those first five months. I had taught learning support students before and I knew how to differentiate and keep them included, but this wasn’t just a few students in a class of mostly regular education. This was the opposite- mostly learning and emotional support with a few English language learners and one or two regular education students. The most valuable lesson I took from that class was that they needed to know my number one priority was
always their safety and success. I did everything I could to help them feel comfortable and confident that I was there for them, every single day.

For the next three years, I stayed with this track of struggling readers teaching math, language arts and social studies. However, my teammates and I decided that it would best for our students if we combined our two classes so that we could make smaller groups to better meet individual needs. For example, we were able to have four small groups during math instruction, each with its own adult- two regular education teachers, one learning support teacher and one instructional assistant. This created new opportunities for us to group flexibly, providing extra support or challenges when necessary. Even though we had this unique and rewarding structure, our students still doubted themselves and exhibited helplessness more than any other single quality. Needless to say, I did not take this lightly.

As an educator, I believe that my students can do whatever they set their minds to and I felt the need to help this group of students find their confidence. For many of these students, school had always been difficult and whether they were in reading or math class, they lacked confidence, focus and enthusiasm. I wanted to change this. I wanted to make my students understand that everything they do is meaningful and what they learn in one class can and should be applied in other classes. I thought specifically about reading, where many of my students
had the greatest difficulty, and knew that I needed to explicitly point out the connections that exist between reading and math.

I began researching reading and literacy strategies that can be used in math and made connections of my own. I thought about ways that I could track both academic progress, such as vocabulary and skill performance, as well as confidence levels for my students. These ideas became my pilot study, through which I was able to test out implementing literacy strategies in math. I also came up with some new ideas throughout my pilot study that I would include in my research project. I realized how important it was to guide and encourage my students to have mathematical conversations with each other. This became our “math talk”, which would also play an important role in my research project. From my students’ feedback, they felt happy that they were being encouraged to talk to each other instead of working silently. However, I did not see as much of an improvement in vocabulary scores as I hoped I would see. All of the results from my pilot study, both positive and negative, confirmed my commitment to implement literacy strategies and math talk for my research project.

To prepare for my research study, I started to modify my ideas and materials. I reflected on what went well and what needed to be improved from my pilot study so that I would be well prepared to get started with my research study when the new school year began. Nevertheless, if there is one thing I learned in my first eight years of teaching, it’s that an educator should always be prepared
for change. And change is exactly what I was surprised with at the end of the school year. My school was planning to reorganize the sixth-grade structure from teams of two classes to teams of three classes. This meant that each teacher would be focused on one specific content area (Math, English or Science) and Social Studies. We were also doing away with tracking, but not completely heterogeneously grouping students yet. The only team that was not projected to change was my team, which was previously referred to as the “C Track” team made up mostly of students with learning support and/or emotional support and enrolled in the Read 180 program. With this in mind, I assumed that I would be staying with the team that was not changing, but instead, I was surprised to hear my principal list my name as the “advanced math” teacher on a different team! I knew that teaching advanced math would be a much different experience than teaching modified math. I also knew that my original reasoning that brought me to my research question might not apply to my new set of students. However, I believed in the importance of implementing literacy strategies and math talk in the math classroom and started preparing for my research project with some new ideas in mind.

As a researcher, and as an educator, my focus is always on what’s best for each and every student involved. Implementing literacy strategies in math is a way for students of any ability level to make cross-curricular connections. I believe students learn best when they are executing strategies and skills; making
them completely immersed and engaged in their own learning. I believe that this is when knowledge is constructed. Students must be committed to, and feel that they have ownership of what they are learning. It is my hope that by engaging in “math talk” conversations and reflecting on these conversations, as well as making the cross-curricular connection between literacy strategies and math, students will become active agents of their own progress.
Literature Review

Educators across the nation are aware that, as Hurst and Pearman (2013) describe, “many schools encourage all teachers, regardless of their subject area, to emphasize reading in their classes” (p. 225). There are a variety of ways to emphasize reading other than simply allowing reading time, such as applying literacy strategies in content-area classes and focusing on vocabulary, written language and oral language. These are important factors contributing to language development, which Kilpatrick (2015) stresses as a practice that all educators need to prioritize (p. 282). Language development does not end when students begin their secondary education, but rather it should continue to develop in a literacy-rich environment across content areas, including mathematics.

Fello, Paquette and Gentile (2008) eloquently described the importance of mathematics and literacy when they stated “learning mathematics in a literate environment fosters inquiry and problem solving, promotes self-confidence, and empowers learners to use and understand mathematics” (p. 85). All of these factors are important pieces that should make up a secondary mathematics classroom. Problem solving is a difficult yet imperative aspect of mathematics and as Gee (2017) supports, math word problems can be confusing and often do not connect to real life situations (p. 62). Under these circumstances, students need to be able to inquire, explore and even create their own problems to solve. In a literate environment, these tactics are encouraged and supported.
For some students, there are roadblocks before they even attempt to interpret word problems in mathematics. With a wide range of student reading levels in sixth grade mathematics classes, many mathematics texts are overly complex with unfamiliar text structure, multiple-meaning words, scaffolding, and multi-part problems. It is the job of the mathematics teacher to provide not only a literate environment, but also specific strategies that will assist students in making sense of these complex texts. As Metsisto (2005) clearly states, “teachers must help students use strategies for acquiring vocabulary and reading word problems for meaning” (p. 23). Even the strongest readers will need support to be able to completely comprehend mathematics texts at the secondary level.

**Literacy and Math**

Despite the lack of professional and peer-reviewed research on the historical background of literacy and math, there are recent studies that reveal the need for cross-curricular literacy instruction. There are a variety of ways to incorporate literacy instruction and application into any content-area. Shanahan and Shanahan (2008) refer to this as “‘disciplinary literacy’ — advanced literacy instruction embedded within content-area classes” (p. 40). Reading and writing may look different depending on the subject; for example, the purpose for and structure of reading or writing in mathematics can be very different than that in a science class. It is important, however, to make connections to the similarities that are carried across content. No matter what the purpose may be for reading,
strategies can be applied in all situations. Hurst and Pearman (2013) discuss research-based reading strategies including rereading, using context clues, predicting, visualizing and making connections. Rereading is imperative in mathematics, especially when evaluating what information in a word problem is important and necessary in order to understand and solve the problem. Context clues and predicting are helpful when reading and comprehending word problems with unfamiliar content. Visualizing is a very helpful aid when picturing shapes and figures, or imagining word problems in real life situations. Finally, making connections to personal experiences will not only help students understand what they are reading and doing, but will also help them remember what they read and how to solve problems (Hurst & Pearman, 2013).

These reading, or cognitive, strategies are defined by the National Institute of Child Health and Human Development (2000) as “the specific procedures that guide students to become aware of how well they are comprehending as they attempt to read and write” (as cited in Reed, 2009, p. 2). These strategies are rooted in the reading classroom, but it is also an important responsibility of content-area teachers to continue the growth and application of said strategies as students develop and are exposed to new and challenging texts. Reed (2009) synthesized several studies that focused on professional development and implementation of literacy strategies for middle school content-area teachers. The findings suggested that when professional development and school-wide
initiatives reflect the perceived needs of the middle school content-area teachers, there would most likely be an increase in literacy instruction and improved reading skills across the curriculum. If provided with appropriate training and opportunities, teachers would be even more comfortable and confident integrating literacy strategies and instruction within content-area classes.

The idea of catering professional development, such as that of literacy strategies, to the needs of the teachers is very appropriate when one considers that the purpose and process of reading and writing differ across content areas. Shanahan and Shanahan (2008) conducted a two-year project during which the first-year goal was to understand the literacy demands in each content area and then in the second year, they worked on creating discipline-specific literacy strategies. They worked closely with content-area teachers to come up with strategies that would be most helpful to the students in each of their classes. For example, in the mathematics classes, rereading and understanding specific function words stood out as imperative to student comprehension and understanding of mathematics texts. Vocabulary strategies were needed in order to learn the precise mathematical definitions of words presented in introductions, examples and directions. Overall, “disciplinary teams advocated strategies that mirrored the kinds of thinking and analytic practices common to their discipline” (Shanahan & Shanahan, 2008, p. 56). Although specific strategies could be better fit for one content area over another, research suggests that implementing literacy
strategies and teaching students how to apply them in content-area classes well help developing secondary students successfully read and write across the curriculum, especially in mathematics. Research and data in this area can be summed up by Sturgeon (2017) as she proclaims “the possibilities of how to effectively incorporate literacy into a successful math curriculum are limited only by your imagination” (p. 560). With such a variety of possibilities to implement literacy into the mathematics curriculum, all students to have the opportunity to learn these integrated skills.

**Vocabulary in the Math Classroom**

One of Shanahan and Shanahan’s four components that make up the dimensions of a literacy framework is vocabulary (2008, p. 48). There are many approaches to teaching and learning vocabulary and these should be explored not only in a reading or writing class, but also in the mathematics classroom and across content areas. Understanding vocabulary is an essential aspect of learning mathematics. Not only must students learn new vocabulary words, but they must also understand new meanings for words that already exist in their own vocabulary. Sullivan (1982) referred to these as the “little” words in mathematics and conducted research to see if teaching the mathematical meanings of commonly known and used words would enhance student mathematical performance. When compared with students who received drill practice on their math facts, she found that “teaching the students the meanings of the general
vocabulary used in mathematics is at least as effective as drill on basic facts and may yet be shown to be more effective” (Sullivan, 1982, p. 11). This may be an older study, however, the same “little” words that she refers to continue to present challenges for students today. For example, is meaning equals, or the meaning one specific thing. Students need to be taught how to be aware of what certain words can signal for them to do, such as the word split implying the operation of division.

Other than words having multiple and new meanings when used in a mathematical context, teachers need to point out parts of words that can help students better understand their meaning. Phillips, Bardsley, Bach and Gibb-Brown (2009) suggest that mathematics teachers use mini-lessons to explicitly teach prefixes and allow students to determine and report the meanings of words with said prefixes (p. 471). Prefixes and suffixes can be helpful for students as they read directions and learn new mathematical concepts. For example, in directions, a word that has an -ly suffix, such as abstractly, tells the students how to solve a certain problem. Knowing the meaning of prefixes, such as bi and tri, will help students be aware of what kind of shape or number they need in that problem. Sanacore and Palumbo (2010) also suggest a vocabulary strategy in which teachers use mathematical words that students will be seeing in the near future, in context, before they encounter the words in their math class. Students should infer the meanings of these words and participate in discussions so that
when the students need to understand meaning in directions or problems, they will have already been exposed to the words in context (p. 184).

Another powerful way to incorporate vocabulary into math instruction is through the use of word walls. Word walls are an important tool, even in secondary classrooms, and should be taken advantage of for all students. Gore (2010) supports the use of interactive word walls and stresses the importance of actively using the word wall and allowing students to be involved with it, adding new words or creating pictures to serve as visual representations of vocabulary words (p. 60-61). If a word wall is created completely by the teacher and nothing is done with it until the teacher adds or removes words, it is not serving a helpful purpose. However, to make the most out of a word wall, students should be suggesting and adding words to it as well as referring to the word wall in explanations and discussions. It should be a tool for each and every student to use while they are in that classroom. Yates, Cuthrell and Rose (2011) shared their middle school’s approach to implementing content-area word walls in their classrooms as well as in the hallway. The spark for this study came from the realization that the state assessment math test is truly a reading test that students must be able to comprehend before they can solve the problems. Throughout this study, students were encouraged to create and interact with the words on their word wall. They referred to these words as “power words”, which were “engaging, precise, and meaningful to the students” (p. 33). Students were heard
using the words from the word wall in conversations both inside and outside of the classroom. Students also reported back to their teachers when they encountered one of these words elsewhere, including on the end-of-grade test. Ultimately, the study found that “interactive word walls are a promising instructional tool in all content areas for this middle school, as evidenced by gains in state test scores and positive teacher and student feedback” (p. 36). If used properly, interactive word walls can become a dynamic tool for every student to apply to their learning and use when communicating mathematically.

**Oral Language**

Communication is an important skill, which should be practiced across all content areas. Speaking and listening appropriately and effectively do not come easy to all students. It is important for teachers to model what thinking, speaking and listening should look and sound like in specific content areas and to provide opportunities for students to practice these skills. Explicit instruction on relaying one’s thinking through conversation can be extremely beneficial to all individuals involved. Roberts and Billings (2008) shared the following:

> Our experience with teaching thinking has taught us that learning to think requires frequent deliberate practice. To become clear, flexible, and coherent thinkers, students need to work with both the process and the product. The only way we have found to teach the process and product of
thinking is to recognize the profound relationship between thought and language. (p. 33)

In order for students to truly understand their thinking and learning processes, they must be able to communicate to others the steps that they have taken. Although this may seem like a new idea, Dewey was encouraging communication during learning all the way back in 1938. He challenged educators to understand that despite our own past experiences, it is important to realize that experiences must be social. A true experience involves contact and communication with others, not solitude and silence. If we want education to be a positive experience, we need to be sure to include contact and communication (Dewey, 1938, p. 38). By teaching students how to effectively communicate their thinking and learning processes, teachers can allow students to have a social experience while they are learning. Not only does this process help a student determine how they are solving a problem, but it also allows students to hear the thoughts and processes of others. This is an imperative aspect of a mathematical learning community and sets the tone as a safe place for all to learn. In a study promoting student mathematical thinking, the setting was described by stressing the importance of establishing a mathematical learning community and the work of Yackel & Cobb (1996) and Forman (2003) was paraphrased by stating that “mathematical reasoning and understanding naturally results from the communication that takes place in such communities” (as cited in Mueller,
Yankelewitz & Maher, 2014, p. 4). In mathematical learning communities where speaking and listening is expected among the students, communication can lead to deeper understanding of the topics and processes being discussed. Roberts & Billings (2008) also shared their findings of the importance of thinking through the process of speaking and listening for sixth grade students by explaining:

Both speaking and listening are forms of thinking because they allow a nascent thought to be refined through conversation. The better a student’s verbal communication skills, the more quickly his or her thoughts about a complex topic gain clarity and coherence. (p. 34)

Speaking and listening are important skills which need to be taught and practiced across all content areas. In mathematics in particular, it is necessary for students to understand and use the terms and phrases needed to comprehend and solve problems. The use of these terms becomes more authentic when students take part in conversations with each other, not just with a teacher. In a middle school mathematics classroom where literacy and communication are valued and expected, “Students should be able to comprehend mathematical terms and concepts, discuss those terms and ideas fluently with classmates, and apply their mathematical understanding clearly, logically, and sequentially through written or oral communication.” (Fello, Paquette & Gentile, 2008, p. 76). Communicating mathematically is more than simply explaining the answer of a problem. When engaged in mathematical conversations, students should be able to explore and
discuss multiple approaches to problem solving, different interpretations of
problems and solutions, as well as sharing individual pathways to solutions.

Phillips, Bardsley, Bach & Gibb-Brown (2009) agree that if students are taught to
use different literacy strategies in order to deal with the demands of mathematical
texts, their learning and communication skills in mathematics will improve (p.
468). Furthermore, Sturgeon (2017) acknowledges that “using literacy to present
and review mathematical terminology and concepts has the added bonus of
increasing the accessibility for verbal students (and teachers) who don’t consider
themselves ‘mathematically-minded’” (p. 557). Encouraging communication can
allow students who would normally struggle with problem solving on their own a
chance to discuss problems with others, share their own ideas and hear the ideas
of their peers.

Sharing ideas and processes through dialogue and communication can
unlock mathematical mindsets that may have previously been resistant in
students. Routman (2003) elegantly yet simply states that “collaborative talk is a
powerful way to make meaning” (as cited in Hurst & Pearman, 2013, p.228).
Freire (1970) supported the need for collaborative talk and explained “only
dialogue, which requires critical thinking, is also capable of generating critical
thinking. Without dialogue there is no communication, and without
communication there can be no true education” (p. 92-93). In order for our
students to think deeply about their learning and processes, they must be able to
partake in conversations with their peers where they can explain their thinking, reasoning and understanding in a safe and encouraging environment.

**Written Language and Reflection**

Just as oral communication needs to be modeled, taught and practiced, so does written communication. Writing cannot be limited to an English class; it is a crucial skill that should develop as students grow and learn in each subject. Writing in mathematics can range from computation to problem solving steps and even to reflections. Most students would think that writing in mathematics might only require them to explain the steps they chose to use to solve a particular problem. However, in order for students to truly explain their choices and processes, they must be able to reflect upon how and why they made each decision along the way. This process of metacognition needs to be modeled and taught in order to students to be able to reflect and record their thinking. Dewey (1938) encouraged quiet reflection time for all ages. Even though self-reflection is a complex task, it is important for all ages to engage in it. Children will benefit from time that is specifically laid out for reflection (p. 63). Reflection is an important step in the learning process, which is often forgotten about. It is necessary for teachers to plan for this time and model for their students how to reflect upon their learning. Sturgeon (2017) states that “writing about math necessitates reflection, requiring students to organize and consolidate their
understanding.” (p. 557). This final step in the learning process can allow students to synthesize what they have learned and truly understand each process.

There are many ways that teachers can provide the time and means for student reflection. Teachers could offer specific questions for students, which would elicit reflective answers about how they solved problems in mathematics and why they chose those processes. Another option could be less specific but still highly structured through journaling time. Cummings (2010) implemented reflective journaling in her study on attitudes in the art classroom. She allowed a specific amount of time during each class for journaling so that students could reflect and she read their journal entries each week (p. 57). In the mathematics classroom, this journaling time could be used to reflect on the learning that took place as well as the attitudes and feelings towards mathematics and student learning. These types of reflections can be personal and therapeutic never to be read by anyone but the author, they can be shared solely between the student and the teacher, or they can be shared with peers.

When writing and reflections are shared, we can make the process even more effective. Haltiwanger and Simpson (2013) wanted to help their middle school students increase their mathematical literacy by focusing on writing and reflection. They shared several writing strategies that they implemented in order to increase the amount and variety of writing in their mathematics classrooms. They found that writing frequently and consistently helped their students “clarify
their thoughts and helped them build connections between mathematical content and their lives” (p. 497). The implementation of writing and literacy strategies in their classrooms also promoted critical thinking and resulted in clear communication between students as they shared their ideas and thinking.

Writing and reflecting are two important skills that can become tools for success for all students, especially in the mathematics classroom. When combined, written reflection can be a way for students to not only communicate their thinking and processes, but also to look back and revisit these reflections as a way to build upon their learning. Written reflection should be explicitly taught and modeled and there should be specific time deliberately set aside for this process.

**Student Collaboration**

Collaboration between students is an essential part of today’s classrooms. Rows of desks and students working silently and completely on their own are now in the past. As educators, we must recognize the benefits of students working together and can encourage this collaboration subtly by grouping desks together and allowing conversations about learning throughout lessons. Research has supported this notion of collaboration for decades. Dewey (1938) not only supported collaboration for learning, but also stressed the importance of the effect collaboration could have on students’ attitudes. Regardless of the subject matter that we are teaching, there is always a hidden curriculum, which is sometimes
even more important than the content that we teach. We need to keep in mind that everything we present and ask students to take part in will have an effect on their attitudes towards learning. These attitudes are more important to the students’ futures than the content they are learning (p. 38). When we allow students to collaborate and work together, they are learning other useful skills such as how to communicate with others, to include and appreciate the thoughts and needs of others, and to both speak and listen while working in a group.

In 1970, Freire also taught us that collaboration between students is necessary and that teachers do not have all of the answers to every question. Teachers should not just be feeding information into the students. There should be a dialogue between students and teachers, through which students can learn from themselves and each other as well as the teacher, and teachers can in turn learn from the students. These shared experiences will ultimately lead to the generation of true knowledge (p. 80). As students are encouraged to work together and share their thoughts and processes, teachers should listen carefully to the conversations that emerge. Sometimes students can explain things to each other in a different way that we might not have thought of without hearing these collaborative conversations. This type of collaboration can result in critical thinking that would not come easily from individual work. When Delpit (2012) described some of the American school visits she made where she saw teachers actually teaching and making connections for students, she points out that these great teachers had
students explain concepts to each other. These students asked each other questions, which inspired critical thinking (p. 8-9). Questioning techniques may need to be explicitly modeled for students before they are able to engage in high-level conversations about mathematical processes. Teachers can model questioning techniques when the norms are set for group work and group conversations. Teachers can also take advantage of high-quality questions and conversations as they happen by sharing them with the entire class and thanking the students involved.

Allowing for collaborative learning may require a shift in teaching style. Burns, Pierson & Reddy (2014) shared their study in which active learning was integrated in math and science classrooms. As the teachers in this study interacted more with the students and allowed the students to work together, they began to rethink what would be best for their students as learners. These changes in teacher beliefs and behaviors, as well as the implementation of collaborative practices led to improvements in their students’ abilities (p. 25). Similarly, Phillips, Bardsley, Bach & Gibb-Brown (2009) found that as teachers and students in their project to integrate literacy strategies into math instruction became more reflective and collaborative, the result was an increase in confidence, mathematics and literacy knowledge and enthusiasm (p. 472). An increase in confidence and enthusiasm is another wonderful outcome of collaboration. Students may also feel more focused when working with others. When Metsisto (2005) discussed different techniques...
to help students understand mathematical texts and what the questions were asking, such as reading the problems aloud, she found that “for some students, the attention of someone else listening may help them to focus” (p. 17). The attention of someone else, especially when that someone else is a peer, can make a difference in a student’s willingness to participate and share his or her thinking and reasoning.

Conclusion

There are many ways to implement literacy strategies in the mathematics classroom. Applying literacy strategies such as making connections, re-reading, using context clues, predicting and visualizing must be modeled and expected of students in the mathematics classroom. Vocabulary, specifically, is an imperative piece of the mathematics puzzle and requires explicit teaching and learning. It is not enough to memorize mathematical vocabulary for a test or during a certain topic. In order to understand and use mathematical vocabulary properly, students must be engaged in mathematical conversations that require the use of their vocabulary words. These conversations will not only allow students to practice using their mathematical vocabulary, but also require speaking and listening skills, which are two very important aspects of literacy. Additionally, while engaged in mathematical conversations, students work collaboratively and share their thoughts and processes. Collaboration is an indispensable learning opportunity for all students involved. It allows students to not only explain their
own learning but to also hear and understand the learning of others. Finally, written language and reflection allows students to consider their own thought processes and results of learning and to communicate how they feel about those outcomes. In a middle school classroom, it is crucial to continue to model, expect and refine all of these literacy strategies. Students need to be aware of the importance of literacy across all content areas, and as educators, we must be able to build the bridge for these cross-curricular connections.
Research Design and Methodology

Setting

The setting of this study was a middle school in Pennsylvania with just over 1,000 students. This school is one of four middle schools in the sixth largest school district in the commonwealth of Pennsylvania. The students who attend this middle school come from a variety of socioeconomic status, cultural backgrounds and family structures.

In our classroom, the desks and tables were arranged in groups of six. There were a few tables around the perimeter of the room as well for small groups of students to work when needed. There was a large whiteboard in the front of the room with a projector that displayed onto the whiteboard. Two bulletin boards on the side of the room were used for math vocabulary words; one for “Math Survival Words” (words the students had already learned and would continue using) and the other for “Math Talk” (words the students were currently learning and using most often). Each student had a Chromebook to use throughout the school day. Most importantly, the classroom was a safe space where students were expected to respect and value themselves and each other.

Participants

The participants of this study were sixth grade students, all eleven or twelve years old. There was a total of 25 students: 14 female students and 11 male students. Only one of the students had an Individualized Education Plan for
Speech and Language. All students were in a regular education sixth grade math class. All students took part in the discussion when this study was introduced and gave their assent to anonymously be part of the study.

**Research Goals**

The goal of this research study was to observe the effects of implementing literacy strategies and math talk in the sixth-grade mathematics classroom. The students in this study were asked to identify and use important mathematical vocabulary words, work collaboratively on mathematics problems while discussing their processes, and reflect on these procedures. Students were expected to work together and were reminded of the importance of collaboration and math talk daily.

**Procedures**

Prior to starting my study, it was important to follow all ethical and legal procedures in order to gain approval for the action research project. The first step was to complete and submit a Human Subjects Internal Review Board (HSIRB) Proposal Form (Appendix A). I completed and submitted this form in May of 2018. The HSIRB reviewed my proposal and decided that my research project was ethical and would protect any human subjects involved, and therefore approved my proposal in August of 2018. I also received approval from my building principal near the end of the 2017-2018 school year to conduct my research study the following school year. Finally, before implementing my action
research, I explained and discussed the study with my students and had each student complete an assent form to participate in the study as well as explain the study to their parents or guardians and ask for their approval. Once I received completed parental/guardian consent forms, I felt confident and ready to implement the research and strategies outlined in my study.

The procedures that became norms in this study relate to and enhance the structure recommended by our mathematics curriculum. Typically, each lesson spans over two school days. On the first day of the lesson, the key concept is introduced and discussed, examples are completed and explained as a whole group, subsequent examples are completed individually or collaboratively and any questions or confusion is addressed. Students usually completed a homework assignment on the night of the first lesson, which reviewed key concepts and vocabulary used in that lesson. On the second day of the lesson, students would review the key concept and a few new examples, finish any individual or collaborate work that was not done the day before, and then students would complete additional practice using our online resources through Pearson and IXL. For this study, specific elements were added to our routine including expected conversations and collaboration among students, and quiet time to reflect on our learning and conversations. Another aspect of this study, which became routine, was using our “Math Talk” board by adding vocabulary and other important terms and phrases that the students thought they should be using throughout their
 conversations. Somewhat surprisingly, the students very quickly took responsibility for adding to this board and were eager to create and add new cards throughout our lessons.

**Data Collection**

*Student Surveys.* At the beginning of the study, each student completed a pre-survey (Appendix E) to gauge levels of confidence and literacy awareness. The results of the survey were analyzed and compiled into graphs for a visual comparison to the post-survey. The post-survey (Appendix J) was completed by each student at the conclusion of the study. Again, the results were analyzed and compiled into graphs, which could be compared to the results from the pre-survey in order to view and share changes in student responses.

*“Math Recaps”.* In order to guide students to reflect upon their learning and processes, each student took part in “Math Recaps” at the end of class several times per week. At the beginning of the study, we discussed “Math Recaps” in comparison to the recap at the beginning of a show, which sums up what has already happened in a show to get you ready for what comes next. Each student created a Google Doc, which was shared with me, in which they could add to the document each time we completed a Math Recap. We answered the same four questions every time:

1. How do you feel about what we did today in math?
2. What were your math conversations about today?
3. Did you use any literacy strategies today while you were reading math problems? If so, what strategies do you think you used?

4. What are your suggestions or questions right now?

An added bonus of using Google Docs for this data collection was that it provided a safe space for the students to ask questions or post concerns to which I could respond in a timely and private manner. The students were excited when I responded to their questions and comments, which heightened their engagement with our recaps.

**Vocabulary Analysis.** At the end of each topic, the first section on the test contained important vocabulary words and definitions. After the students completed their tests, I looked carefully at which definitions the students answered correctly versus incorrectly. I created graphs to show the number of students who defined each vocabulary word correctly. After all, three topics were completed, I was able to compare the vocabulary scores and identify any trends or changes.

**Observations.** Throughout the study, I kept track of observations in my field log. I recorded actions and behaviors that I observed during whole group instruction and discussion as well as during collaborative group work. I tried to capture snippets of conversations between students as they worked collaboratively by typing them quickly into my field log. During these observations, I focused on
listening for math conversations between students as well as understanding of the topic at practice.

Field Log. My field log allowed me to keep track of the lesson and topic being taught each day, outcomes and reactions, observations and interpretations. This was a very versatile and valuable document for my study, serving as both a calendar and a diary in different ways. I not only recorded all of the important data mentioned above, but I also reacted to and reflected on the data that I recorded. Throughout the study, I re-read and analyzed the entries in my field log and coded them in accordance with the emerging themes.

Summary

The focus of this study was to observe the behaviors, conversations and reactions when literacy strategies and math talk were implemented into our sixth-grade mathematics classroom. As the progressed, the importance of vocabulary and reflection emerged as a major aspect of the study. Data was collected in a number of ways including surveys, recap reflections, vocabulary analysis and observations. These data were then analyzed and cross-referenced in order to develop the themes that resulted from this study.
Trustworthiness Statement

In order to maintain trustworthiness and validity as a teacher action researcher throughout this study, I followed specific ethical guidelines. As McNiff (2017) describes, “Ethical considerations involve three main aspects: Negotiating and securing access. Protecting your participants. Assuring good faith.” (p. 125). First and foremost, in order to negotiate and gain permission to initiate my research, I outlined and described my action research plan, which I submitted to the Human Subjects Institutional Review Board (HSIRB) of Moravian College. Included with this proposal was informed consent from my building principal approving the research project (Appendix A), consent forms that would be sent home for parental/guardian approval (Appendix D), assent forms for the students that would be part of my research (Appendix C), pre- and post-surveys for the students to complete (Appendices E and J), and the “Recap” questions to be used as a data collection tool (Appendix F). The HSIRB acknowledged that I was properly protecting the rights of all students involved and approved my action research study.

The first step in executing my research study in my classroom, and protecting my participants, was to thoroughly explain the plan to my students. They were all well aware that I am a not only a teacher, but a student and a life-long learner as well. I have talked openly with my students about assignments and research that I have done for my classes and have shared and described the
purpose of this study to my students in clear terms that they could easily understand. Following my description and questions from the students, we reviewed the student assent form and parental/guardian consent forms together. In both the student assent form and the parental/guardian consent form, it was made very clear that all students would be receiving the same instruction whether they chose to be part of the study, or withdrawal from the study. It was also made clear that students would be able to withdrawal from the study at any time if they, or their parents/guardians, desired without any penalty or repercussion. Both forms provided details that the permission they were granting was for me to anonymously use the data collected from each student. As I received completed consent and assent forms, they were stored securely in a locked drawer of my desk until the conclusion of the study.

In a further effort to keep my students protected, I came up with pseudonyms for each student participating in the study as well as an identifying number. The data that I collected and analyzed was recorded under these numbers and pseudonyms; never a student’s real name. I used a variety of tools to collect data because as Hendricks (2017) describes, “collecting multiple sources of data is a necessary step in action research” (p. 65). Some of these data collection tools included pre- and post-surveys (Appendices E and J), “recaps” about math discussions and feelings (Appendix F), vocabulary analysis from topic tests (Appendices G, H and I), observations, field log reflections and recap reflections.
The frequency of data collection was important to the validity of my research as well, for example, “recaps” were collected every other instructional day, as often as possible. My triangulated data were reviewed and critiqued by my peers. Likewise, these peer review groups allowed fellow professionals to present critical questions throughout the research and data analysis process. Hendricks (2017) points out that peer review groups such as this “provide alternate interpretations” (p. 65). These interpretations were helpful and assured that my findings would not be clouded by researcher bias. My peer review group also assisted me when unexpected results surfaced. These results were considered, analyzed and valued equally with data results that were expected. It was also helpful to learn the processes that my peers were using for their own research study and to compare, contrast or make changes to my own processes throughout my study.

Reflection was another critical component of my research study. Hendricks (2017) conveys “in the process of action research, a researcher continually reflects on what is occurring during the study and makes changes to the research plan as necessary” (p. 67). I included reflections in my field log and in a separate recap reflection memo in order to accurately retell the story of my students as well as make appropriate changes throughout the study. It was also important to partake in self-reflection along with my reflections on the students and aspects of the study itself. I believe effective educators constantly self-reflect
in order to improve their practice. Therefore, it was important for me to do so throughout my study. Reflections allowed me to gauge the effectiveness of my study from different viewpoints. Even the participants of my study engaged in self-reflection through our “recaps”, reflecting on mathematical conversations they had with others and how they were feeling about what they learned, what they talked about, and who they worked with.

Finally, McNiff (2017) explains that in order to assure good faith, one must “create a reputation for integrity and protect it” (p. 126). To protect my integrity throughout my study, I followed the plan that I proposed to the HSIRB. I made sure that my students were well aware of their constant participation in my study and if anything needed to change, I made it a point to explain any changes clearly. It was also important for me to stay true to my personal and organizational values, which are to do what is best for each and every student at all times. After all, the students are the reason I teach and the reason I continue to learn.
My Story

Change of Mindset

For the three and a half years prior to this action research study, a majority of the students that I taught were classified as learning support students and were enrolled in the Read 180 reading remediation program. All of the students in my classes throughout that time were reading below grade level and most exhibited some sort of resistance toward learning, sometimes manifested through behavioral and emotional outbursts. In order to accommodate all of the various individual needs, it was necessary to slow down our curriculum, teach in small groups, and make meaningful connections to the content. My team consisted of myself and another regular education teacher, a learning support teacher, and an instructional assistant. Together, we became the best advocates for these children that we could possibly be. Although this work was exhausting, it was also incredibly rewarding.

Near the end of the 2017-2018 school year, the entire sixth grade was informed that we would be making the switch from two-person teams to three-person teams. We were told that every team would be making this change except ours, in order to keep our class size smaller and allow for the flexible grouping that we had been strongly advocating for over the course of the three previous years. Our principals met with all of the sixth-grade teachers to let us know our new teams and who would be teaching each subject on their team. I was completely surprised when my principal said my name as the math teacher with a
new team! The rest of the meeting was rather blurry as I tried to wrap my head around the thought of switching gears completely. After the meeting, I spoke with my principal who told me that he trusted me to teach math at a higher level. I did my best to make it clear that although I was a bit shocked, I was completely ready and willing to take on this exciting new challenge! What this meant for me was that instead of making accommodations and slowing down the curriculum, I would now be teaching two sections of accelerated math as well as one section of regular education math. This required me to change my mindset in order to prepare for the coming school year. I also needed to make some changes and anticipate new and different outcomes for my action research project.

**Literacy Remains**

Although I would no longer be teaching Language Arts, I knew that it was important to continue providing a literacy-rich background for my students as well as support their development of literacy strategies across content areas. My approach to my action research was the only aspect that would truly need to change. My reasoning was no longer because my students were all reading below grade-level and needed extra literacy support, but was now because of the importance of applying literacy strategies across content areas and implementing math talk in order to practice speaking and listening skills. Speaking and listening are imperative skills that usually get overlooked due to the stressed importance of testing.
As a graduate student in a reading specialist program, I was excited and somewhat relieved that I would still be able to teach literacy skills and strategies to my math students. As I reviewed all the sources and information that I had up to this point and searched for new resources, I was surprised by how difficult it was to find research on literacy and math. I tried every combination of search terms that I could think of, but was not able to find the kind of research I was hoping for! This outcome only strengthened my confidence that I needed to conduct and share my action research about implementing literacy strategies and math talk in my mathematics classroom.

“I’m a student, too!”

At the beginning of the 2018-2019 school year, my students were surprised by a few of the details that I shared with them about my life. Of course, sharing that I had danced for 46 hours without sitting or sleeping in order to raise money for pediatric cancer was the most shocking piece of information to them! However, they were also completely astounded that I was not only a teacher, but also a student! They had many questions about how this could be possible, such as, when did I have time to go to school if I was here teaching them, did I get homework, and why did I want to go to school. I was very excited to share these answers with them, especially when discussing the amount of homework I was going to be doing this year. They were surprised by how much writing I had to do,
but also thankful that I would not expect them to do nearly as much homework as I needed to do!

When we discussed my research project, the students were very interested in being involved in my study. I explained that since I teach math, but I really love reading, I wanted to try something new and incorporate literacy strategies into math. At first, there were some groans from several students. I clarified that I did not mean we were going to be doing any extra reading work, but rather that we would be using the strategies we already knew to help us when we read in math. I also explained that we would be using math talk as we worked together in our groups, pointing out the “Math Talk” bulletin board in the room (see Figure 1), to which some students responded “Oh yeah!” Although the “Math Talk” board did not yet have any vocabulary on it, I did have some sentence starters that I thought might be helpful during our math conversations. A few of these sentence starters addressed how to explain one’s thoughts, how to agree with someone and explain why, as well as how to disagree with someone and respectfully explain why.
We read through the parent consent and student assent letters together and I asked for questions along the way. One student asked, “So if I say no, I can just sit here and do nothing?” to which I clarified that everyone in this class would be doing the same thing and the permission was only telling me if I could use their data in my study or not. I reiterated this information to ensure I was clear that all students in my class would be doing the same thing whether or not I was able to use their information in my study.
Let’s Get Started

At the beginning of this study, all students completed a pre-survey (see Appendix E and Figure 2). This survey was meant to gauge how the students felt about math, literacy strategies and how to integrate their knowledge of both. I read all of the questions aloud while the students answered them. The first seven questions were scaled responses. I explained what each number on the Likert Scale should represent for each of those questions so that my students could answer as honestly and accurately as possible. While finishing up the survey, one of my students described a vocabulary game that she had played the year before in her fifth-grade class and asked me to help her figure out how to write the explanation of the game.
Figure 2. Completed Pre-Survey Student Example

I gathered these surveys as my starting point. I began with the scaled questions at the beginning. It made sense in my mind to create graphs for the data from these questions. I looked at each answer and included it in a graph of that question. I could easily see how the majority of my students felt about each of those first seven questions as baseline data for the beginning of my research.
Most of my students felt that they sometimes struggle when reading math problems (see Figure 3.1). Not even one student responded “yes, all the time” to the question about using reading strategies in math and most students responded “not at all” (see Figure 3.2). Most students felt confident about our math vocabulary and their math skills (see Figures 3.3 and 3.4). Most students sometimes needed help with math problems (see Figure 3.5). Majority of the students responded that math is only a little bit too hard for them (see Figure 3.6) and that they sometimes talk with others about math (see Figure 3.7).

*Figure 3.1. Graph of Pre-Survey Question 1 Results*
Figure 3.2. Graph of Pre-Survey Question 2 Results

Figure 3.3. Graph of Pre-Survey Question 3 Results
Figure 3.4. Graph of Pre-Survey Question 4 Results

Figure 3.5. Graph of Pre-Survey Question 5 Results
When we started this action research project, we were learning about fractions. As we were exploring our key concept for the day, one student asked,
“What is an improper fraction? I forget!” I asked the class if anyone would be able to explain what an improper fraction was and another student nicely described it by saying, “when the numerator is bigger than the bottom number, the denominator”. I thanked the students and told the class that I thought that was an important word and I would like to hear it during our math talk in our groups. I asked the student who originally forgot what an improper fraction was to write it on an index card and then I hung it up on the “Words we’re using now” section of our Math Talk board. This improper fraction vocabulary card would be the first of many to get hung up on our Math Talk board.

The following day, I introduced the “Math Recaps” and we created our “Recap Docs”. I started this discussion by talking about the recap at the beginning of a television show. The students knew exactly what I meant and offered input such as “it tells you what happened” and “it reminds you about the show so you’re ready for what’s next”. I made the connection to our reflections by telling the class that our recaps would be a way for us to think and write about what we did during math class, including who we worked with and what we discussed together while we were working. There were no complaints from any of the students and they all seemed open to this type of reflective process.

In order to keep a running document of our recaps, I had each student create a Google Doc in which they would add the date and the answers to our recap questions each time we conducted our reflections. The students answered
the same four questions every time we completed a recap. This was an effective way for me to gauge any changes in their responses as they worked collaboratively and used new mathematical language in their conversations. The questions were projected on the board and the students were simply asked to add the date to their Google Doc and number their answers (see Figure 4 or Appendix F). On this day, we did not have time to complete our recap, instead we only created our Google Docs and discussed what we would do during the next class when we would complete our first recap.

<table>
<thead>
<tr>
<th>Math Recap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer the following questions in your &quot;Math Recap&quot; Document with today's date.</td>
</tr>
<tr>
<td>1. How do you feel about what we did today in math?</td>
</tr>
<tr>
<td>2. What were your math conversations about today?</td>
</tr>
<tr>
<td>3. Did you use any literacy strategies today while you were reading math problems? If so, what strategies do you think you used?</td>
</tr>
<tr>
<td>4. What are your suggestions or questions right now?</td>
</tr>
</tbody>
</table>

*Figure 4. Math Recap Questions Slide*
Too Many Interruptions

This study began on September 13, which was the day we completed the assent and consent forms and I was able to begin collecting data and diving into my action research. This was, ironically, the thirteenth school day of the school year. Understandably, there are a lot of other things going on at the beginning of the school year, such as assemblies and other introductions to the school. After that first day of the study, we did not have math instruction on four other school days, and that was just in the month of September. The reasons for the lost instructional time were the administration of the SLO, schools closed for Yom Kippur, early dismissal with a lock-in/lock-down drill, and a school-wide walk-a-thon. After this first full month of school, I was feeling a bit scattered and stressed that this study was not going to go well due to constant interruptions. I was trying to put into place strategies and norms within our math classroom, which ironically had provided no normalcy at all, so I began to question how effective these structures could be.

Compounding the stress of a fragmented launch to the new school year, I was faced with the challenge of adapting to new team dynamics and an unfamiliar schedule. We had an extremely long morning as part of our new schedule for this school year. I was teaching three math classes in the morning, with each class lasting for 70 minutes. When including the first 30 minutes of student arrival and homeroom, I was working with students for 240 minutes straight. I was only
conducting this study with the first of my three math classes and I began to worry that I would have a hard time keeping accurate notes and reflections on that class when I had two other classes immediately following the first. After consulting with my colleagues and professor, I decided I would need to keep my field log open and type in anything that seemed important to my study as quickly as I could.

Although there were many obvious interruptions throughout the beginning of this study, there were also many others lurking beneath the surface. I focused on one student, Jenny, who I knew had a lot going on outside of school and also had a difficult time focusing. Academically, she had already been held back one year in elementary school, so she was a year older than most of the other sixth grade students. The previous year, when she was in fifth grade, she failed most of her academic subjects, but was still promoted to sixth grade despite those grades. She was aware of this situation and mentioned once that someone at home told her that the school passed her out of pity. She also mentioned that her uncle killed himself because of drugs, which we later found out from her mother was true. It was a devastating loss for their family and clearly had an impact on Jenny as well. The fact that her mom confirmed this was very important to us because Jenny told a lot of stories and we never knew what we could actually believe. We had been very concerned about a repeated story she told us about going to a park with a high school student. The situation seemed unsafe and inappropriate. We had
relayed all of her stories to our guidance counselor to look into further. She was very distracted during class and rarely had any homework done, which resulted in very low grades, including many zeroes. These distractions needed to be considered just as seriously as schedule interruptions. Jenny was just one example of how distracted a student could be in their own minds, and I needed to consider this for each student in my class.

**Taking Initiative**

Despite many interruptions in our schedule, the students began taking initiative and truly investing in the structures and routines of this research project. In the beginning of October, we had established a routine to complete our Math Recaps and to add words to the “Math Talk” board. Throughout that month, I noticed that the students began to take more initiative, especially with the “Math Talk” board. They also started to make meaningful connections between the vocabulary words we were adding to the “Math Talk” board and the conversations they were having with each other while they worked collaboratively, as evidenced by the conversation in Table 1.
Table 1: Student/Teacher Conversation: “Math Talk” Vocabulary Words

<table>
<thead>
<tr>
<th>While writing a Math Recap...</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ben:</em> Can we talk about the words we added to the board that we’re using?</td>
</tr>
<tr>
<td><em>Mrs. Glase:</em> Absolutely! What a great idea!</td>
</tr>
<tr>
<td><em>Ben</em> turned around to look at the board while smiling brightly, then quickly turned back to his Chromebook to start typing.</td>
</tr>
</tbody>
</table>

During a discussion about the literacy strategies we could possibly use during math, we decided to create a list on the board that we could reference again later. Several different students contributed to our discussion and came up examples of literacy strategies. We discussed rereading as a good strategy to use with both word problems and directions. Many students agreed that they often needed to reread or if they did not reread, they might not answer the problem correctly. Students thought using context clues would help us understand math problems and make connections. We discussed that the connections we made would also help us visualize what was happening in each math problem. We planned to revisit the list of strategies throughout the rest of the study (see Figure 5).
When we started Topic 2, I had moved all of our vocabulary words from the Math Talk board over to the “Math Survival Words” board. I pointed out that we will probably still use many of those words, even though they would no longer be our focus. I explained that if they came across a word that should be put up on the “Math Talk” board as we started our new topic, they should let me know so they could fill out a card with that word. When we went over our key concept, a few students offered to make the obvious cards for our new vocabulary words integers and opposites. Then several other students raised their hands and offered...
less obvious words such as distance, positive, negative and number line. I was impressed and proud of these words and I hung them up on the board immediately! The students worked well together and used these words in their conversations as they worked. Many of the students expressed that they felt confident with this lesson and two students added to our graffiti wall (a paper on the door where they could write anything they wanted to share) about how fun and easy math class was (see Figures 6 and 7).

Figure 6: Photo of Graffiti Wall (a)
At this point, we had already completed five Math Recaps. The students began to notice that I was leaving comments on their Google Docs in response to their answers, which was a feature that I loved about using Google Docs. There was an exciting conversation as one student looked over her Math Recap document (see Table 2).
Table 2: Student/Teacher Conversation: Comments in Math Recap Document

<table>
<thead>
<tr>
<th>While reviewing a Math Recap document...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jasmine:</strong> Mrs. Glase, I really like how you write comments to us and give us feedback!</td>
</tr>
<tr>
<td><strong>Mrs. Glase:</strong> I love it, too! It’s so easy in a Google Doc to talk to each other!</td>
</tr>
<tr>
<td><strong>Jasmine:</strong> That’s so cool!</td>
</tr>
</tbody>
</table>

As we continued in our study, I started to observe palpable excitement as we came up with new words that the students thought should be on our word wall. Without even a suggestion from me to think about new vocabulary words, students began offering some ideas. Before I knew it, students were raising their hands and shaking their arms to be called on to suggest a new word that they thought was important enough to be used in our math conversations. They were then able to write the word on a card and I hung it up on the word wall. Their excitement was contagious and I was impressed with their thoughts! They were not simply choosing random words that we might need to hear in our conversations. The students came up with incredibly important and useful words such as: *absolute value, distance, number line, positive* and *negative*. Even though they might have already known some of these words, such as positive and negative, they were still incredibly important. Sullivan (1982) referred to the importance of even the smallest words that could have different meanings in
mathematical context throughout her study. I knew that my students were on the right path thinking about the words and phrases they were going to be using in their math conversations and I was extremely happy to hang up these new cards!

**Focus on Vocabulary**

At this point in the study, it started to become apparent that vocabulary needed to be the central focus. As a major literary component, vocabulary was impacting our comprehension, conversations and reflections. I was confident in the growing importance of our “Math Talk” board, which had become a truly interactive word wall. A lot of the research that influenced my study stressed the importance of word walls for secondary students. For example, Gore (2010) supported students being actively involved in adding words and creating visuals for interactive word walls. Yates, Cuthrell and Rose (2011) shared their success with collaborative content-area word walls in their classrooms and hallways. My students were adding to and referencing our word wall daily.

During conversations and collaborative problem solving, students could look at the words on our board if they forgot how to explain what they were doing, or needed a reminder of the steps to solve the problems. Even if a student looked at the “Math Talk” board, chose a word and started trying to use it in a conversation with a peer, that could lead to a meaningful mathematical conversation. As the students talked during what Dewey (1938) referred to as important social experiences, they would ultimately share their thinking and
processes with each other. This incredible learning experience could be sparked by a simple vocabulary card on our word wall. As described earlier, *positive* and *negative* were two vocabulary words that were added to our word wall at this point in the study. As the students worked together, I heard notable and helpful conversations in which these words were included (see Figure 8).

![Figure 8: Pastiche of Student Conversations (a)](image)

The vocabulary on our “Math Talk” board was also helpful during student reflections. Our Math Recaps, which at first were set up as a means to collect data, had become a vital process of reflection. While answering each of our four Math Recap questions, students were challenged and encouraged to “organize and
consolidate their understanding” (Sturgeon, 2017, p. 557). When answering the question “What were your math conversations about today?”, many students referenced the “Math Talk” board to see which important vocabulary words they had used throughout their conversations that day. In relation to the same lesson discussed above, 49 percent of the students stated that they used the word positive and 52 percent stated that they used the word negative. Four other vocabulary words from our board were also identified in the answers to the math conversation question. This verified my belief that vocabulary had become an integral part of my study.

We’re on Fire!

Around the same time that I realized my study should have more of a focus on vocabulary, I started to see a clear increase in confidence, through conversations between students and outright desire to help others understand. One student asked me if she could go to another table to help someone. This was a student who didn’t usually exhibit much confidence so I was happy to let her take charge and help others! I was also reading a lot of positive feelings in our Math Recaps (see Figure 9).
These responses were near the end of Topic 2. After the Topic 2 test, I made some analytical notes and comparisons. I looked back at our Topic 1 test results in which only 52 percent of the students passed and compared that result to our Topic 2 test in which 81 percent of the students passed. The first question on both tests was a vocabulary question asking the students to match each vocabulary word to its definition. Partial credit was offered and I analyzed each term to see the breakdown of correct versus incorrect answers. On the Topic 1 test, there were five vocabulary words and on the Topic 2 test, there were nine vocabulary words.
The average score for the vocabulary on the Topic 1 test was 53 percent correct, but on the Topic 2 test the average score was 71 percent correct. I was very hopeful that the increase I was seeing in scores and vocabulary could have a close correlation to our increased use of vocabulary in our math conversations.

After our Topic 2 test, similar to when we finished Topic 1, I moved all of our vocabulary cards from the “Math Talk- Math words we’re using” board over to our “Math Survival Words” board. By the end of this second topic, we had 35 vocabulary words that were important enough to our math conversations to hang them on the board (see Figure 10). The students were a bit shocked to see the “Math Talk” board looking so empty again, but we quickly started to fill it up as soon as we dove into Topic 3.
During the first and second lessons of Topic 3, the students came up with more than twelve vocabulary words and phrases that they thought we should be using during our math conversations. Some of these words and phrases included: power, evaluate, base, exponent, repeated multiplication, composite numbers, factor tree, GCF, LCM, prime number and prime factorization. After we began practicing, there was a wide range of confidence levels with the skills we were using, but as we continued working collaboratively, student understanding increased. Responses from our Math Recap at the beginning of the lesson
reflected the range of confidence levels (see Figure 11) and the pastiche of student conversations is evidence of the collaboration and understanding of vocabulary and concepts (see Figure 12).

Figure 11: Math Recap Responses (b)
As I walked around the room to check in with groups, one student hadn’t started his work yet. When I asked him why he hadn’t started, he explained that he wanted to help the student sitting next to him. I asked if he had already finished and he said “He needed help, so I wanted to help him solve this problem first. I can finish my work after we’re done.” When I heard this response, my heart was full of pride! Not only were my students working hard together, using math vocabulary appropriately and practicing their math skills, but they were also
developing compassionate and kind tendencies to help others before helping themselves. This was part of a hidden curriculum that I had not expected.

As we continued in Topic 3 and learned about the order of operations and how to solve numerical expressions, the students continued working together and having mathematical conversations, and we referenced our list of literacy strategies throughout our lessons. The students also continued creating vocabulary cards to add to our “Math Talk” board, including words and phrases that would help us remember the steps to solving numerical expressions, such as the “Triple O Cupid Shuffle”, which was a song and dance about each step. As we got ready to complete our next Math Recap, I reminded the class “You are reflecting on you. This should be a quiet time for you to think about how and what you learned today and then write about it.”. This was something that I would continue to remind them when we completed Math Recaps. I wanted to make sure they understood the importance of reflection, just as I had learned when conducting my research, and grasped that they were doing more than simply answering questions for me, but they were thinking metacognitively about their own learning. Through this Math Recap I was able to see some varied levels of confidence with this topic. Most students who said they started out confused, felt better after they practiced with a few different problems. There were a few students who said they needed more help, and one who even asked if I could help her. This allowed me to
bring a few students in during lunch or after class to help them clear up any confusion. (See Figure 13)

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure13}
\caption{Math Recap Responses (c)}
\end{figure}

As we finished up our work with numerical expressions, I heard a lot of helpful conversations between students who were working together. I was beginning to hear a lot of encouragement along with our vocabulary and the steps to solve numerical expressions. As two students worked together and finished solving a problem, one exclaimed “boom shaka laka” with pride and confidence! I was also hearing kind and considerate explanations. Students were not judging
each other if someone didn’t understand. Instead, they were breaking down each step to help each other (See Table 3). This was more evidence of the hidden curriculum I had started to see earlier!

Table 3: Student/Student Conversation: Solving Numerical Expressions

<table>
<thead>
<tr>
<th>While explaining their steps to solving numerical expressions...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student A:</strong> She said two to the power of three is eight, but it’s six.</td>
</tr>
<tr>
<td><strong>Student B:</strong> No, because two to the power of three is two times two times two, which is eight, not two times three.</td>
</tr>
<tr>
<td><strong>Student A:</strong> Ohhhh!!!</td>
</tr>
</tbody>
</table>

A Little Distracted…

As we glided on through Topic 3 and began one of my favorite strands of mathematics, Algebra, I was feeling proud of my students and confident in my action research study and how it was playing out in my classroom. And then… winter happened. We started out strong, adding words and phrases to our “Math Talk” board, such as, *algebraic expression, variable, term* and *coefficient*. The students also added words that they already knew but would be using a lot in conversations, such as *product* and *quotient*, and even created cards for the new symbols for multiplication. During our math period that day, the principal made an announcement that we would be getting out early due to implement weather, which made the students very excited and distracted. It was difficult to keep them
focused for the rest of the class period. The next day was a snow day as well, followed by the weekend.

When we returned to school the following week, we only had two days before Thanksgiving break and both of those days were early dismissals for student-led conferences. On early dismissal days we still get to see all of our classes but the periods are shortened. Although this still left me with a good amount of time, it was hard to keep our normal routine going. I wanted to make sure all of my students had their portfolios ready with as much academic information as possible in order for them to take control and lead their conferences. I must admit that I did not even make an entry into my field log on either of these days. I began to worry that our progress might suffer, but I had to be hopeful that we would be able to pick back up where we left off after the Thanksgiving break.

When we returned, I had planned to review what we had learned before our snow days and break. The students needed a lot of redirecting since it was the first day back from a long break. We spent our time reviewing and finishing up online work in order to get ready for their quiz the next day. Several students were helping each other, but others were distracted with conversations unrelated to our math processes. A few students asked me for help since they forgot what to do for certain problems. Finally, we completed our first Math Recap in 15 days and I reminded students that the answers should not just be yes or no and that they
should be telling me about what they did that day and reflecting on how they used their math time. I was hoping for redemption from some students who I thought were very distracted and I knew this could be their opportunity to prove me wrong and explain what their math conversations were about. One student did say that they got a little off-topic, but that they understood everything they were doing. One student said that since we had such a long break, she forgot how to do some of the work she needed to finish. I thought this was a great example of metacognition that she was able to realize and admit that. Some students talked about helping other students, which is exactly what I was hoping to find out! Finally, many students felt happy that they were able to finish up their work. I was relieved that most students felt confident and ready for their quiz (see Figure 14).

Figure 14: Math Recap Responses (d)
“How am I supposed to do this?”

After our quiz on algebraic expressions, we started a new concept of substituting values for variables so that we could solve algebraic expressions. We discussed this as getting the next piece of the puzzle. Now that we had all the pieces of the puzzle, we were able to solve all of the expressions. Most students seemed ready for this step in the process of algebraic expressions. As we went over our key concept, I mentioned that the word *substitute* now had a new math meaning for us. Immediately about five students called out “Can I make a card for it?”! We ended up adding the new vocabulary words *substitution, replace, plug in, simplify, numerical value* and *numerical expression*. Students also suggested a few words and phrases that were already on our “Math Talk” board, such as *expression* and *value*. We discussed the importance of these words, which was clear because we wanted to use them more than once. As the students worked on problems in their workbooks, they were able to work together and help each other. Students discussed that this next step made sense after what we had already learned.

As I tried to reflect on what happened while the students worked together, I found myself getting frustrated because I was mixing up my three different math classes. I was worried that I wasn’t going to have enough evidence of the important conversations and use of vocabulary and literacy strategies in my classroom to share through my action research. I discussed my concerns with my
colleagues and professor. They suggested that I try to record as many quotes and pieces of information as I could during class. Although I mostly relied on my computer, they suggested that I keep a paper and pencil notebook as another means to record quickly. We also discussed the best way that I could reflect on all of the Math Recaps that my students were completing. I knew that these would be invaluable sources of information but I was feeling a little overwhelmed trying to figure out how to sort through all of that information. I decided to create a memo, in which I would analyze what vocabulary was being used, summarize the feelings of the students and record important quotes. The next day, I immediately began recording as much of the student conversations that I could. As our Math Recaps continued, I was very comfortable with my new approach to transmitting and recording my students’ responses.

The Saga Continues

In the final month of my action research study, our routines became stronger than ever. I started to see the students internalizing the process of metacognition and talking through the steps as they solved problems. As we worked on writing equivalent expressions, students volunteered to come up to the board and solve problems where we were substituting and evaluating different expressions to eventually see if they were equivalent or not. When the students came up to the board, they were able to solve these two or three step problems just by talking out loud through the problems and then finding the final answer to
fill in our table. I told the students that I was very impressed and proud of them for being able to solve those different steps in their heads and explain what they were doing to find the answer! We continued working together in groups and then when we completed a Math Recap, I reminded the students that they were quietly reflecting on their experience that day. There was some apparent confusion and frustration throughout the Math Recaps, but there was an overall understanding that they needed to practice more in order to understand better (see Figure 15).

Figure 15: Math Recap Responses (e)

The next day, we went over the workbook page together and helped each other explain and solve each of the problems. Students used vocabulary words
that we had added to the “Math Talk” board such as \textit{distribute}, \textit{substitute} and \textit{evaluate} while we explained each problem. After we completed these together, students were able to work with their group to complete the online work. There were many conversations and a lot of mutual helping amongst the students (see Figure 16). Most of the scores for the online practice were extremely high and students expressed feeling much better about this lesson than they had felt the day before.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{student_conversations.png}
\caption{Pastiche of Student Conversations (c)}
\end{figure}

As we continued working with algebraic expressions, we discussed simplifying algebraic expressions by combining like terms. After we went over
our key concept, I asked if anyone thought we should add any more words or phrases to our “Math Talk” board, which I pointed out was full of awesome words and phrases that we were using. The students created cards for variable part, like terms, common variable, and combine. They also mentioned several words that were already on our board, such as equivalent, expressions, simplify and variable. I thanked them for reminding us that we should have still been using those important words! Once we were ready to practice the new concept in our workbooks, students came up to the board to identify the like terms and then combine them. We used the name picker to spin for random student volunteers and they loved using that! One student would circle the like terms using one color marker and other like terms in a different color and then another student would come to the board to combine the like terms and write our equivalent expression.

With a shortened schedule and after going over homework, we did not have time to finish our workbook together or complete our final Math Recap. We picked up with our collaboration the next day. Although the students started out very quiet and tired, once we started using the name picker to have students explain each step of the problems we were going over, they got more excited and were able to explain the steps. The students expressed that they were feeling much better about this lesson than the previous lesson and that they were ready to get going on their online work. As they completed their online practice, they were allowed to work together and help each other. A few students seemed to be
unfocused and talking about unrelated things. When we stopped to do our Math Recap, I reminded students that they should reflect on their experience that day and what they did to help their learning. I also reminded them that this was where they could prove to me that they were having math discussions by sharing what their conversations were about. In this Math Recap, almost every student wrote about feeling more confident and comfortable with the current math problems. Many said that at first it was challenging, but it got easier. There were also a lot of comments about working together, enjoying working together and appreciating other students that worked with them. These comments made my heart melt! I was so proud of the collaboration and kindness that I read in these Math Recaps—especially after I felt that some of the groups had been off task. I was so glad the students were able to relay their feelings and accomplishments with me through this Math Recap, and that they were all feeling more confident with the work that we were completing (see Figure 17).
Before I wrapped up my study, we concluded and reviewed Topic 3, completing the post-survey and our Topic 3 test. After analyzing the Topic 3 test, which 72 percent of the students passed, I was able to compare the vocabulary analysis for all three topics. This provided evidence of an increased understanding of the math vocabulary. On the Topic 1 test, the average score for the vocabulary was 53 percent correct. On the Topic 2 test, the average score for the vocabulary was 71 correct. On the Topic 3 test, the average score for the vocabulary was 75 percent correct (see Figures 18, 19 and 20).
Figure 18: Topic 1 Vocabulary Analysis Graph

Figure 19: Topic 2 Vocabulary Analysis Graph
After we completed the post-survey, in which the students answered the same questions that they had answered on the pre-survey at the beginning of the study, I was able to analyze those answers and compare them to the answers from the beginning of the study. For the most part, I saw an increase in vocabulary understanding and implementation of reading strategies and a decrease in feelings of struggle (See Figures 21 and 22).
Figure 21: Comparison of Pre-Survey and Post-Survey
Although this action research study had come to an end, the procedures and processes had become part of our classroom routine. The only “ending” to the study was that the students completed their post-survey. After that, we continued to use the “Math Talk” board, adding vocabulary words even when I almost
forgot about it! We did not add any words for one of our lessons and during the following lesson, one of my students asked if we could still add new vocabulary cards to the board and we have continued to do so ever since. Math conversations are always encouraged while we work together and my students enjoy helping each other and explaining their math processes. The implementation of literacy strategies, especially vocabulary, collaborative mathematical conversations, and student and teacher reflection has become the norm within my mathematics classroom, which I believe is exactly how it should be!
Data Analysis

Student Surveys

In this study, the students completed a pre-survey at the beginning and a post-survey at the end. The pre-survey and post-survey were comprised of the same Likert scale questions in order to provide a clear comparison from the beginning of the study to its conclusion. These seven questions asked the students to rate their feelings towards mathematics, word problems, reading strategies, vocabulary, confidence and collaborative conversations. These Likert scale questions were followed by several open-ended response questions. Most of these open-ended questions were the same on the pre- and post-surveys. In the pre-survey, some of the open-ended questions asked for suggestions or ideas from the students about certain aspects of our mathematics classroom, such as what would help the students feel more confident or what strategies might be useful for them when they learn vocabulary. In the post-survey, the open-ended questions prompted the students to discuss specific parts of the study, for example, strategies that they used, or experiences and conversations they had with other students.

Once the post-survey was completed, I was able to analyze and compare the student responses. These responses, directly from the students involved in this study, were proof of increased implementation of reading strategies, increased confidence, and increased mathematical conversations (see Table 4).
Table 4: Student Survey Results Comparison

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Pre-Survey: Most Common Response</th>
<th>Post-Survey: Most Common Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you feel like you struggle when reading math problems?</td>
<td>3- Sometimes</td>
<td>3- Sometimes</td>
</tr>
<tr>
<td>2. Do you ever use reading strategies during math?</td>
<td>1- Not at all</td>
<td>3- Sometimes</td>
</tr>
<tr>
<td>3. Do you feel like you understand our math vocabulary so far?</td>
<td>5- Yes, all the time</td>
<td>5- Yes, all the time</td>
</tr>
<tr>
<td>4. Do you feel confident in your math skills?</td>
<td>3- Sometimes</td>
<td>5- Yes, all the time and 3- Sometimes</td>
</tr>
<tr>
<td>5. Do you feel like you usually need help with math problems?</td>
<td>3- Sometimes</td>
<td>2- A little bit and 3- Sometimes</td>
</tr>
<tr>
<td>6. Do you feel like math is too hard for you?</td>
<td>2- A little bit</td>
<td>1- Not at all</td>
</tr>
<tr>
<td>7. Do you talk with others about math?</td>
<td>3- Sometimes</td>
<td>5- Yes, all the time</td>
</tr>
</tbody>
</table>

The open-ended questions on the pre- and post-survey allowed the students to elaborate on their feelings, which Likert scale questions did not. The open-ended response that stood out the most from the pre-survey was from a student who stated a need for collaboration by saying that she would feel more confident if someone helped her (see Figure 23).
Overall, when comparing the pre- and post-survey results, there was a clear increase in confidence, as evidenced in the student responses to several of the survey questions. One of the questions directly asked the students to “tell me about your confidence level in math” and all but two of the responses to that question were positive and expressed feelings of confidence. The students also identified new literacy strategies on the post-survey, which were not identified in the pre-survey including rereading, making connections, using context clues and removing extra information. Many students referred to the “Math Talk” board and the vocabulary words that we hung on that board as strategies that they used or important parts of their conversations (see Figure 24). Several students noted that hearing others explain their steps to solving problems made it easier for them to understand. One of the questions on the post-survey was, “Did it help you understand when I explained my thinking as we went through math problems?” Many of the responses to this question pointed out that not only my explanations were helpful, but also the explanations from their peers (see Figure 25). This was
also clear through Nate’s response that talking helped him understand problems (see Figure 26). Finally, as evidence of increased metacognition, one of the student’s post-survey responses was that even though she didn’t feel very confident, she was aware of her processes (see Figure 27).

*Figure 24: Student Survey Responses Referring to the “Math Talk” Board*
Observational Data

Throughout this study, I kept track of observational data in my field log. My observations focused mainly on collaboration between students. As the study progressed, I realized that I needed to keep track of the conversations I was hearing between students. I tried to do this by typing direct quotes into my field log.
log, which I could later reflect on and analyze. These quotes became a great source of data. I was able to hear through their conversations whether or not students understood concepts enough to be able to explain them to their peers as well as use the important vocabulary we had put on our “Math Talk” board (see Figure 28). I was also able to hear some misconceptions. Sometimes other students cleared up the misconceptions for their peers, but if not, I was able to explain correctly. My field log was also a way for me to keep track of which lessons we were learning, what days we completed Math Recaps, testing dates and schedule interruptions (see Figure 29).

![Figure 28: Field Log: Sample of Student Conversations](image_url)
Math Recap Data

Our Math Recap documents became the most important and generative method of data collection throughout this study. Before the study began, reflection was not necessarily one of the top priorities. However, once we created the Google Docs to house our reflections each time we answered the Math Recap questions, I realized just how valuable it was going to be. The four questions that we answered each time we completed a Math Recap focused on different aspects of this action research study. The first question, “How do you feel about what we did today in math?” focused on confidence. The second question, “What were your math conversations about today?” focused on mathematical content. The
third question, “Did you use any literacy strategies today while you were reading math problems?” focused on the implementation of literacy strategies and finally, the fourth question, “What are your suggestions or questions right now” allowed the students a safe place to ask any questions, clear up any concerns or make other suggestions. There is a clear increase in metacognition in these responses from early in the study to the end of the study. The students discussed their feelings and were able to ask specific questions in order to make their learning environment ideal. See Table 5 for student responses to all four of these questions throughout the study.

<table>
<thead>
<tr>
<th>Math Recap Question</th>
<th>Focus of Question</th>
<th>Student Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How do you feel about what we did today in math?</td>
<td>Confidence</td>
<td>10/3: “It was fun and easy.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10/22: “It was surprisingly easy because last year I never understood things like this because it was never broken down, but now that it is, I understand it.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10/24: “I feel good about what we did in math I was pretty good at it and I answered a lot of the questions that Mrs. Glase asked and I got a Charger Dollar.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11/12: “I felt like I could get used to this type of math.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12/6: “I feel good because I got a 100% on MathXL.”</td>
</tr>
</tbody>
</table>
2. What were your math conversations about today?

<table>
<thead>
<tr>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/3: “About how you use the reciprocal on the second fraction.”</td>
</tr>
<tr>
<td>10/15: “Our conversations were about decimals and fractions.”</td>
</tr>
<tr>
<td>11/7: “My math conversation was about the factor tree and how to determine which numbers are prime and which are composite numbers.”</td>
</tr>
<tr>
<td>11/27: “Our conversations were about PEMDAS, we also did get a little off topic but we still understand everything.”</td>
</tr>
<tr>
<td>12/6: “Evan and Amy helped me, mostly our whole table helped each other.”</td>
</tr>
</tbody>
</table>

3. Did you use any literacy strategies today while you were reading math problems? If so, what strategies do you think you used?

<table>
<thead>
<tr>
<th>Literacy Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/10: “I crossed out any useless information to narrow the problem.”</td>
</tr>
<tr>
<td>10/15: “Reread the problem.”</td>
</tr>
<tr>
<td>10/15: “I made connections to the text to better understand the problem.”</td>
</tr>
<tr>
<td>10/17: “I visualized to help better understand the problems.”</td>
</tr>
<tr>
<td>10/17: “I crossed out extra info that I didn’t need.”</td>
</tr>
<tr>
<td>11/12: “I used a strategy because when I was reading the problem it didn’t make any sense but when I kept reading, it made sense.”</td>
</tr>
</tbody>
</table>

4. What are your suggestions or questions right now?

<table>
<thead>
<tr>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/2: “I suggest we do this more (:”</td>
</tr>
<tr>
<td>10/4: “My suggestions are that we should have a paper that says how you can do it, so whenever we forget, we could use our paper.”</td>
</tr>
<tr>
<td>10/22: “We need different math groups.”</td>
</tr>
<tr>
<td>11/7: “I was really confused on the [factor] trees so I think we should do it often so I can improve on it.”</td>
</tr>
<tr>
<td>12/6: “I helped Adam with some of his problems and working with him is fun.”</td>
</tr>
<tr>
<td>12/6: “I have no questions but to make harder questions!”</td>
</tr>
</tbody>
</table>
Test Scores and Data

Throughout this study, we completed the first three topics of our sixth-grade curriculum. On each of the topic tests, the first question was a compilation of the most important vocabulary used during that topic. These questions were set up so that the terms and definitions were provided and the students needed to match each term with its definition. For each of the three topic tests, I analyzed the vocabulary questions in great detail. I looked at how many students chose each definition for a given vocabulary word. I also compared the amount of terms answered correctly for all three tests (see Figures 18, 19 and 20). Although the vocabulary was a major focus in this study, the mathematical content was equally important. I analyzed the overall test scores for each of the three topic tests as well, which I was then able to compare at the end of the study. The topic 2 test was the peak outcome with 80 percent of the students passing. This test also occurred during the heart of the study: 29 instructional days into the study, and with 21 instructional days left in the study. This showed a sizeable increase in passing scores from the topic 1 test, which was only 54 percent. Finally, the topic 3 test results were very close to topic 2, with 72 percent of students passing (see Table 6). Overall, a clear increase of passing test scores resulted as the routines of this study became norms in our classroom.
Table 6: *Overall Test Grade Comparisons*

<table>
<thead>
<tr>
<th>Test</th>
<th>Percentage of students who passed</th>
<th>Percentage of students who failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 1</td>
<td>54 percent</td>
<td>46 percent</td>
</tr>
<tr>
<td>Topic 2</td>
<td>80 percent</td>
<td>20 percent</td>
</tr>
<tr>
<td>Topic 3</td>
<td>72 percent</td>
<td>24 percent</td>
</tr>
</tbody>
</table>

**Coding for Themes**

Near the end of this study, I began to code my data and look for emerging themes that were recurring across documents. The documents that I analyzed for these themes included my field log, completed student pre-surveys, my recap memo with content from student Math Recap responses, test and vocabulary analysis from all three topic tests, and completed student post-surveys. The themes that became the most prevalent and important throughout all of these documents were *collaboration, confidence, literacy strategies, math talk, vocabulary identification and vocabulary usage* (see Figures 30, 31 and 32). These results confirmed beyond a doubt that the implementation of literacy strategies, collaboration, and math talk resulted in a notable increase in confidence among my students.
### Coding Index

**Documents:** Field Log- **FL**, Post-Survey- **TS**, Pre-Survey- **PS**, Recap Memo- **RM**, Topic 1 Test Analysis- **T1**, Topic 2 Test Analysis- **T2**, Topic 3 Test Analysis- **T3**

<table>
<thead>
<tr>
<th>Codes</th>
<th>Documents &amp; Page Numbers</th>
<th>Related Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active Engagement</strong></td>
<td><strong>FL:</strong> 1, 7, 10, 11, 12, 13, 14, 16, 17, 18, 19, 21, 22, 24&lt;br&gt; <strong>TS:</strong> n/a&lt;br&gt; <strong>PS:</strong> 39&lt;br&gt; <strong>RM:</strong> 3, 5, 6, 7, 8</td>
<td>Collaboration, Confidence, Reflection, Math Talk</td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td><strong>FL:</strong> 1, 2, 7, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24&lt;br&gt; <strong>TS:</strong> 4, 6, 8, 10, 12, 14, 16, 18, 22, 24, 26, 28, 30, 32, 34, 36, 42, 44, 46, 48, 50&lt;br&gt; <strong>PS:</strong> 3, 7, 9, 11, 13, 21, 25, 33, 35, 39, 41, 47, 51, 53&lt;br&gt; <strong>RM:</strong> 3, 5, 6, 7, 8, 9, 10</td>
<td>Active Engagement, Math Talk, Enjoyment</td>
</tr>
<tr>
<td><strong>Confidence</strong></td>
<td><strong>FL:</strong> 2, 13, 14, 18, 19, 21, 22, 23, 24&lt;br&gt; <strong>TS:</strong> 3, 4, 6, 8, 10, 12, 14, 18, 22, 24, 26, 28, 30, 32, 34, 36, 40, 42, 44, 46, 48, 50&lt;br&gt; <strong>PS:</strong> 1, 3, 35&lt;br&gt; <strong>RM:</strong> 2, 3, 4, 5, 6, 7, 8, 9, 10&lt;br&gt; <strong>T1:</strong> 1, 2, 3&lt;br&gt; <strong>T2:</strong> 1, 2&lt;br&gt; <strong>T3:</strong> 1</td>
<td>Enjoyment, Teacher Pride</td>
</tr>
<tr>
<td><strong>Connections</strong></td>
<td><strong>FL:</strong> 11, 17&lt;br&gt; <strong>TS:</strong> 38&lt;br&gt; <strong>PS:</strong> n/a&lt;br&gt; <strong>RM:</strong> 4</td>
<td>Literacy Strategies, Resources, Vocabulary Identification, Vocabulary Usage</td>
</tr>
<tr>
<td><strong>Enjoyment</strong></td>
<td><strong>FL:</strong> 1, 3, 7, 11, 13, 14, 15, 18, 24&lt;br&gt; <strong>TS:</strong> 14, 24, 34, 36, 42, 44, 50&lt;br&gt; <strong>PS:</strong> 9, 11, 25, 41, 43, 45, 51&lt;br&gt; <strong>RM:</strong> 3, 4, 6, 7, 8, 9, 10</td>
<td>Active Engagement, Collaboration, Confidence</td>
</tr>
<tr>
<td><strong>Interruptions</strong></td>
<td><strong>FL:</strong> 1, 2, 3, 13, 14, 20, 21&lt;br&gt; <strong>TS:</strong> n/a&lt;br&gt; <strong>PS:</strong> 49&lt;br&gt; <strong>RM:</strong> 8</td>
<td>Student Frustration, Teacher Frustration</td>
</tr>
</tbody>
</table>

*Figure 30: Coding Index Page 1*
<table>
<thead>
<tr>
<th>Codes</th>
<th>Documents &amp; Page Numbers</th>
<th>Related Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Literacy Strategies</strong></td>
<td></td>
<td>Connections, Math Talk, Resources, Vocabulary Identification, Vocabulary Usage, Comprehension, Fluency</td>
</tr>
<tr>
<td>FL: 1, 2, 11</td>
<td><strong>PS:</strong> 1, 4, 9, 10, 11, 12, 13, 16, 22, 28, 32, 34, 36, 52, 53</td>
<td><strong>TS:</strong> 1, 3, 4, 6, 7, 8, 10, 11, 17, 19, 23, 25, 31, 35, 43, 49 <strong>RM:</strong> 2, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>Math Talk</td>
<td><strong>FL:</strong> 2, 10, 12, 14, 16, 18, 19, 20, 21, 22, 23, 24, 25</td>
<td><strong>TS:</strong> 6, 8, 10, 12, 18, 28, 32, 34, 38, 50 <strong>PS:</strong> 3, 37, 47 <strong>RM:</strong> 5, 6, 7, 8, 10 <strong>T2:</strong> 2</td>
</tr>
<tr>
<td>Metacognition</td>
<td><strong>FL:</strong> n/a</td>
<td><strong>TS:</strong> 6, 8, 18, 24, 26, 28, 30, 32, 42, 44, 48, 50</td>
</tr>
<tr>
<td>Reflection</td>
<td><strong>FL:</strong> 10, 11, 17, 18, 19, 20, 23, 25</td>
<td><strong>TS:</strong> n/a <strong>PS:</strong> n/a <strong>RM:</strong> 2, 4, 8, 9</td>
</tr>
<tr>
<td>Resources</td>
<td><strong>FL:</strong> 11, 12, 13, 16, 17</td>
<td><strong>TS:</strong> 10, 36 <strong>PS:</strong> 5, 25, 29, 39, 43 <strong>RM:</strong> 6, 7 <strong>T2:</strong> 2</td>
</tr>
<tr>
<td>Student Confusion</td>
<td><strong>FL:</strong> 3, 4, 13</td>
<td><strong>TS:</strong> n/a <strong>PS:</strong> 1, 21, 37, 40 <strong>RM:</strong> 2, 3, 6, 7, 9 <strong>T1:</strong> 1, 3 <strong>T2:</strong> 1 <strong>T3:</strong> 1</td>
</tr>
</tbody>
</table>

*Figure 31: Coding Index Page 2*
After analyzing all of my data and compiling my coding index, I was able to organize the results into a graphic organizer (see Figure 33). This graphic organizer was created as a visual depiction of the five major themes that emerged.

### Bins

Figure 32: Coding Index Page 3

<table>
<thead>
<tr>
<th>Codes</th>
<th>Documents &amp; Page Numbers</th>
<th>Related Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Frustration</td>
<td>FL: 8, 21, 23</td>
<td>Interruptions, Math Talk, Reflection, Teacher Frustration</td>
</tr>
<tr>
<td>TS: 1, 2, 21, 22</td>
<td>PS: 1, 2, 3, 5, 17, 20, 21, 29, 30, 40, 49</td>
<td></td>
</tr>
<tr>
<td>RM: 6, 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Frustration</td>
<td>FL: 1, 2, 8, 10, 15, 20, 21, 24</td>
<td>Interruptions, Reflection, Student Frustration</td>
</tr>
<tr>
<td>TS: 1, 2, 21, 22, 27, 41</td>
<td>PS: n/a</td>
<td></td>
</tr>
<tr>
<td>RM: 8</td>
<td>T1: 1, 3</td>
<td></td>
</tr>
<tr>
<td>T2: 1</td>
<td>T3: 1</td>
<td></td>
</tr>
<tr>
<td>Teacher Pride</td>
<td>FL: 11, 12, 13, 14, 17, 18, 23, 24</td>
<td>Active Engagement, Collaboration, Confidence, Connections, Enjoyment, Math Talk, Reflection</td>
</tr>
<tr>
<td>TS: n/a</td>
<td>PS: n/a</td>
<td></td>
</tr>
<tr>
<td>RM: 3, 4, 5, 6, 8, 9, 10</td>
<td>T1: 1, 2, 3</td>
<td></td>
</tr>
<tr>
<td>T2: 1, 2</td>
<td>T3: 1</td>
<td></td>
</tr>
<tr>
<td>Vocabulary Identification</td>
<td>FL: 1, 2, 3, 7, 10, 11, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24</td>
<td>Connections, Literacy Strategies, Math Talk, Reflection, Resources, Vocabulary Usage</td>
</tr>
<tr>
<td>TS: 4, 5, 10, 16, 19, 22, 36, 40, 48</td>
<td>PS: 1, 40</td>
<td></td>
</tr>
<tr>
<td>RM: n/a</td>
<td>T1: 1, 2</td>
<td></td>
</tr>
<tr>
<td>T2: 2</td>
<td>T3: 1</td>
<td></td>
</tr>
<tr>
<td>Vocabulary Usage</td>
<td>FL: 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25</td>
<td>Connections, Literacy Strategies, Math Talk, Reflection, Resources, Vocabulary Identification</td>
</tr>
<tr>
<td>TS: 3, 4, 10, 16, 19, 22, 36, 44, 48</td>
<td>PS: 1, 3, 9, 17, 29, 37, 40, 41, 51</td>
<td></td>
</tr>
<tr>
<td>RM: 2, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>T1: 1, 2, 3</td>
<td></td>
</tr>
<tr>
<td>T2: 1, 2</td>
<td>T3: 1</td>
<td></td>
</tr>
</tbody>
</table>
from this action research study. Under each theme, I listed the recurring and related codes that led to each conclusion.

Figure 33: Coding Graphic Organizer
Theme Statements

After carefully analyzing all of the data in this study and creating codes, there were five clear themes that emerged. As depicted in the Coding Graphic Organizer (see Figure 33), each of the five themes were supported by many codes from throughout all of the data. The major themes are as follows:

1. **Collaborative Learning:** Through collaborative learning, students are able to discuss mathematical thinking and processes with their peers, which not only allows students to share and explain their own thinking, but also allows students to gain insight from others as well as to discover new ways of thinking that may differ from their own.

2. **Vocabulary Supports Student Learning:** When students identify and understand important vocabulary, they are more likely to use the vocabulary in their conversations, which then leads to an authentic, in-depth understanding of the topic because students not only recognize key terms, but they are also able to use appropriate vocabulary in their own explanations.

3. **Mathematical Oral Language:** When modeled and encouraged, mathematical oral language between students can lead to a deeper understanding of both vocabulary and mathematical processes. In this study, mathematical oral language includes using important vocabulary
during conversations with peers to explain how and why to perform each step when solving mathematical problems.

4. **Awareness of Literacy Strategies:** When literacy strategies are discussed and modeled in the mathematics classroom, students become more aware of how to apply these previously acquired strategies while reading in mathematics. Many students who feel intimidated by word problems in mathematics begin to feel more confident as they apply literacy strategies to help them comprehend word problems and directions.

5. **Written Self-Reflections:** When written self-reflections are modeled and expected, students must consider *how* they learned and *what* they did to maximize their learning, not only thinking about their learning process, but also expressing this reflection in a written document. This document functions as an effective communication tool between the student and teacher, offering a ‘safe space’ to be honest about effort and understanding.
Research Findings

The purpose of this study was to implement math talk and literacy strategies into a sixth-grade mathematics classroom. It quickly became apparent that vocabulary and self-reflection would play a big role in this study as well. I was hoping to see an increase in confidence, collaboration, and, of course, scores. What I found throughout this study was indeed an increase in confidence and a slight increase in scores, but most importantly, a clear escalation of collaboration. In addition, my students and I learned the importance of explicitly identifying and using important mathematical vocabulary, both in writing and speaking, being aware of and applying appropriate literacy strategies, and reflecting on our learning regularly. The data from this study aligned to present prevalent themes, which were all intertwined. For example, vocabulary identification and usage along with metacognition were seen and heard throughout collaborative oral conversations, as well as written self-reflections. This overlap of data shows the importance of all five themes within our mathematical learning community.

Collaborative Learning

Collaborative learning has many benefits. At the beginning of this study, one student responded to the pre-survey question asking what would make the student feel more confident in math by saying, “If someone would help me.” (as seen in Figure 23). This response stood out to me as an indicator and reminder that students should not be expected to work solely in an independent manner.
Throughout this study, I modeled and encouraged collaboration between students, which became a norm in our classroom.

Some of the benefits that were seen throughout this study were that students felt comfortable and confident working with their peers, they were able to discuss their thinking and mathematical processes with each other and in turn hear others share and explain their thinking, which at times proved to be different and very helpful. This insight could not have been gained if the students had only heard the point of view of their teacher. There are many examples of these benefits in the data from this study, including Math Recap responses and captured student conversations. Many students expressed their experience as fun on different occasions, exhibiting an enjoyment of working with others (as seen in Figures 9, 13 and 17, and Table 5). Other positive responses throughout the study include student feelings of improvement (as seen in Figure 9), as well as students identifying both helping others and gaining help from their peers (as seen in Figures 14 and 17, and Table 5). Students also reported specific explanations that were helpful, such as how to use a T-Chart to find the Greatest Common Factor of two numbers, which was a strategy that I never saw before and would not have been able to share with my students (as seen in Figure 12), talking through solving a power (as seen in Table 3), and using important vocabulary to help each other solve problems (as seen in Figure 16). Students even explained to each other processes that were not successful, saying “that didn’t work” (as seen in Figure
In the post-survey responses, students shared that they talked about our math vocabulary and got “a better look at the problem” because of the explanations of others (as seen in Figures 24 and 25). All of these responses suggested that the students truly benefitted from working collaboratively and sharing both successful and challenging processes with each other.

Secondary to the collaboration, I also noticed a change in how my students treated each other. There was a noticeable spread of kindness and caring, which I believe was the most amazing and unexpected result! An example of compassion can be seen in a student response stating “I worked with Otto and he is very kind.” (as seen in Figure 17). Students often identified the peers who were helpful to them with a sense of gratitude and benevolence. Students also began taking initiative to help others. One student, who is generally shy and not very outspoken, asked on several occasions if she could go to other tables to help people. I do not believe she would have shown this leadership without the implementation of collaboration in this study. We often had students from each group act as “checkers” who would check their peer’s work and explain the process if a problem was incorrect. I observed many students who were eager to become the “checker” for their table so that they could help others finish their work. I was very proud of this increase in enthusiasm to help others.

Dewey (1938) and Freire (1970) both wrote about the importance of collaboration and student experiences with their peers. Deloit (2012), Burns,
Pierson & Reddy (2014), and Phillips, Bardsley, Bach & Gibb-Brown (2009) all shared the positive outcomes and effects on learning that come from allowing and encouraging student collaboration in the classroom. I could not agree more with these researchers after conducting my own action research study and seeing similar results, which were evidenced by student responses in our Math Recap documents, observations in my field log, as well as clear changes in student opinions between the pre- and post-survey, specifically the positive change in response to the question “Do you talk with others about math?” (as seen in Table 4).

**Vocabulary Supports Student Learning**

At the beginning of this study, I modeled and encouraged the identification and use of important mathematical vocabulary. My students quickly took responsibility for and pride in identifying words that they thought were significant enough to our learning to be part of the “Math Talk” board, where we hung vocabulary words for each topic. This board became a primary resource for my students to use while discussing their math processes with peers and reflecting on their own learning. This board also became a truly interactive word wall, just as suggested by Gore (2010). Students volunteered words and asked repeatedly if they could make vocab cards to add to the “Math Talk” board. The words added to this word wall ranged from explicit vocabulary, highlighted and defined by our textbook, to secondary vocabulary such as steps in our mathematical processes,
and even to the “little” words, as referred to by Sullivan (1982) such as the word of meaning that we should multiply, and even the new symbols to show multiplication. All of these words were similar to the “power words” in the study by Yates, Cuthrell and Rose in 2011. An example of our “Math Talk” board, filled with important words from topic 2 can be seen in Figure 10.

The identification and use of these powerful vocabulary words throughout each topic in this study, some of which were suggested more than once during a topic, lead to an authentic, in-depth understanding of concepts and processes. The students were able to use the vocabulary in explanations with their peers as well as in their own personal reflections of their learning. Observations of student explanations recorded in my field log and reflections through our Math Recap documents along with the visual of our “Math Talk” board serve as evidence of the importance and influence that mathematical vocabulary supported student learning in this study. I kept track of the days when we added new vocabulary to our board in my field log (as seen in Figure 29). Throughout our Math Recap documents, students identified specific vocabulary terms that they used in conversations with their peers. Some of this vocabulary included repeated multiplication, prime factorization, PEMDAS, math words, distributive property, algebraic expressions, fractions and more (as seen in Figures 11, 13 and 17). In Table 5, the content-focused questions showed growth in the identification and reporting of vocabulary including reciprocal, fraction, decimals, factor tree,
prime, composite and PEMDAS. Use of vocabulary was also captured in student conversations, which included words and phrases such as prime numbers, powers, value, factor, order of operations, divide and times (as seen in Figures 12, 16 and 28 and Table 3).

By the end of this study, the identification and use of mathematical vocabulary became a common routine in our classroom. The results of the post-survey are evidence that the students were more aware of mathematical vocabulary. In response to the Likert scale question “Do you feel like you understand our math vocabulary so far?”, not even one student answered No, not at all. The majority of students answered Yes, all the time, with the next most popular response being Pretty often, and then Sometimes. Although the most common response to this question was the same for the pre- and post-survey (as seen in Table 4), there was a positive increase in the overall responses (as seen in Figure 21). Finally, in response to post-survey questions about strategies and conversations, many students referred to the “Math Talk” board for examples of vocabulary words, adding new words to the board, and using the vocabulary words to better understand math problems (as seen in Figure 24). The “Math Talk” board provided the students with a resource that they helped create and could refer to and use at any time, and the students in this study did use this resource very often.
Mathematical Oral Language

In this study, mathematical oral language included using important vocabulary during conversations with peers to explain *how* and *why* to perform each step when solving mathematical problems. These conversations required metacognition in order for the students to explain their thinking to each other. The deliberate practice of this process was exactly what Roberts and Billings (2008) described as necessary to strengthen the relationship between thought and language. These conversations formed the foundation of the mathematical community in our classroom. Students were expected to use mathematical oral language and listen to each other respectfully. Through these conversations, students not only practiced using important vocabulary and expressed their thinking, but they were also introduced to new or different approaches to solving problems. Dewey (1938) supported the social aspect of these conversations, and Freire (1970) supported the need for dialogue between students in a classroom.

Throughout this study, my students enjoyed being able to work together and discuss the problems they worked on. They were able to express a deeper understanding of the material and vocabulary, as well as their own metacognitive processes. These conclusions were drawn based on my observations of student conversations, as well as many student responses to our Math Recap questions throughout the study. I was able to capture student conversations by recording them in my field log (as seen in Figure 29). These conversations were powerful
evidence that students were using mathematical vocabulary and metacognitive processes to explain their thinking and learning to each other. For example, while working on prime factorization, one student asked another, “Does anything else go into 51?” (as seen in Figure 12). Two students worked through solving exponents together, explaining why their first attempt was incorrect and how to appropriately solve the problem (as seen in Table 3). One student patiently explained to another student, “You have to see if they’re the same. If they have the same value.” (as seen in Figure 16). Encouragement was evident when one student helped another and said “Then 32 divided by 4 is 8! Boom shaka laka!” (as seen in Figure 28). Throughout the Math Recap documents, students explained their conversations with one another, identified specific vocabulary they used, and recalled solving a problem on the board, which required talking through the process of solving that problem (as seen in Figures 11, 13, 15 and 17). Table 5 also shows examples of the growth in student responses to the content-focused Math Recap questions, in which students explained their mathematical conversations. Finally, the post-survey responses showed a clear increase in talking with others about math (as seen in Table 4). Students shared that they talk about our “Math Talk” words, the problems and how to solve them (as seen in Figure 24). One student even wrote, “the more we talk about [the problems], the more I will understand them.” (as seen in Figure 26).
Awareness of Literacy Strategies

At the beginning of this study, I suggested a few literacy strategies that could be incorporated into the mathematics classroom and I modeled what that would look like. The students in this study also provided suggestions of literacy strategies that could be applied in the math classroom and examples of when and how to use them (as seen in Figure 5). My field log showed that we created this list while learning about solving multi-step word problems and noted that students provided examples (as seen in Figure 29). These strategies aligned with the list from Hurst and Pearman (2013) of research-based reading strategies as well as with the strategies agreed upon in the studies synthesized by Shanahan and Shanahan (2008). Since all of the strategies we discussed throughout this study had been previously acquired, the students needed only to become aware that they could apply these strategies during math. The students were able to recall and apply different reading strategies as they encountered directions and word problems, which were reported by the students in their Math Recap documents. For example, one student explained that using the rereading strategy helped him make sense of a problem (as seen in Figure 13).

By the end of this study, although students still felt that they sometimes struggled with word problems, there was a clear increase in the use of literacy strategies and confidence across student responses to the post-survey questions (as seen in Table 4). These results also showed that students do struggle when reading
math problems, but there were more varied answers to the question, “Do you ever use reading strategies during math?”, which was very different than the pre-survey responses to the same question (as seen in Figure 21). When asked in the post-survey about the strategies they might use in math, many students responded with vocabulary as a strategy that helps them, even referring specifically to the “Math Talk” board (as seen in Figure 24). Although vocabulary was not necessarily one of the literacy strategies on the list we created, it is a very important pillar of reading and has been effective for the students in this study. The awareness of literacy strategies and how to apply them to mathematical directions and word problems allowed the students in this study to feel more confident in their abilities to approach and solve math problems.

Written Self-Reflections

The written self-reflections, or “Math Recaps” in this study served as a means for the students to metacognitively reflect on their learning and processes and commit those thoughts to written language. This practice became routine in our classroom and also gave students an opportunity to relay important information to their teacher in a safe and private place. For example, students who may have seemed off-task were able to explain exactly what they worked on and talked about with their peers, students who were confused or frustrated were able to ask questions without anyone else hearing or feeling embarrassed, and finally, students who felt confident could express their certainty without feeling as though
they were bragging in front of their peers. In order to answer our Math Recap questions (as seen in Figure 4) or pose their own questions to the teacher, the students needed to quietly reflect on their math time, which Dewey (1938) encouraged for learners of all ages. In this study, the quiet time spent on reflecting, which took place 12 times, was highly valued because it led to a deeper understanding of student metacognition as well as a strengthened bond between the students and the teacher. As Sturgeon (2017) suggested, and this study supported, writing these reflections caused the students to consolidate their understanding.

Examples of metacognitive thinking and expression of feelings and processes can be seen throughout the Math Recap data provided in this study. Many student responses started their responses with the words “I feel...” (as seen in Figures 9, 11, 13 and 15). Students were able to explain when they were confused and what part of our learning was difficult for them (as seen in Figures 11 and 14), and even asked for help when necessary (as seen in Figures 11 and 15). Students also expressed times where the learning was difficult at first, but then it got easier and started to make more sense (as seen in Figures 14 and 17). Finally, students expressed feelings of confidence and enjoyment (as seen in Figures 13, 14, 15 and 17).

As the study progressed, most students showed growth through their Math Recap responses, in which they explained how they felt and why they felt that
way, as well as asked questions or made suggestions in a private conversation with the teacher (as seen in Table 5). These responses provided evidence of the increase in confidence, content knowledge, literacy awareness and metacognition. At the conclusion of this study, student answers to the post-survey questions showed that the students were able to clearly write their feeling and explain the reasons for their answers, showcasing metacognitive skills and meaningful written expression (as seen in Figures 24, 25, 26 and 27).
**What’s Next?**

Although this action research study has officially come to an end, routines have been set in motion which I plan to continue to use with my current class and in the future. Some of these routines include self-reflection, collaboration and mathematical conversations among students, student identification of vocabulary and the use of the “Math Talk” board as a constant resource, and awareness of literacy strategies and how they might be applied in mathematical context. After carefully analyzing the data and routines implemented in this study, I feel that the self-reflection and collaboration aspects were the most impactful changes that I made in my classroom. Even if I do not implement these procedures exactly the same way that I did during the study, I believe it will be beneficial to incorporate self-reflection and collaboration at various levels for all of my students.

It is important to share action-research outcomes with colleagues, and I have already begun to do so throughout this study. My husband also teaches sixth grade mathematics and I have shared my research, plans and outcomes with him. He has applied some of my findings in his classroom and has seen similar benefits, especially relating to vocabulary and student collaboration. At my school, we have several opportunities to meet and share ideas with the other content-area teachers. This will be another opportunity for me to share my findings with those who can directly apply similar routines within their own classrooms.
Vocabulary has always been an important part of my math instruction, however, through this study I was able to see the advantages of encouraging the students to initiate the identification of vocabulary. When the students identify vocabulary words that they believe are significant to what they are learning, the use of those words becomes more meaningful. I have also learned the importance of focusing on the “little” words, including clue words and symbols. I would like to possibly provide a different type of “Math Talk” board, meaning that I would like to make the board even more student-centered and student-controlled. I believe I could do this by providing a blank canvas on the board, where students would be able to write any important vocabulary at any time, instead of having the students put the vocabulary on an index card and then hanging the card on the board. I am interested in finding out what the students would prefer.

The identification and awareness of literacy strategies seemed to be helpful for students throughout this study, which was seen in their reflections when they discussed strategies that they used during class. It was not, however, the main focus of the study. I would like to build this literacy awareness into my routine at the beginning of the school year. I think it would be very beneficial for the students to create a poster or list at the beginning of the year including literacy strategies that can be applied in mathematics and examples of what that might look like. This process could be included in the creation of our classroom norms.
and could be a permanent fixture in the classroom, which could be referenced and added to throughout the year.

Written self-reflection became a very important aspect of this study. The benefits of metacognition and consolidating learning were absolutely worth the time spent to not only provide a quiet reflective period for the students, but also to review and respond to those reflections. I believe that implementing the structure and class time for individual reflection is advantageous for all students involved. Through this study, I found that the use of Google Docs as reflection documents was extremely effective because I was able to make comments and have private conversations with each student. However, reviewing and responding to a document for each and every student took up a substantial amount of time. I would like to experiment with different means for our reflections to find out what would be the most efficient way to provide feedback to student reflections.

Finally, I plan to continue what I believe to be the biggest and most important gain from this study, which is collaboration between students. The implementation of “Math Talk” in this study caused the students to take part in important mathematical conversations with each other while they worked through problems and explained processes to one another. I will definitely continue to model and encourage this collaboration. It would be interesting to consider the results of different strategic groupings. Action research could be conducted to compare the outcomes of different groupings, such as similar ability, mixed
ability, student choice, and more. Regardless of how the students are grouped and no matter what topic they are learning about, it will be beneficial for all involved to offer and encourage collaboration.
References


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Appendices

A. HSIRB Form

2017-2018 HUMAN SUBJECTS INTERNAL REVIEW BOARD (HSIRB) PROPOSAL FORM

This form must be completed for any research activity involving human participants. All researchers should review the Moravian College Human Subjects Research Policy found at p:\hsirb\MoravianCollegeHSIRBPolicy.doc before designing and submitting their proposals.

When you have provided all of the information required in the proposal form below, please follow the submission instructions below. Please be aware that incomplete proposals will be returned to the proposer until they are complete. Failure to submit all documentation will delay the Human Subjects Internal Review Board (HSIRB) review of your research proposal.

Proposal Review Timetable: Please note that during the standard academic year when the committee meets regularly, it typically takes a minimum of two weeks (14 days) for the committee to review and respond to completed proposals. Most proposals require some modifications before we grant full approval and the revision process typically adds an additional week to the review process.

Submit all of the following:

1. This completed Human Subjects Internal Review Board (HSIRB) Proposal Form. Please make sure all required information is complete. We encourage completion of this proposal form as a Word document.

2. A copy of your Informed Consent form and/or other evidence of Informed Consent to voluntary participation [See HSIRB proposed Policy #MC.116 & MC.117. The policy statement can be viewed at Public/hsirb/] You can also find helpful informed consent guidelines at public/hsirb.

3. A copy of all of your instruments (surveys, tests, etc.). If you are showing pictures or videos, a copy of these need to be submitted as well. You may provide links if the material will be accessible online.

Submit electronic copies of complete proposals to:

hsirb@moravian.edu

You have the option of either combining the various documents in one file or submitting separate files as email attachments, but please make sure that the file name clearly indicates the section of the overall proposal package and the author. So, for example, please call your document something along the lines of “johnson.proposal.docx” and “johnson.informedconsent.docx.” The preferred format for all materials is Word (doc/docx) or PDF. We understand that some materials may only be available in other formats, but please make every effort to send files in one of those two formats. At the end of the approval process, we will collect electronic signatures from proposers and their faculty sponsors (if applicable).
Questions: contact  
Dr. Jean L. DesJardins, Chair HSIRB  
Education Department  
desjardins@moravian.edu  
(610) 861-1317

Part I: RESEARCHER

<table>
<thead>
<tr>
<th>1. Proposer:</th>
<th>2. Department:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elizabeth Glase</td>
<td>Education</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Mailing address:</th>
<th>4. Phone:</th>
</tr>
</thead>
<tbody>
<tr>
<td>887 4th Street, Whitehall, PA 18052</td>
<td>484-358-5735</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. E-mail address:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:steng15@moravian.edu">steng15@moravian.edu</a></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. This is a (please check):</th>
<th>7. Research Start/End Dates:</th>
</tr>
</thead>
<tbody>
<tr>
<td>x New Proposal</td>
<td>Make sure you clearly define the start and end dates. Format as month, day, year.</td>
</tr>
<tr>
<td>____ Resubmission of a rejected Proposal</td>
<td>Start: September 10, 2018</td>
</tr>
<tr>
<td>____ Renewal</td>
<td>End: December 7, 2018</td>
</tr>
<tr>
<td>____ Request for modification</td>
<td></td>
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</table>

7. Title of Proposal:  
Implementing Literacy Strategies and Math Talk in the Sixth Grade Mathematics Classroom

8. Faculty Advisor:  
Dr. Tristan Gleason

Part II: PROPOSAL TYPE

1. This research involves **ONLY** the use of educational tests (cognitive, diagnostic, aptitude or achievement).

| ____ Yes |  |
| x ____ No | |

2. This research collects interviews or surveys **ONLY** of elected or appointed public officials or candidates for such.

| ____ Yes |  |
| x ____ No | |
3. This research involves **ONLY** observations of **public behavior**.

   _Yes__
   _No__

4. This research involves **ONLY** existing data, documents, records or specimens.

   _Yes__
   _No__

5. List the **research funding sources**, if any.

   Not applicable.

6. The results of this research will be published.

   _Yes__
   _No__
   _Uncertain__

   If you marked "yes" or "uncertain", please provide a brief description of the possible forum of publication (for example, peer-reviewed journal, conference presentation, etc.)

   Description of publication forum:

   Moravian College Theses Archives Website

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**Part III. DETAILS OF THE RESEARCH PROJECT**

1. In this section, you have the option of either addressing each of the following subheadings individually or together (since there may be some overlap) in your proposal narrative. If providing a narrative, please make sure that each of the following topics is clearly identified in the narrative.

   a. **Objectives**: The objective of this research study is to observe and gather data while implementing literacy strategies and math talk in a sixth grade mathematics classroom. Through this data, I intend to measure awareness and implementation of literacy strategies, the level of confidence in my students when not only solving mathematics problems, but also discussing the processes and vocabulary used to solve them, and finally, achievement on mathematics assessments, focusing on vocabulary knowledge. We will start by brainstorming literacy strategies that can be used in math, for example,
a. visualization and keywords, which will help students be aware of these strategies and implement them across disciplines. Math talk will consist of collaborative conversations where students will discuss math vocabulary and processes while solving problems. These implementations will encourage collaborative learning and hopefully increase the students’ self-confidence in mathematics. I will keep a field log with observations and reflections. I will observe the students and capture dialogue during collaborative learning, keeping student anonymity a priority. Student surveys and self-reflections, written and shared through “recap” emails, will also be an important way to collect and analyze data. These data will be recorded and analyzed for trends and changes in student feelings and achievement.

b. **Design:** Action Research: I will be implementing literacy strategies and math talk in our sixth grade mathematics classroom. The participants will be asked to brainstorm different literacy strategies, but I will encourage the use of strategies such as main idea and details, clue words or keywords, new vocabulary, visualization and monitoring comprehension. Our math talk refers to collaborative conversations about math processes. This will encourage the use of math vocabulary, operations and processes that we will be using to work through problems. To collect data, I will primarily be using student surveys, interviews, self reflection emails, and observations. Student surveys will be given at the beginning and end of the study and will be made up of the same questions in order to track change. Interviews will be conducted with one or more student(s) in order to gauge understanding and feelings, as well as to discuss the kind of conversations that the students are having. The self-reflection emails will consist of the students answering four of the same questions every other day, in a non-threatening and safe email directly to me, the teacher. Observations will be conducted throughout class time when students are working together. Dialogue will be captured during this observation time. The data from these tools will be recorded in a field log and/or spreadsheet in order to track and analyze the data. Student pseudonyms will be used throughout the study to track student progress with anonymity. The data collection time frame consists of four months, from September through December, of the 2018-2019 school year.

c. **Procedures (makes sure you clearly describe what is required of subjects):** The participants in this study will be encouraged to identify and implement literacy strategies in the mathematics classroom. Students will be asked to identify literacy strategies that they already use in either reading or math and to discuss and apply them while working with others in our mathematics class. Students will also be observed, surveyed and interviewed to identify the effects of implementing literacy strategies and math talk. Students will also answer self-reflection questions in our “recap” emails, which, with consent and assent, will be documented to track changes in responses and feelings. Sample questions include “How do you feel about what we did today in Math?” and “Did you talk about math with anyone today? How did it go?” Pre- and post-surveys will be given either on paper or on a Google Survey. Sample questions include “What strategies do you use when you read?” and “Do you feel confident in your math skills?” All students will participate in all activities and will respond to all data collection tools. However, data will only be recorded and used in this study from participants who have given parental consent and participant assent.
a. Outline procedures/steps to reduce risks to subjects:

All students will have the option to participate or not participate in this study. All students will receive the same instruction, assignments and homework. There will be no change in workload or grades if students choose to participate or not participate in this study. All students will have the option to opt out of this study at any time without any form of penalization. The students who choose not to participate in this study or do not provide parental consent will receive the same instruction, assignments, homework and grades, but the data from these students will not be used for the study.

1. This research involves the following GROUP(S) vulnerable to risk. Check all that apply.

   _x_ Subjects under the age of 18
   _ _ Prisoners
   _ _ Pregnant women
   _ _ People with mental, cognitive, intellectual, or physical disabilities
   _ _ Volunteer sample so vulnerable group membership may be unknown

Research Design Note: If you are asking for volunteer participants, you will not necessarily know whether or not your participants are under 18, pregnant and/or disabled. In fact, your volunteers may themselves not know whether they fall into one of these categories. Therefore, if you are asking for volunteer participants, you need to think carefully about whether or not your research project could adversely affect someone in any of these categories, and if so, how you might try to either screen out these individuals and/or design the project so that the risk to these individuals is minimized.

2a. If you checked any or all of the groups identified above, explain why you need to use the group and the methods you will use to minimize risk. If your research design proposes no special risks to these vulnerable individuals even if they happen to be included in your sample, please state why:

The information will be gathered from participants who have parental consent and who have given assent to have their data submitted. No one is required to participate or provide information if they do not wish to do so. Pseudonyms will be used for all participants so that no names or other identifying descriptors will be used for any of the participants. Participants may withdraw from the study at any time without penalty. The data that is collected will not have a negative or positive effect on student grades or evaluations. This research study will directly affect those who may have special vulnerabilities (for example: people with allergies, people taking some medications, people with cognitive impairments such as ADHD, etc.).

2. This research might affect people with special vulnerabilities (for example, pregnant women, people with allergies, people taking some medications, people with cognitive impairments such as ADHD, etc.)

Research Design Note: Think carefully here again about whether or not your research design could negatively affect people with special vulnerabilities. For example, does your research design require so much concentration and/or computation that it might result in considerable stress for someone with a cognitive impairment? Are people completing your instrument in solitude or in a group setting? Might comparative performance result in excessive stress?
If you checked "Yes", explain the methods you will use to minimize risk to these people.

In order to minimize risk to the participants in this study, parental consent and participant assent will be required in order to use any data from the participant for the study. No one is required to participate or provide information if they do not wish to do so. Pseudonyms will be used for all participants so that no names or other identifying descriptors will be used for any of the participants. Participants may withdraw from the study at any time without penalty. The data that is collected will not have a negative or positive effect on student grades or evaluations.

4. Describe your subject pool including:
   a. the intended number of subjects
   b. subject characteristics/demographics

The participants in this study will include eight to fifteen sixth grade students with various social, economic and ethnic backgrounds within the ages of ten through thirteen. These students will also have varied ability levels, including but not limited to specific learning disabilities, emotional support needs, physical needs and behavioral support needs. The participants will include both male and female students who have parental consent and who have given assent to participate in this study.

5. Describe in detail the methods you will use to recruit your subjects.

Not applicable.

6. This research involves deception of subjects.

   _____ Yes
   _____ No

If you checked "Yes", describe the nature of the deception and your debriefing procedure. You will need to provide the debriefing statement with the full proposal submission. Even if the debriefing will be done orally, you need to submit the text of the verbal statement that will be read to participants.

7. Explain by whom and how the subjects will be informed of the purposes of this research project. (Remember to provide a copy of the informed consent form with this proposal form.)

   All students will receive informed assent documents, which will be presented and read aloud to them. They will be able to reread the information and then make their decision. Parental consent will be sent home and then collected along with student assent. Consent and assent forms will include an explanation and purpose for the study. These documents will be securely stored until the end of the study, when they will be destroyed.
8. This research collects information, which (check all that apply)

- [x] deals with sensitive aspects from the participant’s point of view.
- [ ] identifies the subject by name or number codes.
- [ ] might place the subject at risk of liability if made public.
- [ ] might place the subject’s financial standing or employability at risk if made public.

Research Design Note: Think carefully about whether or not your research deals with topics that may be sensitive from the participant’s point of view. Sometimes it is not obvious to the researcher that the subject of their research may be a sensitive topic for others.

If you checked any or all of the categories above, explain the methods you will use to

a. safeguard the data you collect (you need to describe this safeguarding procedure in detail, including but not limited to a description of how the data will be protected (for example, in a locked cabinet), whom will have access to the data, and how and when the data will be destroyed)

b. inform subjects of available support services (If your participants are drawn from the Moravian College community, please provide contact information for the Counseling Center, Campus Safety and the Health Center—contact information available on the HSIRB website. For participants drawn from other communities, please provide the comparable support service information.)

c. minimize the risk of identification of subjects.

All data will be stored in a password protected file on my password protected computer, which will be kept in a locked drawer in a locked classroom. All physical documents will be stored in a locked drawer in a locked classroom. All data and documents will be destroyed at the conclusion of this study.

All students involved in this study will be made aware of available support services such as after-school help, homework club, lunch period help, and counseling services offered by the East Hills Middle School teachers and counselors.

Pseudonyms will be used for all participant names. Data will be stored using these pseudonyms. Names of family members and/or specific family background information will never be used in this study.

Appendices: Consent Forms and Instruments

Appendix A: Signed Principal Consent Form

https://drive.google.com/open?id=1WqY6CZU4FqGvEX6i21aZqFg1GiuevA
Appendix B: Consent Forms (Principal, Parent and Student)

https://drive.google.com/drive/u/2-folders/1jFkMc4rYybLCN_G5NfFR1m1aa89l4i7og

Appendix C: Pre-Survey

https://drive.google.com/open?id=196x1k6QObyrup7IT8a3QUHfHkQuYRv

Appendix D: Post-Survey

https://drive.google.com/open?id=1OICpWQ-bfki9dJfKf9AGGD-9xr6S24Q

Appendix E: Curriculum Design/Unit Plan

https://drive.google.com/open?id=1ubpiKVAHCtWhbAwNfoSux2PWdjsj4Tgr

Appendix F: Recap Email Questions

https://drive.google.com/open?id=1F5H9F8VfQj6PMcFMOw58psMj4gc

Appendix G: Recap Email Data Collection Sheet

https://drive.google.com/open?id=1yq0nmGqEe3RppcLU8QmunELh9IvHif

Appendix H: Observational Shadow Log Recording Template

https://drive.google.com/open?id=1xRiplA2x1k_gvU0zBR4i9R9WGQ7zuc
B. Principal Consent Form

April 13, 2018

Dear Mr. Horvath,

As you are aware, I am currently a graduate student at Moravian College. I am in the process of preparing a teacher action research project through which I plan to model and encourage my students to apply literacy strategies and talk in our mathematics class. If approved, this study will take place from September through December of the 2018-2019 school year.

The goal of my study is to help my students learn to use literacy strategies routinely and intrinsically while comprehending and solving mathematics problems. I have observed a lack of confidence in my students when reading and trying to comprehend mathematics instructions and problems. My belief is that through modeling and encouraging the use of literacy strategies and collaborative math talk, my students will feel a boost of confidence, which will allow them to comprehend and solve mathematics problems on their own. I feel confident that this study is in the best interest of all my students.

Throughout the research study, I will be collecting data in the form of observations and notes, student surveys and interviews, including recap emails from students, and analysis of student artifacts. All research materials and collected data will be kept in a secure location in my classroom or on my password protected computer and will be destroyed at the conclusion of this study. All students' names will be kept confidential, as well as any faculty or staff. All students and any associated faculty or staff will be given a pseudonym in my action-research project.

Every student in my classroom will receive the same instruction and opportunities and all educational IEP and ELL accommodations will be utilized throughout this study. Students will have the option to participate in this study, but all students will be required to participate in the instruction and complete assignments even if they do not wish to have their data included as a study participant. Choice of participation in this study will not affect any of my students' grades. Any student may withdraw from the study at any time without penalty.

If you have any questions or concerns, please contact me at 484-358-5735 or elglase@bspsdshona.org. Please feel free to contact my Moravian College professor, Dr. Joseph Shoosh at 610-661-1482 or by email at jshoosh@moravian.edu.

Please cut along the dashed line above and return to me as soon as possible.

Please check the appropriate box to give permission for this study:

☑ I give permission for Elizabeth Glase to conduct this action-research study.
☐ I do not give permission for Elizabeth Glase to conduct this action-research study.

I have read the information above and fully agree with my decision.

[Signature]

Date

Thank You,

Elizabeth Glase
C. Student Assent Form

September 4, 2018

Dear Students,

In addition to being a teacher, I am also a graduate student at Moravian College. I am going to need your help during my latest project! The goal of my teacher action research project is to help you feel more confident during our mathematics class. This study will take place from September through December.

Throughout this project, I will be collecting information through observations, conversations with you, surveys, recap emails, and samples of your work. All materials and information will be kept safe in the classroom or on my password protected computer and destroyed when the project is over. During the study, all students’ names will be kept confidential and pseudonyms, or fake names, will be used.

All of my students will receive the same instruction and complete the same activities. If you participate or not will have no effect on your grade. You may ask questions or withdraw from the study at any time, without penalty, by talking to me. There are no risks involved in participating in this study.

Thank You,

Mrs. Glase

----------------------------------------------------------------------------------

Please cut along the dashed line above and return to me as soon as possible.

Please check the appropriate box to give permission for this study:

☑ I give permission for my data to be used in this action-research study. ☐ I do not give permission for my data to be used in this action-research study.

I have read the information above and fully agree with my decision.

________________________________________

Student Name

________________________________________

Signature

________________________________________

Date
D. Parent/Guardian Consent Form

September 4, 2018

Dear Parents/Guardians,

In addition to teaching at East Hills Middle School, I am currently a graduate student at Moravian College working towards my Master’s Degree and Reading Specialist certification. I am in the process of preparing a teacher action research project through which I plan to model and encourage my students to apply literacy strategies and talk in our mathematics class. This study will take place from September through December.

The goal of my study is to help my students learn to use literacy strategies routinely and intrinsically while comprehending and solving mathematics problems. My belief is that through modeling and encouraging the use of literacy strategies and collaborative math talk, my students will feel a boost of confidence, which will allow them to comprehend and solve mathematics problems on their own. I feel confident that this study is in the best interest of all my students.

Throughout the research study, I will be collecting data in the form of observations and notes, student surveys and interviews, including recap emails from students, and analysis of student artifacts. All research materials and collected data will be kept in a secure location in my classroom or on my password protected computer and will be destroyed at the conclusion of this study. All students’ names will be kept confidential, as well as any faculty or staff. All students and any associated faculty or staff will be given a pseudonym in my action-research project.

Every student in my classroom will receive the same instruction and opportunities and all educational IEP and ELL accommodations will be adhered throughout this study. Students will have the option to participate in this study, but all students will be required to participate in the instruction and complete assignments even if they do not wish to have their data included as a participant. Choice of participation in this study will not affect any of my students’ grades. Any student may withdrawal from the study at any time without penalty. There are no risks involved in participating in this study.

If you have any questions or concerns, please contact me at 484-358-5735 or eglase@basschools.org. Please feel free to contact my Moravian College professor, Dr. Joseph Shosh at 610-861-1482 or by email at shoshj@moravian.edu. You may also contact our principal, Mr. David Horvath at 610-867-0541 or dhorvath@basschools.org.

Thank You,

Mrs. Elizabeth Glase

Please cut along the dashed line above and return to me as soon as possible.

Please check the appropriate box to give permission for this study:

☒ I give permission for my child’s data to be used in this action-research study. ☒ I do not give permission for my child’s data to be used in this action-research study.

Student Name: ____________________________________________

I have read the information above and fully agree with my decision.

__________________________________________________________

Signature Date
E. Pre-Survey

Name ________________________________  Date ____________

Pre-Survey. Please answer the following questions honestly!

Circle the number closest to your feelings from no to yes.

1. Do you feel like you struggle when reading math problems?
   No 1 2 3 4 5 Yes

2. Do you ever use reading strategies during math?
   No 1 2 3 4 5 Yes

3. Do you feel like you understand our math vocabulary so far?
   No 1 2 3 4 5 Yes

4. Do you feel confident in your math skills?
   No 1 2 3 4 5 Yes

5. Do you feel like you usually need help with math problems?
   No 1 2 3 4 5 Yes

6. Do you feel like math is too hard for you?
   No 1 2 3 4 5 Yes

7. Do you talk with others about math?
   No 1 2 3 4 5 Yes

8. Tell me about the reading strategies you usually use when you read.

   __________________________________________________________

   __________________________________________________________

   __________________________________________________________

9. Tell me about the most challenging aspect of math for you.
   __________________________________________________________

   __________________________________________________________
10. Tell me about what would make you feel more confident in math. For example, what would help you understand the problem better?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

11. Does it help you understand when I explain my thinking as we go through math problems?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

12. Tell me about a time you were allowed to work with another student.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

13. Please share any ideas you have that might help us understand our math vocab and concepts better.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
F. Recap Questions

**Math Recap**

Answer the following questions in your "Math Recap" Document with today's date.

1. How do you feel about what we did today in math?
2. What were your math conversations about today?
3. Did you use any literacy strategies today while you were reading math problems? If so, what strategies do you think you used?
4. What are your suggestions or questions right now?
## G. Topic 1 Test Vocabulary Analysis

### Topic 1 Test: Vocabulary Analysis

#### 1. The first number in a division sentence: Dividend
- **Dividend**: 12
- **Divisor**: 13
- **Product**: 0
- **Quotient**: 1
- **Reciprocal**: 1

#### 2. The second number in a division sentence: Divisor
- **Dividend**: 10
- **Divisor**: 10
- **Product**: 5
- **Quotient**: 0
- **Reciprocal**: 2

#### 3. The answer to a multiplication problem: Product
- **Dividend**: 1
- **Divisor**: 1
- **Product**: 18
- **Quotient**: 5
- **Reciprocal**: 1

#### 4. The answer to a division problem: Quotient
- **Dividend**: 4
- **Divisor**: 0
- **Product**: 3
- **Quotient**: 27
- **Reciprocal**: 2

#### 5. To write a division expression as multiplication, multiply by the _____ of the divisor: Reciprocal
- **Dividend**: 1
- **Divisor**: 1
- **Product**: 1
- **Quotient**: 4
- **Reciprocal**: 20
H. Topic 2 Test Vocabulary Analysis

<table>
<thead>
<tr>
<th>Topic 2 Test Vocabulary Analysis</th>
</tr>
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<tbody>
<tr>
<td><strong>1. This can be used to show a temperature that is below zero: Negative Number</strong></td>
</tr>
<tr>
<td>Negative Number: 23</td>
</tr>
<tr>
<td>Coordinate Plane: 0</td>
</tr>
<tr>
<td>Integers: 1</td>
</tr>
<tr>
<td>Opposites: 0</td>
</tr>
<tr>
<td>Ordered Pair: 0</td>
</tr>
<tr>
<td>Absolute Value: 0</td>
</tr>
<tr>
<td>Positive Number: 1</td>
</tr>
<tr>
<td>Origin: 0</td>
</tr>
<tr>
<td>Rational Number: 0</td>
</tr>
</tbody>
</table>

| **2. A grid with an x-axis and a y-axis: Coordinate Plane** |
| Negative Number: 0 |
| Coordinate Plane: 24 |
| Integers: 0 |
| Opposites: 0 |
| Ordered Pair: 1 |
| Absolute Value: 0 |
| Positive Number: 0 |
| Origin: 0 |
| Rational Number: 0 |

| **3. Positive whole numbers, their opposites and zero: Integers** |
| Negative Number: 1 |
| Coordinate Plane: 0 |
| Integers: 13 |
| Opposites: 3 |
| Ordered Pair: 1 |
| Absolute Value: 2 |
| Positive Number: 1 |
| Origin: 0 |
| Rational Number: 4 |

| **4. Numbers on opposite sides of 0 on the number line and the same distance from 0: Opposites** |
| Negative Number: 1 |
| Coordinate Plane: 0 |
| Integers: 3 |
| Opposites: 18 |
| Ordered Pair: 2 |
| Absolute Value: 0 |
| Positive Number: 1 |
| Origin: 0 |
| Rational Number: 0 |
5. The location of a point in the plane, \((x,y)\): Ordered Pair

<table>
<thead>
<tr>
<th>Negative Number</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate Plane</td>
<td>1</td>
</tr>
<tr>
<td>Integers</td>
<td>2</td>
</tr>
<tr>
<td>Opposites</td>
<td>3</td>
</tr>
<tr>
<td>Ordered Pair</td>
<td>17</td>
</tr>
<tr>
<td>Absolute Value</td>
<td>1</td>
</tr>
<tr>
<td>Positive Number</td>
<td>0</td>
</tr>
<tr>
<td>Origin</td>
<td>0</td>
</tr>
<tr>
<td>Rational Number</td>
<td>1</td>
</tr>
</tbody>
</table>

6. This is always positive and it tells the distance from 0 on a number line: Absolute Value

<table>
<thead>
<tr>
<th>Negative Number</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate Plane</td>
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</tr>
<tr>
<td>Integers</td>
<td>0</td>
</tr>
<tr>
<td>Opposites</td>
<td>0</td>
</tr>
<tr>
<td>Ordered Pair</td>
<td>1</td>
</tr>
<tr>
<td>Absolute Value</td>
<td>15</td>
</tr>
<tr>
<td>Positive Number</td>
<td>7</td>
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<tr>
<td>Origin</td>
<td>1</td>
</tr>
<tr>
<td>Rational Number</td>
<td>1</td>
</tr>
</tbody>
</table>

7. This can be used to show a credit in your bank account: Positive Number

<table>
<thead>
<tr>
<th>Negative Number</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate Plane</td>
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</tr>
<tr>
<td>Integers</td>
<td>0</td>
</tr>
<tr>
<td>Opposites</td>
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<tr>
<td>Ordered Pair</td>
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<tr>
<td>Absolute Value</td>
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<tr>
<td>Positive Number</td>
<td>11</td>
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<tr>
<td>Origin</td>
<td>0</td>
</tr>
<tr>
<td>Rational Number</td>
<td>6</td>
</tr>
</tbody>
</table>

8. The center of the coordinate plane, located at \((0,0)\): Origin

<table>
<thead>
<tr>
<th>Negative Number</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Absolute Value</td>
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<td>Origin</td>
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</tr>
<tr>
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<td>0</td>
</tr>
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</table>

9. Numbers that can be written as fractions or decimals: Rational Number

<table>
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<tr>
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</thead>
<tbody>
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<td>Integers</td>
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<tr>
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<tr>
<td>Positive Number</td>
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<tr>
<td>Origin</td>
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<tr>
<td>Rational Number</td>
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</table>
I. Topic 3 Test Vocabulary Analysis

<table>
<thead>
<tr>
<th>Topic 3 Test Vocabulary Analysis</th>
<th>Coefficient 16</th>
<th>Simplify 1</th>
<th>Equivalent 1</th>
<th>Term 3</th>
<th>Substitution 2</th>
<th>Variable 0</th>
<th>Evaluate 1</th>
<th>Like Terms 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The number part of a term that contains a variable: Coefficient</td>
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<tr>
<td>2. Combining like terms of an expression: Simplify</td>
<td>Coefficient 1</td>
<td>Simplify 18</td>
<td>Equivalent 0</td>
<td>Term 0</td>
<td>Substitution 1</td>
<td>Variable 2</td>
<td>Evaluate 2</td>
<td>Like Terms 1</td>
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<tr>
<td>3. Expressions that have the same value: Equivalent</td>
<td>Coefficient 2</td>
<td>Simplify 0</td>
<td>Equivalent 20</td>
<td>Term 0</td>
<td>Substitution 0</td>
<td>Variable 1</td>
<td>Evaluate 0</td>
<td>Like Terms 2</td>
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<tr>
<td>4. Each part of an expression separated by a + or a -: Term</td>
<td>Coefficient 3</td>
<td>Simplify 1</td>
<td>Equivalent 0</td>
<td>Term 18</td>
<td>Substitution 0</td>
<td>Variable 1</td>
<td>Evaluate 0</td>
<td>Like Terms 2</td>
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<tr>
<td>5. Replacing a variable with a number: Substitution</td>
<td>5. Replacing a variable with a number: Substitution</td>
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<table>
<thead>
<tr>
<th>6. A letter that represents an unknown quantity or value: Variable</th>
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<tbody>
<tr>
<td>Coefficient</td>
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<table>
<thead>
<tr>
<th>7. Solve: Evaluate</th>
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</tr>
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<tbody>
<tr>
<td>Coefficient</td>
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<tr>
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<td>21</td>
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</table>

<table>
<thead>
<tr>
<th>8. Terms that have the same variable part: Like Terms</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td>0</td>
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<td>Evaluate</td>
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<tr>
<td>Like Terms</td>
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</tbody>
</table>
J. Post-Survey

Name ___________________________ Number _______ Date ____________

Post-Survey: Please answer the following questions honestly!

Circle the number closest to your feelings from no to yes.

1. Do you feel like you struggle when reading math problems?
   No 1 2 3 4 5 Yes

2. Do you ever use reading strategies during math?
   No 1 2 3 4 5 Yes

3. Do you feel like you understand our math vocabulary so far?
   No 1 2 3 4 5 Yes

4. Do you feel confident in your math skills?
   No 1 2 3 4 5 Yes

5. Do you feel like you usually need help with math problems?
   No 1 2 3 4 5 Yes

6. Do you feel like math is too hard for you?
   No 1 2 3 4 5 Yes

7. Do you talk with others about math?
   No 1 2 3 4 5 Yes

8. Tell me about the reading strategies you usually use when you read: ________________________________

9. Tell me about the most challenging aspect of math for you: ________________________________
10. Tell me about your confidence level in math. For example, do you think you are understanding the problems better?


11. Did it help you understand when I explained my thinking as we went through math problems?


12. Do you feel like you have more strategies to use when solving math problems now? Tell me about some of the strategies.


13. Tell me about some of the times you worked with other students during our math class.


14. Tell me about some of the conversations you had with other students during math class.


