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Vocabulary Instruction as a Tool for Helping Students of Diverse Backgrounds and Ability Levels to Understand Mathematical Concepts

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Math in the Middle Institute Partnership
Action Research Project Report

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Vocabulary Instruction as a Tool for Helping Students of Diverse Backgrounds and Ability Levels to Understand Mathematical Concepts

ABSTRACT

This action research project describes a research project designed and implemented specifically with an emphasis on the instruction of mathematical vocabulary. The targeted population was my second period classroom of sixth grade students. This group of seventeen students represented diverse socioeconomic backgrounds and abilities. The school is located in a community of a population of approximately 5,000 people in the Midwest. My research investigation focused on the use of specific methods of vocabulary instruction and students' use of precise mathematical vocabulary in writing and speaking. I wanted to see what effects these strategies would have on student performance. My research suggested that students who struggle with retention of mathematical knowledge have inadequate language skills. My research also revealed that students who have a sound knowledge of vocabulary and are engaged in the specific use of content language performed more successfully. Final analysis indicated that students believed the use of specific mathematical language helped them to be more successful and they made moderate progress in their performance on assessments.

Introduction

When I began to focus on a topic of inquiry, I was concerned with my students' willingness to participate meaningfully in math class. As I started the school year, I was faced with students with a wide range of mathematical and reading abilities. Students come to my classroom from a variety of environments. Because of the diversity in our district, many societal differences exist. I had students from upper class families, rural farming backgrounds, families who work labor intense jobs with split shifts, transient populations, and foster care situations. The support for education in the home is sometimes limited because parents are often not at home. This ever-changing picture of home environments is reflective of the culture in my district. Consequently, I needed to find ways to deal with students who have a variety of exposure to using language. I decided to focus on vocabulary as a means of strengthening students' communication skills.

As the practice of homogenous grouping takes place from year to year in the elementary school that feeds into my sixth grade, I see the gap in the students' abilities widen. As students enter our middle school, they are placed in heterogeneous groups. As a math teacher, it is my responsibility to close the gap, making sure the foundation of mathematical concepts is acquired so that students are prepared to take on more challenging classes as they enter seventh and eighth grades. Planning lessons that will meet the needs of the wide range of abilities was very challenging. I had to be continuously aware that the language I used was understood by everyone.

A majority of students in my classroom also lacked confidence to participate. Most often they would just sit and stare at me when I asked questions or encouraged them

to explain. Often the responses included hesitant responses with vague words such as “that number,” “the other one,” “when you put them together,” and finally ending with, “you know what I mean.” These students lacked the ability to find specific language to support their explanation. I realized that if the students in my classroom could not effectively communicate their ideas to me, they definitely were not communicating successfully with each other.

I was challenged to design my mathematical instruction in such a way as to reach all students in my classroom regardless of their ability level or background. I wanted my students to have the skills to be successful and enjoy mathematics. I wanted them to see math as a challenging and fun subject, but most of all, they needed to communicate mathematically. The combination of our district reading goal and the desire for my students to better communicate and participate in class were the two variables that led me to inquire into the value of vocabulary, specifically the use of precise mathematical language. As a teacher, I needed to take a look at my instructional techniques and methods that assisted me in creating an environment that enabled all students in my class to be successful through increased use of mathematical vocabulary. I hoped that as I provided instruction through increased emphasis on use of precise mathematical vocabulary, students would improve their mathematical language through oral and written communication skills. By increased use of mathematical language, I hoped students would gain confidence and a better attitude toward mathematical achievement.

As I researched the topic of vocabulary, I was amazed at the complexity of the topic. Vocabulary takes on many forms when considering the kinds of vocabulary students should know or must learn. There are a large number of words that students are

expected to pick up incidentally. There are an average number of words that students are expected to need minimal instruction for, and there are a relatively smaller number of words that need to be covered intensively. The last group of words are be those words needed for understanding specific content areas.

As I analyzed my students, it was difficult to know the extent of their mathematical vocabulary knowledge. Some students had been in the district several years, some had been in several schools during their educational years, and some had limited English backgrounds. This variety of educational backgrounds created a classroom with some students with many educational experiences and some students with very limited educational experiences. It has been my experience, that students with limited experiences have difficulty making connections to concepts because of their limited knowledge. Because of limited vocabulary knowledge, these students struggle to find the vocabulary necessary to use in order for them to express their thoughts and ideas in meaningful ways. Therefore, I needed to use methods and techniques that offered students experiences so that these students used and increased their language knowledge in mathematics.

In my review of the research on this topic, I found that several teaching strategies were discussed to help with the instruction of vocabulary. Activities such as partner games, a word wall, a student dictionary, word cards, small group activities and the use of manipulatives were just a few of the suggested techniques. I had occasionally used some of these methods but decided to concentrate on them more often during my action research project. I decided that I would study my efforts to use these strategies and see if students could become more active participants in their own learning.

Problem Statement

The problem of practice I focused on for my research was vocabulary instruction. Understanding precise mathematical vocabulary is necessary for the success of students' understanding of mathematical concepts. I believed understanding mathematical vocabulary was necessary for all my students to have good use of mathematical language in order to better understand and communicate mathematical knowledge. As I considered my project, I referred to the National Council of Teachers of Mathematics (NCTM) *Principles and Standards for School Mathematics*, (2000). The NCTM process standard addressing communication is directly related to a student's ability to use vocabulary. Students often struggled with the transition of using specific language for mathematical communication. Often times, I observed many frustrated students' faces as they searched for the words necessary to express their thoughts. Students needed to develop the ability to exchange thoughts and ideas through communication both oral and written.

Communication takes many forms. My students needed to develop oral language, the use of pictures, and objective and symbolic representations to express their thoughts. For example, they often said "that number" instead of the divisor, or "the top number" instead of numerator. All students must possess these skills in order to be successful in mathematics. I wanted to help all of my students to improve their ability to speak the language of math. In addition, I wanted my students to be able to use mathematical vocabulary effectively to communicate their understanding of mathematical concepts in written form.

In order to effectively communicate, my students needed to have a working vocabulary. I believed the knowledge and use of language, the communication of

language, and the ability to transfer knowledge of language to other areas of learning is vital in today's world. As a teacher, I needed to find strategies and methods to professionally plan, instruct, and use these strategies and methods to help students gain a working vocabulary, specifically, a mathematical vocabulary, necessary to participate in today's ever changing society.

In addition to having good communication skills, I wanted to make sure that all my students were provided the same mathematical opportunity, including my students with diverse backgrounds. Again, I believed all students should have access to a quality education and I tried to increase the quality of their education through my focus on vocabulary instruction. Here was where the NCTM principle of equity came into consideration. Often low expectations are associated with students who live in poverty or students who are not native speakers of English, have disabilities, are females, or are nonwhite. My intentions were to use teaching strategies that would meet the needs of all students. Non-native English speaking students are at a disadvantage in understanding and using mathematical language. Through strategies based on different modalities, I hoped to better reach students with different learning styles and backgrounds.

Literature Review

Over the past few years, students have come to my classroom with a decreasing ability to understand and communicate ideas fluently; whether it is their ability to speak, their ability to read language, or their ability to write their ideas in various content areas. The purpose of my action research project was to focus on vocabulary, specifically, mathematical language, in order to help students develop a better understanding of mathematical concepts. I was very interested in strategies that would affect all students,

including students from diverse backgrounds and students within my classroom with varying ability levels.

My project was designed to develop teaching strategies that allowed me to effectively close the gap of abilities that students have, through an emphasis on vocabulary instruction. I used the analysis of the research to guide my instruction. As I researched books and articles related to this topic, the following themes emerged. First, I realized, students' ability to be capable readers was critical. Second, their ability to communicate in a variety of ways is important to their understanding of mathematical concepts. The majority of the articles I reviewed reflect current studies. However, some articles, that were older studies, indicated to me that knowledge of precise vocabulary in content areas had been an ongoing concern in the field of research for a number of years.

Students' Abilities to be Good Readers and Its Relationship to Vocabulary Use

As I began my inquiry into students' abilities to be more consistent in using mathematical language, I discovered that prior to using precise math terms, students must have the ability to be good readers. According to Rasinski (2004), reading required readers to process the text, its surface meaning, and comprehend the text, its deeper meaning. Students must be able to expend as little effort as possible in decoding, comprehending, and automatically processing the general language within the text before they could begin to comprehend and make sense of new vocabulary and language specific to a content area such as math.

As I searched for key components of developing the skills of reading, vocabulary knowledge kept showing up over and over. According to Billmeyer and Barton (1998), developing skills of reading was not so much about teaching students how to read as it

was about teaching students to use reading as a tool for thinking and learning. The research they conducted over the past ten years revealed that vocabulary knowledge was the single most important factor that contributed to reading comprehension. Because each content area had its own unique vocabulary, or lexicon, teachers needed to incorporate vocabulary work into their instructional strategies in each content area.

According to research reported by the National Reading Panel (2000), research in literacy education described the strong connection between readers' vocabulary knowledge and their reading comprehension. In a review by Blachowicz and Fisher (2000), they reported that students who received little support for vocabulary growth in their daily lives had a vocabulary gap compared to students whose family backgrounds valued reading. This study also reported that good vocabulary instruction could teach students the words they needed to know to learn to read. The report indicated that students from low-literacy homes placed in high-literacy classrooms could reverse the effects of limited prior literacy experiences. The study also pointed out that a young student's reading vocabulary usually ran about two years behind his or her oral vocabulary. In addition, students needed to be exposed to concepts in books and written materials in order to develop additional vocabulary and vocabulary comprehension.

Blachowicz and Fisher (2004) suggested four practices that teachers could use to promote vocabulary development. First, teachers should develop word awareness and love of words through word play. Second, teachers needed to deliver explicit, rich instruction to develop important vocabulary. Third, teachers must instill in students strategies for independent word learning. Finally, teachers should engage students actively with a wide range of books.

Incorporating vocabulary into instructional strategies was a very complex process, according to Stahl and Nagy (2006). Their work focused on the many facets of vocabulary development. They indicated that vocabulary knowledge and reading comprehension correlated so highly (from 0.85 to 0.95 range), that some authors have argued that the two are psychometrically identical. Vocabulary acquisition came from many sources. The most noted difference of early vocabulary development indicated that children from professional parents had 50% more exposure to words than working class families and five times greater exposure than children from the lowest income homes. However, good school experiences could overcome the effects of inadequate home experiences.

Communication Skills and Vocabulary Use

In order for students to demonstrate their knowledge of vocabulary acquisition, they needed to be able to communicate the language in a variety of methods. Students needed to be able to express language in both oral and written communication. Students needed to be able to use these skills in informal as well as formal settings. Throughout this literature review, an obvious difference was reflected between children who come from different cultural backgrounds as well as different socioeconomic backgrounds. The following research also reflected that students' abilities to communicate were connected to their exposure of personal experiences. Students who came from lower socioeconomic backgrounds or environments of poverty had less variety in family, community and educational experiences. Thus, they had less exposure to literacy experiences.

Heath (1990) reported on an extensive study that compared two different communities. She presented a descriptive narrative on the development of patterns of

language used within communities that are influenced by cultural patterns. Children's ability to use and communicate language was highly influenced by the face-to-face relationships of people within their social networks. When students experienced limited social connections, for example, limited to their family and neighborhood, they had a tendency to only develop language necessary to communicate basic needs within the family or neighborhood setting. These individuals' exposure to outside knowledge and concepts was minimal at best. These students had limited opportunity to develop a large language base of vocabulary.

Heath (1990) discussed an additional study that described the use of journal writing in a high school mathematics class that made use of recorded consumer mathematics. Students recorded transactions with local merchants. The students used a journal writing strategy to help them make the connection between keeping records of financial transactions as a necessary skill when dealing with budgeting their money. This different approach to mathematics incorporated problem-solving strategies, provided practice in initiating additional strategies, that helped students understand critical details, and provided a different kind of practical learning experience.

The following articles supported the need for students to develop communication skills within the content area of mathematics. Each of the articles presented strategies that were more student-centered versus direct instruction by the teacher. As students developed their ability to communicate, both orally and through written communication, careful planning by the teacher was necessary so that the direction of acquisition of mathematical language became an avenue where student ownership of language dominated versus being teacher directed.

Schwarz (1999) studied a rural K-12 school district located in the Midwest. His research targeted a program that enhanced vocabulary development and communication within the content area of math. Evidence for the existence of the problem included teachers' observation, class discussion, Arithmetic Done Daily (ADD), assessment of mathematics performance, and journal entries. Strategies studied included vocabulary journals, math journals, a vocabulary word wall, and Multiple Intelligence strategies in order to reach all learners. Post intervention data indicated increased understanding and use of mathematical vocabulary, performance, and communication.

Another study by Schoenberger and Liming (2001) focused on improving students' mathematical thinking skills through improved use of mathematics vocabulary and numerical operations. The targeted population included sixth grade mathematics students from a variety of ethnic and socioeconomic backgrounds. The program involved a variety of strategies to develop better communication between students. Strategies used included pair-share, direct instruction, student-made glossaries of mathematical vocabulary, and self-monitoring. These strategies led to an increased use of vocabulary words in literal and abstract sentences and identify parts of mathematical equations. Students also demonstrated an increased ability to accurately recognize cue words when completing word problems.

Kotsopoulos (2007) reported on student discourse within the mathematics classroom. She studied her ninth grade classroom discourse through taping their conversations in the classroom. She also noted that students had difficulty in their inability to distinguish between meanings of terms due to interference from everyday language. She described this as textual interference. Kotsopoulos stressed that teachers

need to be explicit and intentional in developing students' mathematical register and provide learning opportunities for students to use mathematical language.

The need to help students develop good communication skills was one of the more complex concepts to develop. As Stahl and Nagy (2005) reported, "children from the most advantaged homes had receptive vocabularies five times larger than did the children from homes with the lowest incomes" (p. 5), also, "Differences in word knowledge occur early in life, and there are dramatic differences in the exposure to new words among families of different social classes" (p. 5). The challenge for me during this project was to have the ability to perceive when students in my classroom were making connections between the three components of comprehensive vocabulary instruction. Those components were teaching specific words, immersion in rich language, and developing generative vocabulary knowledge. Identifying, developing, and using precise content language and general vocabulary was considered by Stahl and Nagy to be a valuable part of verbal proficiency.

Teaching Strategies to Promote Vocabulary Use

Organization of materials was an important skill students need to develop in order to take ownership of their work. The use of binders to organize materials is a suggested technique in developing successful mathematical students. Students could divide the binder into the following sections. There could be sections for keeping journal entries, homework, forms and guides, returned homework, collecting vocabulary entries, and additional materials. Murray (2004) suggested that the procedure of keeping students' work in an organized manner, helped students become independent learners.

Journal writing was another method, which helped students develop logic, reasoning, and critical thinking skills about mathematical concepts. Students who had the ability to successfully communicate, while performing these activities, were more likely to develop competency as mathematicians. Being immersed in the use of language, including specific mathematical vocabulary, was essential to learning and expanding the students' understanding of mathematical knowledge. As students developed the use of precise mathematical vocabulary and used the vocabulary to journal about their work and results, they continued to take ownership of their level of understanding. Borasi and Rose (1989) stated that journal writing introduced a new and important dimension to the mathematical classroom. Journal writing allowed students to reflect on their knowledge. Journal writing also provided teachers with information to meet individual student needs.

Graphic organizers are additional tools used to help students with vocabulary development. Billmeyer and Barton (1998) presented a variety of organizers in their book, *Teaching reading in the content areas*. Concept definition mapping is a strategy for teaching students the meaning of key concepts. The Frayer model is a word categorization activity. It analyzes a word's essential and non-essential attributes and also looks at examples and non-examples of words. Semantic feature analysis is a way to help students compare terms to similar terms that fall into the same category or class, for example polygons. Students can create a matrix that provides a visual summary of features to help examine the similarities and differences. Billymeyer and Barton explained that all of the above strategies relied on one final key strategy necessary to pull the learning all together--the teacher.

Rubenstein (2007) was interested in making mathematics accessible to all students. He reported that students require skills necessary to make the distinction between words used in mathematics and everyday language. For example, words such as prism, fraction, acute, and median could be confusing when used in mathematical language if the students' prior knowledge of such terms were associated with other content areas such as science (prism), an injury (acute pain), or a highway (median). In order to assist students in distinguishing the difference in usage of such vocabulary terms, the students must first have strategies and skills in place, such as knowing how to use a dictionary or content awareness to help them better understand the different applications of the word. For example, knowing which meaning to use when looking up math terms such as plane, bisect, or point. Sometimes students would just copy the first meaning which might not have been applicable to a mathematical concept.

Murray (2004) stressed that teacher responsibilities included establishing an environment for learning. The attitude of the teacher was critical to encouraging students to build their vocabulary, reported Billmeyer and Barton (1999). The teacher's enthusiasm for learning and how he or she models this attitude demonstrated to students that vocabulary development was not only important but was a continuous process that needed to continue for a lifetime. In addition, Murray (2004) stressed the connectedness of five categories necessary to establish this environment. The five categories included classroom management activities, classroom culture activities, classroom rituals, assessment and evaluation activities, and specific vocabulary activities. Murray (2004) stated that when teachers carefully planned for the interaction of the above activities,

students had the opportunity to become individuals who were fluent in the language of mathematics.

Conclusion: Reviewing Relevant Literature

After reviewing the many publications related to the topic of vocabulary, I came to see that many variables must come together in order for students to use vocabulary as a tool to become successful in the acquisition of knowledge, especially in a specific content area. As was reported by Nagy (2006), Payne (2005), and Murray (2004) students must first have the basic skills necessary to be good readers before they could begin to understand and make connections using vocabulary and language specific to a content area such as mathematics. All national, state, and local standards require that teachers meet the needs of all students.

As NCTM (2000) standard stated, students must also have a variety of skills in communication. As reported by Borasi and Rose (1989), the use of vocabulary in journal writing, problem-solving justification, and verbal communication was critical when trying to express one's thoughts and understanding of content knowledge. Many examples of instructional strategies were found throughout the readings to guide teachers on how to best develop and use vocabulary knowledge.

As I reviewed vocabulary development, the complexities associated with its development was mind boggling. I focused on vocabulary language necessary for student discourse and the comprehension of directions as well as specific terms necessary for understanding mathematical content. As I incorporated these variables into my classroom, my results reflected that strategies which focused on specific vocabulary instruction in combination with a cooperative learning environment had a positive impact

on all students no matter their ability or background. Students believed that they had a better understanding of mathematical concepts and the ability to better communicate mathematical knowledge.

Purpose Statement

The purpose of my research project was to inquire into the use of vocabulary instruction as a tool for students of diverse backgrounds and ability levels in order to better understand mathematical concepts. I examined the following variables while seeking the answers to my research questions. The variables were 1) the quality use of mathematical language used during the project, 2) results of vocabulary quizzes and tests throughout the project to measure pre and post vocabulary knowledge, and 3) the quality of mathematical language used in oral presentations to homework solutions.

I was interested in learning if the methods and strategies of instruction that I used would impact the students' ability to better communicate their knowledge of and improve their understanding of mathematical concepts. I wanted to develop within the students more confidence as they acquired more language. As I learned through the literature review, quality instruction could provide the interconnected knowledge of concepts that drive comprehension. As a student develops a richer knowledge about a topic of a text, the more an individual could learn from that text.

I formulated the following research questions to study my problem of practice: 1) What will happen to student achievement after receiving instruction using specific mathematical language? 2) How will students' use of mathematical language improve during oral presentations after receiving precise vocabulary instruction? 3) What will my

teaching look like when I give students specific instruction in mathematical language and vocabulary?

Methods

To begin the process of data collecting, I started by organizing my permission forms. The copies were made for both the students and the parents and necessary interpreted forms for my Hispanic students were done by our office secretary. I asked the reading coach in my building to be in charge of collecting the returned forms. She agreed and came in and explained the project to the students. I had 100% return rate of student and parent consent forms.

Next, I gathered the necessary materials for the project. I organized my calendar to plan my data collecting so that it was spaced out to a manageable timeline. I also prepared the student journals and student vocabulary dictionaries. After the reading coach informed me that all students had returned the necessary forms, I selected my focus group of students. I selected six students who represented students of mixed gender, diversity, and abilities. I selected three girls and three boys. Two students were of higher ability, two students of average ability, and two students of low average ability. Four of the students (two boys and two girls) were Hispanic, and two of the students (one girl and one boy) were Caucasian.

In addition, I recorded my thoughts and classroom activities in my teacher journal. I tried to jot down notes each day and then I made a summary entry once a week. The students also wrote in their journals once a week on topics that we were working on in the classroom. They also made entries into a prepared vocabulary dictionary, which included the entry word, its definition, and a symbolic representation of the entry word.

For their take home practice, students created vocabulary cards on three by five index cards. For their oral presentations, the students were given a check list of expectations (see Appendix A), and I used a rubric (see Appendix B) for the assessment of their presentation.

When analyzing my data, it was difficult to decide which information would best reflect my questions of inquiry. I had collected other data, but after data collection I realized I needed to narrow my focus, and just analyze data pertaining to vocabulary. There were some situations that developed that made data collecting a bit difficult. There were times of inclement weather which interrupted the timeline I had established. Also, one of the students in the focus group was ill for an extended period of time.

Findings

As a math teacher of sixth grade students, I believed I had a professional responsibility to prepare my students with a well-defined foundation of mathematical concepts prior to exiting the sixth grade. When I began planning my project, there was a need for students to have a better understanding of the importance of language as a means of communication in all content areas. Students struggled with the skills to communicate both verbally and in written form. Not only did some lack the skills, they seemed to lack the confidence to put forth quality effort, which translated into poor attitude. I chose vocabulary instruction as the focus of my inquiry. I believed that if students were given the precise words to use within the correct context, and were instructed with strategies on how to use them, they would have the tools to become successful learners.

Throughout my action research project, data was gathered from many sources. I collected data from my mathematics class, my student focus group, student journals, and

my teacher journal. As I analyzed the results of my inquiries, I made several assertions based on the results of the data collected. The following sections are organized in such a way as to present each of my research questions focused on vocabulary instruction and the data that supported the results of my inquiry. I first describe what a typical day looked like in my classroom during the period of data collection.

Typical Day

During my action research project, the environment in my classroom had a different feeling for me. Because I needed to search for answers to my inquiry questions, I experienced a heightened consciousness of the day to day activities. I began each day, knowing that I was looking for evidence. Thus, I was continually aware of student behaviors, my behaviors, and the element of time. My average classroom routine took on a different look this semester.

The period began with what I called a “bell ringer” activity. In order to get the students started without losing instruction time, I had an approximately five to seven minute activity that the students worked on independently while I took attendance. Before they proceeded with the activity, they were expected to open up their notebook to display their homework from the previous day. Students were aware of my expectations to prepare for a possible individual presentation. Usually, five to seven students shared their solutions to the bell ringer activity. Everyone took this seriously because they never knew on whom I would call. This procedure worked well for behavior management. This activity got the students into the room quickly and usually kept them from messing around in the hallway. The practice also acted as a repetition of practice for new terms students were learning within the chapter.

An example of a bell ringer was the use of the laminated vocabulary words off of the word wall. When the students entered the room, I handed them a vocabulary card which had a math term on that they had studied during some previous lesson. Students were expected to say the term, spell the term, give the definition, and write a symbolic representation on the board if possible. The students were allowed to prepare by using their textbook and their vocabulary dictionary, or they asked a peer. After I took attendance, I walked around and put a plus, check, or minus on students' homework notebooks depending on the apparent completion of their homework.

My goal was to make this process as random as possible. I used a variety of strategies to call on students. I used techniques which included student birthdays, words that started with letters of the alphabet, all boys one day, all girls one day, student hair color, and drawing out popsicle sticks with their names. The students were always excited to see how I was going to call on them. The anticipation was a fun way to keep students alert.

Other examples of bell ringer activities included a five to ten minute review of computational problems, writing the steps to a process, or possibly solving a story problem that students could work on together with their table team. In these situations the students would be asked to share their solutions. Once I finished with attendance and the homework check, I called on students to share their answers.

After the review process, about ten to fifteen minutes were spent on checking homework. Students were allowed to ask each other questions if they had concerns over a particular problem. We discussed answers and solutions over problems of concerns. At times, students shared their solutions. I really embraced this practice because the students

who were confident enough to share their solutions acted as role models to my more reserved students. Sometimes, students shared solutions as a team. This practice also gave my more reserved students the eventual confidence to know that they too had mathematical knowledge to share. After all the discussion was completed, I picked up everyone's papers so that I could look the assignments over and record their completion grades.

Following the homework time, I began the instruction time on the next lesson or new concept. I allowed about fifteen to twenty minutes depending on the lesson and the above activities. If a new concept was introduced and materials were needed to be passed out, the team leaders would be responsible for getting those materials for their team. I always had the manipulatives organized by groups ahead of time. Students were then given time to read, discuss, and solve the problems depending on the type of concept. After work time students were then asked to share solutions. Depending on the time, additional practices were allowed or homework was assigned.

This routine was sometimes difficult to follow within a given day. Often, I was frustrated with the time element. The middle school schedule allowed for forty-six minute periods. I did not think this was enough time to allow students an inquiry learning style of instruction. Often when students were at the point of making connections to the concept or idea, time would run out. Beginning the next day, review time was needed and I started the class where we had left off. I would like to have at least a fifty-five minute class period next school year so that there would be fewer interrupted lessons.

When I first started using this practice, students were unsure of working together. They had been conditioned to consider working together on their homework as

“cheating.” However, when I compared it to the game of basketball, in the sense that they had to practice first and then show their skill, the procedure made more sense to them. After homework practices and reviews, I gave the students a periodic formative assessment such as a five to ten question quiz. At the end of each chapter the students took a summative test.

One study practice I allowed the students to do was to select a peer tutor. For example, a student, who indicated he or she would like a peer tutor, selected two to three students from his or her math class or their home room class who were also students of my math classes, to work with. When the student wanted help, he or she could work with the tutor during the end of the day study period. This time could be used for help on homework, review practices, and study for assessments. However, not all homeroom teachers agreed with my study strategy. Some teachers considered this cheating also, especially when the students were working on homework. As a result, students in my math classes often came to my room to work on their math rather than go to their assigned end of day study period classroom.

Managing the time element was at times stressful. Making time for students to write in their journals was sometimes a balancing act. My first goal was to write every Thursday which seemed reasonable. However, when every Thursday came around, there were times when I was torn between writing in the journal and finishing a lesson or needing to give a quiz. I learned I needed to be flexible with every aspect of my daily routine.

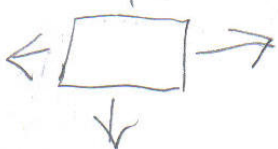
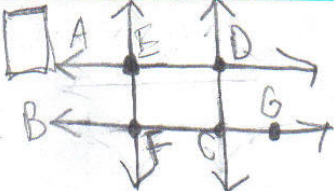
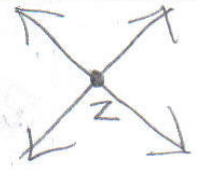
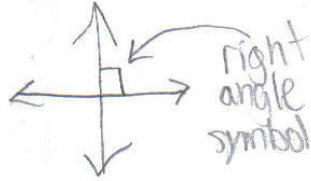

Vocabulary and Achievement

“How can I affect student achievement by using instruction of specific mathematical language?” was the focus of my first question of inquiry. I had always had the belief that in order to measure students’ performance, the performance must always be linked to hard numbers (i.e. grades) in order to show growth. Therefore, I used the following strategies, which included a word wall, student vocabulary dictionaries, and student journals, to try to achieve some measurable results. My goal was to provide the students with a variety of practices so that they did not get bored with the repetition of studying their new terms or using the traditional “copy the word down in your notebook” method.

Students responded very positively to using their vocabulary dictionaries. During my action research project, concepts of geometry were the focus of instruction. As new terms were introduced students were asked to record the terms in their dictionaries. I designed a dictionary page that provided a column for the entry term, its definition, and a section for a symbolic representation of the term (see Appendix C). As each new chapter was introduced, terms were entered in the dictionary. I had the students use their dictionaries for review activities in class. I also had the students create vocabulary word cards for take-home practice. The following figure is an example of Bryce’s* work.

Bryce was a student who consistently produced above average quality work. His work was neat and easy to read. The recordings of his definitions were complete. The symbolic representations were well drawn and labeled as well. Overall, this example of Bryce’s dictionary page was typical of most student entries. The students in the class enjoyed recording the math terms in such a concise way. Many students at this age enjoy

* All names are pseudonyms.

Vocabulary Term	Definition	Example
1. plane	A flat surface that extends in all directions.	
2. figure	A closed shape in 2 or 3 dimensions.	
3. intersecting lines	Lines that cross at a point.	
4. perpendicular lines	Two lines that intersect and meet at a right angle.	
5. parallel lines	Lines that are always the same distance apart.	

drawing and found the symbolic representation a fun way to learn and record the meanings of the vocabulary terms. I observed that most students took the time to do quality work in their dictionaries.

The students often used their dictionaries for a variety of reasons. For example, in the above bell ringer activity, students would use the dictionary to look up the assigned term before their presentation. During review practices, students would use their dictionaries as a study tool to review with a partner. Often, as I walked around checking on student work during practice time, I would have students refer to their dictionary when I noticed a missing symbol (for example the line segment symbol above the letters that identified the segment or the angle symbol in front of the letters identifying the angle).

The practice of using the dictionaries provided a unique way for the students to study and use vocabulary terms. The students who liked to draw liked the additional option of the symbolic representation. By drawing a picture first, students could make a better transition to writing about the word that goes with the picture. Students took pride in their books which was reflected in the high quality of the work (see Appendix D).

This example reflected a student from my focus group. On this assignment, students were to explain the process of constructing angles. Candy volunteered to show the steps. She presented the steps (see example 1, Appendix D) on a poster. As Appendix D reflects, Candy had taken time to use quality handwriting. She made sure the steps were written in a straight line. In addition, she color coded each step so that each step was easily identified. I was impressed that Candy used at least ten terms to describe the steps. The process was very clearly described even though she incorrectly labeled the given measurement, 103° , on the wrong side of the 90° she had the order of the steps correct. Candy also composed a written explanation of the steps (see Appendix D, example 2). Again, I was excited to see that Candy went above and beyond the required explanation of the steps to include her knowledge of the names and measurements of general angle descriptions. Candy displayed a big smile and was proud of her work when she was finished and so was I.

Students also created a cover for their dictionaries. I believe it was important to create opportunities for ownership of student work as often as possible. Students were allowed to use their dictionaries when doing their homework and writing in their journals. The following journal entry reflected Auturo's understanding of angles. Auturo was able to use his dictionary to help him compose the vocabulary words to be included in his

writing. Auturo was a student from my focus group that I selected who was of low average ability and had a limited use of English. I was very pleased with Auturo's composition. He used complete sentences and included the terms to the best of his ability. The quality of his handwriting was very legible also.

Topics or lessons for the week: Angles

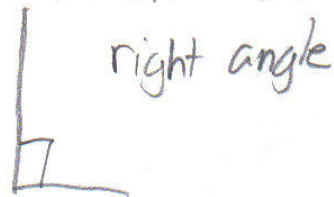
Vocabulary words used this week:

Obtuse angles
drawing angles
protractor

right angles
straight angle
angle

Using the above vocabulary words, describe the new concepts you learned this week. Please end by describing when this skill may be important to know in the future.

Now that I am learning about angles I like them now I used to think I wouldn't like it but now I am. I learned lots of stuff like how to measure angles and how to use a protractor a lot better. I also learned about obtuse angle, right angle and lots of other angles. Another thing I learned was how to use a compass better I used to not know much about them.



As I recorded in my journal,

I observed the students developing a better awareness of the importance of using specific mathematical terms. One student would remind another student to “be sure and say scale” and “don’t forget our model is in proportion of one to four.”

(Teacher Journal, March 10, 2008).

When students were put in groups and allowed to visit as they did their work, the students would remind each other of the expectation to use precise mathematical language. The opportunity to visit while they worked, allowed the students to have an additional opportunity to practice using precise mathematical vocabulary.

Students used many resources as they prepared for their presentations. The students used their textbooks and their dictionaries for symbolic representations, and definitions as they prepared their presentations. The students prepared to present the scale drawings created from cartoon clips during the chapter on ratios and proportions.

Student journals were also used to help students make mathematical connections (see Appendix E). Once a week, time was allowed for students to reflect on the concepts of instruction. The process of reflection and the skill of recording those thoughts was a difficult task. At first their entries were short, quick, and mainly reflected definitions only. As students made additional entries, I used the strategy of brainstorming ideas first on how to better use the language. After modeling ideas and sharing thoughts from student role models more entries began to have more meaningful reflections. Students were writing more complete thoughts and spending more time on their entries (see Appendix F).

When Liliana made one of her first entries in her journal, (see Appendix F, example 1) the entry was very short. I noticed she did not use any of the terms written on the vocabulary words to use from the week. She used complete sentences that were neatly written. Liliana wrote four sentences that described the basic idea describing the project assignment.

In Lilianas' second entry, I noticed that she put more thought into her journal writing (see Appendix F, example 2). This time she used 4 of the 6 terms on the vocabulary word list. This entry was composed of five sentences however, the sentences were more descriptive and of greater length. The sentences also used the terms several times. I was excited to see she wrote about a connection to another content area, social studies and the use of scale on a map.

The final example of Liliana's writing I used reflected the journal topic of small group work (see Appendix F, example 3). The students were divided into small groups in order to provide additional opportunities for conversation and use of language. Liliana reflected on this strategy and her feelings about participating in this kind of setting. Even though her writing did not reflect use of terms, she indicated a positive attitude toward the small group setting. Liliana was a student in my focus group that I considered an above average student but was hesitant to use language because of her cultural background. The journal entry indicated that Liliana was more comfortable to use language in this setting. This last example had several sentences which reflected more thought and time. Liliana even returned after math class on a couple of occasions, during study period, to finish writing in her journal.

Journal writing was one of the activities that I struggled with the most. I could definitely see the value and benefits of the writing process. Giving the students the time to reflect seemed to help them make connections to the value of what they were learning. As one of the above entries illustrated, Liliana saw additional value in scale models because she could use this knowledge in making maps. I was excited to see the connection to social studies. Therefore, taking the time to write was important. However, the time was also the problem. Due to our limited time in the period, forty-six minutes, I often struggled with where to insert journal writing in the week. There were times some students needed to come back during study time to finish their entries.

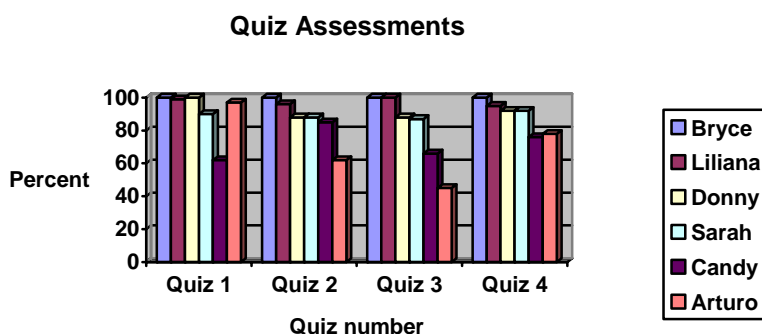
Overall, journal writing was worth the time it took. An additional advantage of this practice was that it provided opportunities for the students to make real world connections. Somewhere throughout the lesson I inquired as to how can this topic fit into our life? Or, has anyone been in a situation where you have heard these terms before? As a class, the students would often get into discussions as to how some of the terms fit into real world situations. I have included two student journal entries that reflected their thoughts on how knowing about the math topic would some day fit into their lives (see Appendix G). I specifically picked these two entries because the entries reflected a struggling student and a top student's points of view.

In appendix G, example 1, Auturo, my struggling student, tried to make sense of math and connections to other areas of the world. In class discussions, the students talked about the terms such as rate, scale and scale models. Auturo indicated how he made connections to math of which he had really never thought of before. He realized the

activities of driving a car (rate) and getting ready for a concert (time) had never occurred to him were activities that made connections to math.

In the appendix E, example 2, Bryce, an above average student, was very to the point in making connections of the math vocabulary to building a house. This student used all the terms in his entry. Bryce had indicated to me that some day he wants to be an architect. Bryce realized the value of knowing the mathematical concepts of lines and connected this idea to blueprints for a house. This entry reflected a typical entry in length. Most students wrote four to five sentences in their journal entries. However, Bryce usually made an effort to include all the terms whereas others tended to use three to four terms.

The third collection instrument I used, in order to see measurable growth from student performance, was assessments. I was hoping that these scores would be the “hard” evidence I needed in order to reflect success. However, the scores were rather consistent with their past performance during first semester. The following graph reflects the six students I followed throughout the project and their assessment scores.



As the graph reflects, students with higher ability consistently maintained higher scores. Students with average to below average abilities stayed rather consistent also in their performance ability. I was excited about the score for Arturo on quiz one. He was

one of my struggling students. His grade reflected above average performance compared to the remaining scores. I believe he worked hard during this project to change his attitude toward math. His journal entry reflected his feelings,

Now that I am learning about angles I like them now I used to think I wouldn't like it but now I am. I learned lots of stuff like how to measure angles and how to use a protractor a lot better. I also learned about obtuse angle, right angle, and lots of other angles. Another thing I learned was how to use a compass better I used to not know much about them (Student Journal, April 1, 2008).

Student journal entries indicated that students were learning new materials and enjoyed their math projects and instruction methods. Students increased the use of vocabulary terms as they progressed through the project. The quantitative data instruments were not as representative due to the time element. A three month period of time was not sufficient to reflect consistent results. However, when I provided students time to work in groups, communication of precise mathematical language continued to occur. In addition, when students were allowed to work with partners or team members using the cards from the word wall or student dictionaries, the number of repetitions and use of precise vocabulary terms increased and appeared to contribute to the retention of the concepts being taught.

Vocabulary and Oral Presentations

The second question of inquiry I was interested in was, "How will students use of mathematical language improve during oral presentations after receiving precise vocabulary instruction?" This particular inquiry did not go exactly as I had planned. In the beginning, I found it very difficult to get students to volunteer to share their work. I

had to carefully shape this process as part of the learning because students did not want to be seen as having the “wrong answer.” This practice was out of their comfort zone. Many students were unwilling to take a risk of not having the correct solution.

I realized I needed to create a classroom environment for success. When I strategically called on students who had confidence in math skills to share solutions, other students became more comfortable in taking risks. Students who were confident with the knowledge of the content and were willing to accept constructive feedback on the solution acted as role models. As a result, students gradually developed confidence in risk-taking. This practice provided students the opportunity to communicate more often, which resulted in additional use of precise mathematical language during oral presentations of student work.

As the project progressed through the semester, students were periodically asked to share their work with the class. I decided first to call on students who I knew were confident in their work. On occasion, there was an error in the solution such as a calculation, lack of a label, or the student presenter had possibly copied off his or her own paper incorrectly. As students presented solutions, other students were asked to agree or disagree with the given solution. A discussion took place and the student who had disagreed had to prove the error with the work. If the consensus was that the first student made an error, the error was corrected and we discussed how important risk-taking was in order to learn from the mistakes that were made.

I eventually was able to get more and more students to take the risk of presenting their work. The following is an entry I recorded in my journal of Donald’s presentation.

I let them practice with their small group so that they could gain a little confidence in getting up in front of the group. I decided to focus my attention on Donny because I could sense he wanted to present. Donald is a shy, quiet, Hispanic student who is of average to above average ability. As Donald got up in front of the class I could see him muster up the confidence to share, because he was confident of the answer. A conscious effort was made to use mathematical language as he carefully described the process necessary to describe the scale of the drawing. Donald used a quality voice and concluded with “are there any questions?” I was excited to see him take this risk. I’m convinced he was a role model for others to follow (Teacher Journal, March 11, 2008).

As the semester went on, students became more and more comfortable with their presence in front of the classroom. The students continued to develop quality presentations. At the end of the project each student was assigned a project presentation. A mathematical topic was assigned from the content the class had studied during the quarter. Each project needed to include the following three criteria: a visual aid, a written explanation of the topic, and an oral presentation. I gave each student a skills checklist (see Appendix A) for the presentation expectations and the rubric for the presentation assessment (see Appendix B).

Sarah presented the following illustration as the visual aid to support her presentation. As Sarah presented her project, she carefully explained each drawing or picture she had included in the poster. Sarah started at the top by explaining the definition of geometry. On the left side of the poster she included examples of polygons. Sarah also described the different kinds of lines and the tools used in geometry. In the middle of the

poster, Sarah included examples of similar and congruent figures. On the right side, Sarah illustrated how geometrical figures could be found in real life places.

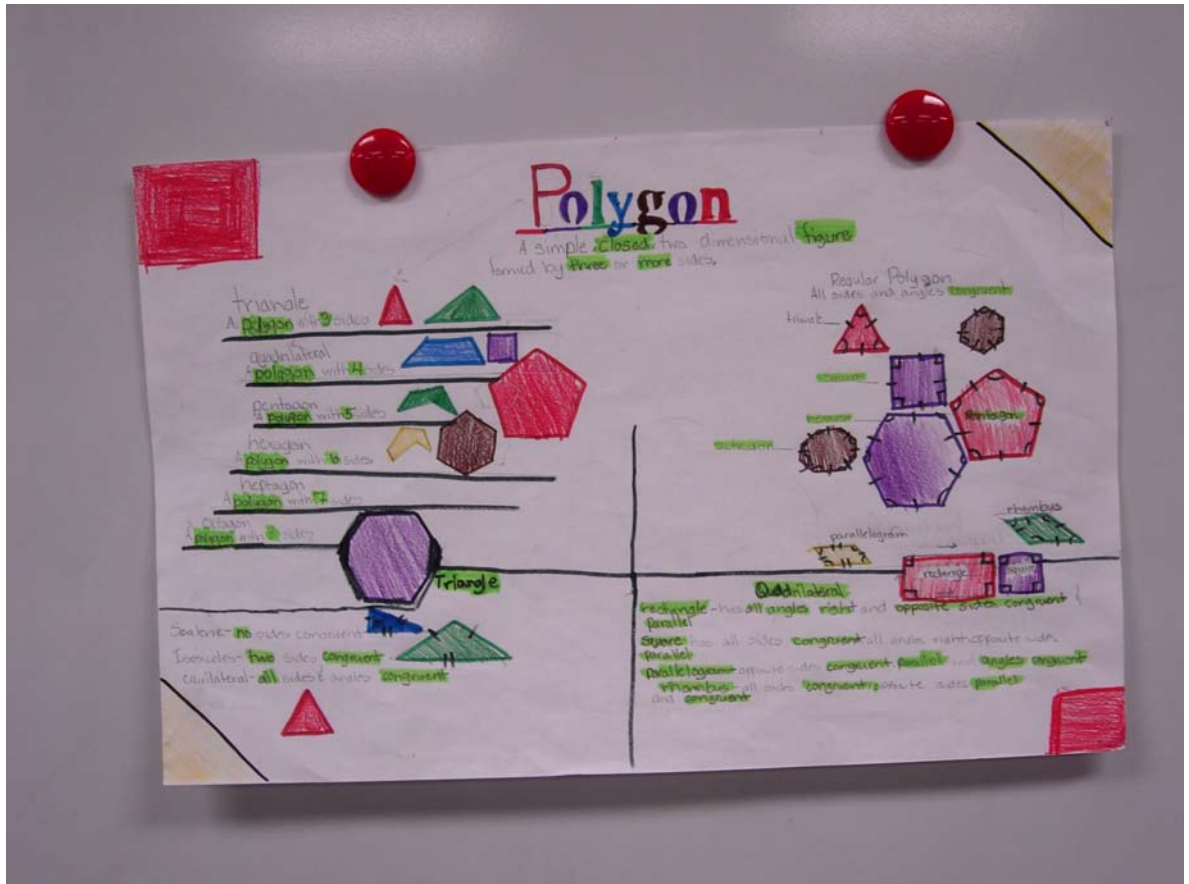
Students were allowed two days to prepare for this oral presentation. I was impressed with the extensive work that Sarah put into her project. As she prepared for her presentation, Sarah spent a lot of time working on terms that were meaningful to her. Sarah allowed class-time to practice her oral presentation with a peer in the hallway. As Sarah presented, she used precise language to explain her topic. I was impressed with the details in Sarah's project. Sarah was so intent in doing a quality job she took her project home both nights to work on it. Sarah was one of the average students I selected for my focus group. Her project reflected above average quality.

Sarah used a written composition to support her project (see Appendix H, example 1). Sarah again exceeded my expectations in her written explanation. She was very precise with the definition of terms. Her writing reflected good organization of paragraph. The paragraphs were organized by topics such as lines, polygons, triangles and quadrilaterals, angles, and tools of geometry. Sarah received a perfect score on her rubric.

Example 1:



In Example 2, Donny presented an oral presentation that reflected his



understanding of polygons. He combined both symbolic representation and labeling on his visual aid. As Donny made his oral presentation, he named each polygon the class studied. I was glad to see that he went into detail with the two polygons that were studied in length. Donny included the different types of triangles and quadrilaterals. This student also went beyond expectations in the written explanation of his project (see Appendix H, example 2). Donny did an excellent job with the use of vocabulary terms as he presented. The only point he lost on the rubric assessment was on eye contact. He continued to be reserved when talking in front of his peers.

Overall, students used complete sentence and specific mathematical terms during their oral presentations. As students presented the results of the assigned topic, I could

tell most students had practiced the oral presentation expectation part of the project. The majority of students used good voice quality and was able to answer questions presented to them from other students. Students who continued to struggle with confidence also struggled with the presentation component of the project. As these students presented, I struggled to hear their voices. The students had a tendency to talk to the board rather than talking to the audience.

My results reflected 67% of the focus group students received 5 out of 5 points on the section entitled student used mathematical vocabulary while presenting their solution. Students who received 4 out of 5 points represented 17% of the scores and students who received 3 out of 5 points represented 17% of the scores. Overall, I was pleased with the results considering very few of my students volunteered to present in front of their peers when I started this project.

An amazing result occurred with the students' written work. Several students demonstrated a more extensive use of written language (see Appendix H). It seems that the improvement in the written work may have resulted from the increased opportunity to communicate verbally in small groups using mathematical language, and the time spent journal writing. Together, the two strategies combined appeared to have given the students more confidence when using written language.

Vocabulary Influence on My Teaching

“What does my teaching look like when I give students specific instruction in mathematical language and vocabulary?” was my last question of inquiry. As a teacher researcher, I started out realizing that the time element, the family element, and trying to balance the project with the expectations of my job created tension in itself. I often

wondered if I was paying enough attention to my students' behaviors. Was I going to be able to gather enough results to reflect adequate findings? What unforeseen factors might influence the work on my project?

One such unforeseen factor was the adoption of a new reading curriculum which ended up adding tension I did not anticipate. Because I taught a section of reading (which I had not taught for several years), I found myself being involved in issues I did not anticipate. I was a part of piloting a new series and my student data had reflected great success. Throughout this process, there was much discussion and debate for and against the program developed.

Those opposing the program called for a hearing in front of the curriculum committee of the school board. I was asked to write testimony in support of the selection process and the curriculum. As a teacher–researcher, I reflected in my journal the following entry,

This controversy is taking more time than I want it to. Attending after school meetings, writing my letter, and going to community meetings has impacted my other responsibilities. I find myself spending extra time on this effort and it is taking away from the focus of my project and my daily planning in general for my math classes; not to mention the fact that my family always seems to be last on the priority list. I am glad they understand this will be only for a limited time (Teacher Journal, March, 2008).

Having to be involved in the many meetings, discussions, and planning for the support of the program was a huge time commitment I did not foresee as I began my research project. A few adjustments were necessary as I proceeded through my action

research, such as holding off on my teacher survey until the reading controversy had settled down a little.

On the brighter side, the remaining time involved in the project was very rewarding. I continually struggled with how to carefully plan my day so as to find a balance between meeting curriculum standards for our current curriculum and planning the time to include the activities I designed for my action research project. I must say I had a new awareness of what I was doing daily. Including the habits of mind problems was exciting to watch. Students enjoyed participating in something new and different. As reflected in one of my students' journals, Sarah wrote,

It was hardest when I got to the picnic one. I did draw a picture though and it helped. I liked it though because it was challenging. I really like this project though. It's kind of interesting because the stuff that you give us is different than what we usually do in this class (Student Journal, April 4, 2008).

Implementing the change of teaching methods and strategies had a large impact on how I approached each day. Every day when my research class started, I was always conscious of "looking for evidence." Instead of looking at "my class of students" I was looking at "the students in my class." By this I mean, prior to this experience, most generally I was always planning for the class as a whole. (I really do not want to admit that, but I am sure I was.) However, as this action research project progressed, I began to look at each student individually. I was constantly aware of how I was teaching, what method or strategy would work for "each" of my students. I wanted to make sure that when I presented the vocabulary and concepts everyone understood my presentation.

Introducing the different teaching instruction methods that were to focus of vocabulary instruction was exciting. At first, I did not know how the students would react to the different strategies of learning vocabulary. I was anxious to get started as I reflected in my teacher journal,

I'm anxious to get started with the vocabulary dictionary and student journal next week. I also plan on starting the word wall as well. I plan on letting students identify the words they feel they know so that they can have some ownership of their learning. My hope is that as they become part of the project, they will begin to build some self confidence with the words they already know and that will motivate them to become more involved. My goal is to have them "teach" the words as we build their vocabulary. (Teacher Journal, February 4, 2008).

As a result, my intentions to focus on specific vocabulary instruction led me in other directions. I found that working in groups, designing cooperative games, using the word wall, graphic organizers, and other methods connected with my methods of instruction, led to other qualitative benefits. Students were using communication skills better between peers and with me. Increased confidence developed among most of my students. Students appeared to have a better attitude toward mathematics than I had anticipated as has been reflected in several of the quotes from the previous journal entries.

I do however want to point out that not all students felt the same as did the majority. I found it interesting that one student, who I would consider an above average student, wrote the following in his journal,

I hate working in small groups because most of the time once they figure out that I'm really good in math all they do is cheat. By just sitting there doing nothing but have me think for them. Sometimes occasionally I have one group that I would like to be in the same group again. I like working with my friends though. There's a quote I made up for all the people I've worked with. "Don't hide in the shadows of the light." (Student Journal, April 18, 2008).

This student wrote a very insightful entry. After reading this entry, I believe I have even more support for the importance in finding the time to allow the students to journal. I doubt I would have ever sensed this feeling from him in a traditional classroom setting. However, by finding the time to allow students to write in their journals, more communication existed between me and my students. I cherished those entries. The means of communication the journal entries provided for me with my students was invaluable and have helped make me a better teacher.

Throughout this project, I became a more active participant in the day to day performance of my math students. As a teacher/researcher I developed a heightened awareness of the factors that contributed to the learning of all students in my classroom. I maintained a continuous awareness of the practices and strategies that would contribute to getting the maximum performance from my students as I noted in the following journal entry,

When I did the first journal entry, students were basically just writing the term followed by just writing the definitions. I wasn't satisfied with their quickness in wanting to be done, or just do it. I had indicated I wanted them to spend about 5 minutes with their entry. This week I decided to use the "brainstorming"

technique of writing to encourage them to put better quality in their work. We took just a couple of minutes to put some ideas on the board related to the terms. This practice seemed to provide others with some ideas on how to get started. The sharing of ideas provided other students the opportunity of where and how to start their entry. I hope this practice will encourage students to write more and eventually the quality of their entries and the using of the terms will be better (Teacher Journal, February 18, 2008).

Creating a positive environment that was safe for risk-taking and provided opportunity for communication was essential. The majority of students appeared to maintain a positive attitude towards math and indicated they preferred the practice of a community of learners. Although not all students agreed, it appears that the practices I used throughout the project resulted in increased performance and use of vocabulary in both oral and written communication

Conclusions

As I conclude this project, I have realized that ongoing research has a major impact on student education. This experience has reinvigorated my desire to never lose sight that each student I teach has a unique learning style. Also, as a teacher I am responsible for maintaining a professional course of action necessary to meet the needs of all my students. Therefore, it is my responsibility to design my instruction and maintain practices that are current with ongoing research in order to meet the needs of every student in my classroom

When I exposed students to a variety of learning strategies and methods of instruction in order to meet the needs of all students I had positive results. When students

used the vocabulary dictionaries as a resource for daily work and project presentations, they included more terms in their work. Students also had a tendency to use the terms multiple times and in a variety of sentences.

Students, who were exposed to a rich vocabulary and were provided with opportunities to communicate, developed a deeper sense of understanding as they practice these skills through repetition. In research done by Schwarz (1999), a program that enhanced vocabulary development and communication within the content area of math included strategies such as the use of journals, a vocabulary word wall, and vocabulary dictionaries. My project reflected the same results. When student activities included a variety of experiences centered on communication, a deeper understanding of the concepts occurred.

During the project, I also began to plan for additional opportunities for students to use vocabulary. I included more project oriented activities in which students used more language. As the students prepared for the oral presentation, they practiced with their peers. These practices allowed for continued communication and repetition of the language with others. In conclusion, as I focused on the use of vocabulary in my classroom, I maintained a heightened awareness of the students' use of language. I continued to plan instruction and opportunities necessary to encourage the students to use the mathematical language in their homework, journals, and oral communications.

Implications

As a result of my study, I plan to use the findings of this project to guide me as a teacher in the future. I have considered using this information in three ways. As a teacher, the results can assist me in setting professional growth goals that are required yearly in

our district. As a peer, I can share the results so that I may assist other teachers of mathematics. I also intend to share the results with our curriculum director. I am hopeful that my intense work will benefit the district in the future.

As a teacher, I believe I will be more sensitive to the needs of all students. Every year, students continue to come to my classroom with a variety of skills and language. As I plan for each new group of students, I will continue to use vocabulary dictionaries, journal writing, project oriented activities and oral presentations as instructional tools. I have come to appreciate the need for a positive and safe classroom environment where risk-taking is a learning experience. I will continue to be sensitive to the needs of all my students. The feelings I have experienced throughout my participation in Math in the Middle will help me realize what my students must be feeling as they try to make sense of math and the connections math has with real world situations. Having experienced the powerful impact as a community of learners, I can appreciate what my students must feel also.

I plan on making better use of student journals in the future. As part of my current job description, I also teach two periods of reading classes. I understand the natural progression of speaking, reading, and writing as necessary skills for students' ability to communicate affectively. As students write in journals, the use of vocabulary increases. I want to make writing a more natural part of my math classes. Giving students the time necessary to reflect on learning and using mathematical terms and concepts creates a deeper understanding of their mathematical knowledge. This practice appears to help the students think more logically also. Writing provides an additional tool of communication.

As a member of the sixth grade team, I will encourage my colleagues to apply some of the techniques to their strategy of teaching. During the school year, teachers of the math department and my sixth grade team have opportunities to share professional growth experiences with each other. I will encourage my peers to use student dictionaries, student journals and more project oriented activities. I will share the results of my findings and so that they too will be encouraged to use more mathematical vocabulary with their students. My sixth grade team also has a team planning period. A goal of mine is to have a positive impact on student performance in our grade level so that the results can be tracked in the district data results.

Our curriculum director has done an excellent job of sharing data results from the Criterion-Referenced Tests and the Norm-Referenced Tests administered in the district. Even though the districts' professional goal during the past year and for this upcoming school year has had a focus on reading, our director has indicated that the next focus for improvement will be concentrated on mathematics. I am hoping the hard work and intense study I have done with this project will be of benefit to our district in some way. I am excited and willing to be an active participant as our district seeks to improve math practices.

This next school year I will be part of a data analysis committee. Over the past several years, the district scores in vocabulary have been the lowest reported. I want to share my data in order to help develop and encourage changes in instructional methods so that the practices of the teachers in my districts support an increase in vocabulary performance. The focus and responsibility of the committee will be to analyze data results and use that information to make decisions regarding the instructional practices

and use of curriculum within the district. I look forward to participation and the work I will be doing with that committee and its impact on math instruction in my district.

In conclusion, I believe all of the above will have a positive impact on me as a teacher. By staying involved with current practices, keeping in good communication with my peers, and participating in ongoing professional organizations, I hope to continue to have a positive impact on the students in my classroom and my district.

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Appendix A: Student Skills Checklist

Student Skills Checklist

Student: _____

Student presentation: _____

Category	Commendable	Satisfactory	Needs Improvement
Eye Contact	Looks out to class	Looks out sometimes	Looks at board or down at floor
Voice Quality	Can be heard clearly	Can be heard most of the time	Difficult to hear
Use of Vocabulary	Uses precise vocabulary terms	Uses terms correctly most of the time	Does not use precise terms or uses vocabulary incorrectly
Visual Presentation	Has clear visual aids	Visual aids are difficult to see	No visual aids or hard to see
Answer responses	Clearly explains answer to questions	Hesitates when responding to questions	Cannot reply to questions

Student checklist for presentation

_____ Student maintained eye contact with the class while presenting their topic

_____ Student used mathematical vocabulary while presenting their solution

_____ Student used good voice volume during presentation

_____ Student was well prepared for presentation (had obviously practiced presentation, knew vocabulary, correct sequenced of solution)

_____ Student was organized with his/her materials

_____ Student was able to answer any questions from other students about result

Appendix B: Student Rubric for Presentation:

Student Rubric for Presentation

Name: _____

Date: _____

Lesson/Topic/Presentation: _____

rating scale:

Scale	1	2	3	4	5
Descriptor	Minimal Effort with skills (needed much assistance)	Struggling effort with skills (needed to assist with organization)	Average effort with skills (presented with few errors)	On target majority of the time with skills (presented with minimal errors)	Student was well prepared, organized, good voice, used terms correctly (no noticeable errors)

Student checklist for presentation:

- _____ Student maintained eye contact with the class while presenting the topic
- _____ Student used mathematical vocabulary during the presentation
- _____ Student used good voice volume during presentation
- _____ Student was well prepared for presentation (presented with confidence, knew vocabulary, had correct sequence of topic)
- _____ Student was organized with his/her materials
- _____ Student was able to answer any questions from other students about results

Comments:

Appendix C: Student Dictionary Page

Dictionary page

Student: _____

Date: _____

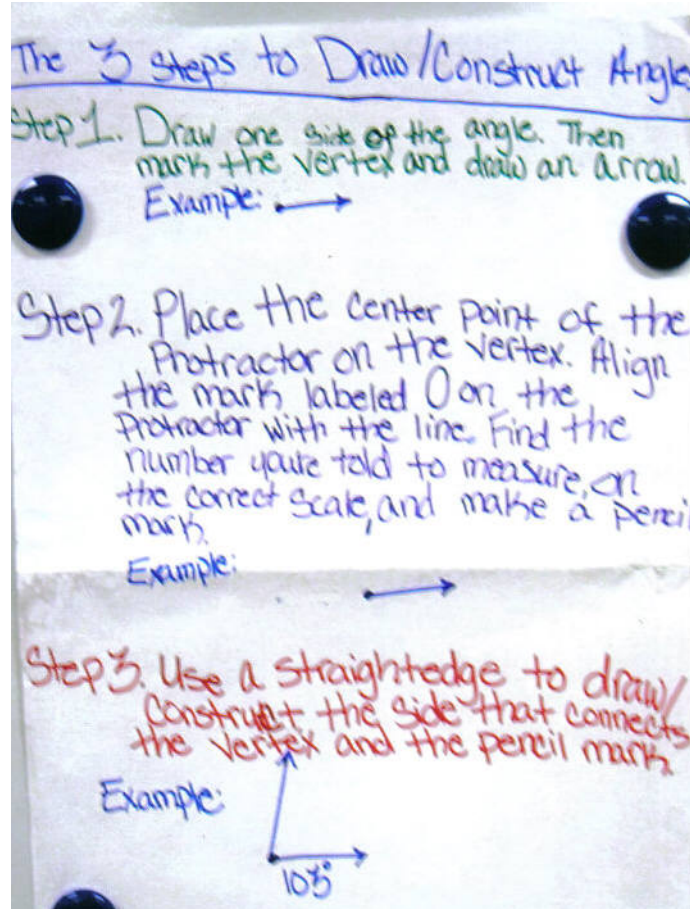
Lesson: _____

Period _____

Vocabulary Terms	Definition	Symbolic Example
1.		
2.		
3.		
4.		
5.		

Appendix D: Student Homework

Example 1



Example 2

Math
Pd. 2

Construction Angles

By: _____

I'm going to teach you how to construct/draw angles. I will also tell you the tools we will be using. I will also tell you the names of angles of the angles. There is 4 types of angles. I'll name them, there is a Right Angle and it measures exactly 90° and has a little symbol indicating it's a 90° angle. There is also an acute angle and it measures less than 90° , there is an obtuse angle and it measure between 90° and 180° . Now there is a straight angle and it measures exactly 180° . I will also teach you the 3 steps to drawing or to construct angles. First construct one side of the angle, then mark the end and draw an arrow. Second you'll place the center point of the protractor on the vertex. Align the mark labeled zero on the protractor with the

line. Find the number you're told to measure on the correct scale and make a pencil mark.

Now third use a straightedge to construct the side that connects the vertex and the pencil mark.

Hope you enjoyed what I showed you!

Appendix E: Student Journal Entry

Student Journal Entry

Name: _____

Date: _____

Topic or lesson for the week: _____

Vocabulary words used this week:

_____	_____
_____	_____
_____	_____

Using the above vocabulary words, describe the new concepts you learned this week. Please include by describing when this skill may be important to know in the future.

Appendix F: Student Journal Entries

The following three examples represent Lilianas' growth in her journal entries:

Example 1:

Topics or lessons for the week: scale drawing project

Vocabulary words used this week:

scale

model

proportion

grid

Using the above vocabulary words, describe the new concepts you learned this week. Please end by describing when this skill may be important to know in the future.

I choose a picture of Garfield. I got the picture from the newspaper. We have to draw what's on the picture on a big piece of paper. Then we're going to color the drawing.

Example 2:

Topics or lessons for the week: Ratios, proportion, scale

Vocabulary words used this week:

scale

ratios

unit rate

scale model

rate

Scale drawing

Using the above vocabulary words, describe the new concepts you learned this week. Please end by describing when this skill may be important to know in the future.

I learned what a scale is. A scale is the ratio that compares the measurements on the drawing or model to the measurement of the real object. I could use a scale if I want to know how far it is from one place to another on a map. I also learned that a scale drawing is a drawing that is similar but measurement either larger or smaller than the actual object. I could use this for a map.

Example 3:

Topics or lessons for the week: Small groups

Vocabulary words used this week:

Using the above vocabulary words, describe the new concepts you learned this week. Please end by describing when this skill may be important to know in the future.

I like working in small groups because I think it's fun. It makes things less serious. I also like it because you don't have to be embarrassed of asking the teacher a question because you can just ask someone who is in your groups. I think working in small groups is also good for studying because I think studying with other people is more useful than studying alone. It's also useful because if you need a pencil or lead you can just ask someone in your group. I think that without small groups math would be as dull as the color gray.

Appendix G: Journal Entries

Example 1

Topics or lessons for the week: ratio, proportion, and scale

Vocabulary words used this week:

ratio

proportion

scale

rate

scale model

unit rate

Using the above vocabulary words, describe the new concepts you learned this week. Please end by describing when this skill may be important to know in the future.

I like all the definitions because it's a new thing I learned and I am amazed on how much math there is in the world I think it will help me in the future when I am driving, or fixing a car see how much time I have to fix two cars or how much time I have to get ready for a concert. At first I thought why should we learn math but now I learned all this new stuff I know why we should learn math.

Example 2:

Topics or lessons for the week: Geometry

Vocabulary words used this week:

geometry

ray

plane

figure

parallel lines

perpendicular lines

Using the above vocabulary words, describe the new concepts you learned this week. Please end by describing when this skill may be important to know in the future.

I learned how to count how many lines are in a figure. I learned how to name a plane. I learned how to name lines parallel, intersecting, and perpendicular to a different line like in a cube. This will be important in the future because when you built a house you will need to know how to tell lines apart in the blueprints.

Appendix H: Students Written Work from Project Presentations

Example 1

Geometry is the branch of mathematics that deals with the deduction of the properties, measurement, and relationships of points, lines, angles, and figures in space from their defining conditions by means of certain assumed properties of space.

Lets go into detail and figure out some different types of lines.

Some different types, are line segments, wich are: straight lines that do not extend forever, but have two extinct endpoints, intersecting lines, wich are: lines that meet and share a common point. Paralell lines, are two lines in the same plane which never intersect, and finally rays, are, a "straight" line that begins at a certain point and extends forever in one direction.

Now, we're going to look at polygons, wich are closed figures made by joining line segments, where each line segment intersects exactly two others. Examples of polygons are: triangles, wich are a three sided polygon, a quadrilateral wich is a four-sided polygon, and a pentagon, a five-sided polygon. There is also a hexagon, wich is a six-sided polygon, a heptagon, wich is a seven sided figure, and the last two are, nonagons and decagons. A nonagon is a nine-sided polygon, and a I'm sure you have already guessed what a decagon is but I've better tell you any ways, it's a ten-sided polygon.

Now that I've told you about the BASIC triangles and quadrilaterals, I'm going to tell you about some DIFFERENT types of them. Some different types of triangles are: an equilateral triangle, a triangle having all three sides of equal length, an isosceles triangle, wich is a triangle having all three sides of equal length. Some other types are triangles such as, scalene triangle which is a triangle having three sides of different lengths, an acute, obtuse, and a right triangle. An acute triangle is a triangle having three sides of different lengths, an obtuse triangle, wich is a triangle having an obtuse angle, and a right triangle, wich is a triangle having a right angle.

Now let's learn about some different types of angles, angles are two rays that share the same endpoint. There are 4 different basic types of angles, there are acute, wich are angles measuring between 0 and 90 degrees, there are also obtuse and right angles, right triangles are angles measuring 90 degrees. Obtuse angles are angles measuring between 90 and 180 degrees. Some other types of angles are complementary, supplementary, and vertical angles. Two angles are called complementary angles if the sum of their degree measurements equals 90

degrees. Two angles are called supplementary angles if the sum of their degree measurements equals 180 degrees, and vertical angles are angles that have the same degree measurement or any two lines that meet.

Now we must learn about the tools you use in geometry so we can get started and maybe even start measuring some angles, making designs, making angles and all those other fun things you use/make, in geometry. The tools are, rulers, compasses, and protractors.

Example 2

Polygon is a simple, closed, two-dimensional figure formed by three or more sides. Anything that you draw is a polygon or made up of polygons. There are many different kinds of polygons that have names. Such as a triangle which is a polygon with three sides. A quadrilateral with four sides, pentagon with five sides, hexagon with six sides. Heptagon which is a polygon with seven sides and octagon with eight sides. These are all specific polygons. There are many kinds of shapes and sizes. That's why there's regular polygons which is the same as polygon but all sides and angles are congruent. These regular polygons can be seen in signs on the streets or in houses and more.

Triangles and quadrilaterals have names. A scalene triangle is a triangle with no sides congruent.

An isosceles triangle is a triangle that at least two sides are congruent.

An equilateral triangle is all sides and angles congruent. Quadrilaterals also have names.

A rectangle is one. It has all angles right. Opposite sides are congruent. A square is another. All sides and angles congruent. And the angles are right.

A parallelogram has opposite sides and angles congruent. And opposite

sides parallel. A rhombus is the last

one. Opposite sides and angles are congruent

And rhombus sides are parallel.