University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Action Research Projects | Math in the Middle Institute Partnership

7-1-2009

The Use of Vocabulary in an Eighth Grade Mathematics Classroom: Improving Usage of Mathematics Vocabulary in Oral and Written Communication

Amy Solomon
Kearney, NE

Follow this and additional works at: http://digitalcommons.unl.edu/mathmidactionresearch

Part of the Science and Mathematics Education Commons

Solomon, Amy, "The Use of Vocabulary in an Eighth Grade Mathematics Classroom: Improving Usage of Mathematics Vocabulary in Oral and Written Communication" (2009). *Action Research Projects.* Paper 29.
http://digitalcommons.unl.edu/mathmidactionresearch/29

This Article is brought to you for free and open access by the Math in the Middle Institute Partnership at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Action Research Projects by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

The Use of Vocabulary in an Eighth Grade Mathematics Classroom: Improving Usage of Mathematics Vocabulary in Oral and Written Communication

Amy Solomon
Kearney, NE

Math in the Middle Institute Partnership
Action Research Project Report

in partial fulfillment of the MAT Degree
Department of Mathematics
University of Nebraska-Lincoln
July 2009

The Use of Vocabulary in an Eighth Grade Mathematics Classroom: Improving Usage of Mathematics Vocabulary in Oral and Written Communication

Abstract

In this action research study of my mathematics classroom of eighth grade students, I investigated the use of mathematics vocabulary by focusing on improving the usage of this vocabulary in both oral and written communication. I discovered oral communication tended to show more improvements compared to written communication done by the same group of students. As a result of this research, I plan to continue to focus my teaching on the use of mathematics vocabulary in an effort to help my students gain a greater understanding of the daily use of that vocabulary.

Through my years of teaching, I have found that the majority of my students were unable to use the proper language of mathematics while expressing ideas or even asking questions. It has become common practice for teachers to simplify the language of mathematics to help students complete the tasks at hand rather than focus on the appropriate terminology. In previous years, I have accepted this lack of formality and proper mathematical language for a few reasons. First, our previous textbook series did not have high expectations with respect to vocabulary. The text placed emphasis on computational skills. Second, the leaders of our district did not encourage the focus of our student assessments to be on mathematics vocabulary. And third, a majority of my students were, and still are, second language learners. Expecting them to not only master the English Language but also the Mathematical Language seemed to be a daunting task.

Last year our district adopted the Saxon (2007) curriculum, which heavily emphasizes mathematics vocabulary. Our district also started assessing students differently with respect to the State Standards. Many of my students are still learning the English Language; however, due to the fact that the curriculum and assessments have changed, I have been forced to look past any native language issues and start working on their mathematical language. As I began to think of a topic to study for my action research project, looking at my students' usage of mathematics vocabulary, in both oral and written communication forms became a perfect choice for me.

I teach mathematics in a sixth through eighth grade building in a city located in central Nebraska. The total enrollment of the building is 587 students. There are approximately 200 students at the eighth grade level with nearly three-fourths of the students being Hispanic and one-fourth being White. Out of the 2,953 students in the district, 74% receive Free/Reduced meals, 39% are classified as English Language Learners, and 15% receive special education services. The mobility rate of students in the district is 17%.

I taught eighth grade during the time of this study, the spring of the 2008-2009 school year. My day included one section of seventh grade math, which I taught to the eighth grade students who did not pass math during the previous year; two sections of Pre-Algebra, otherwise referred to as eighth grade math; and one section of Algebra, which was ninth grade material taught to advanced eighth grade math students. In addition to teaching those four classes, I also taught one section of eighth grade reading and one section of Math Interventions, where I spent additional time working with students who struggled in math.

At the start of the 2008-2009 school year I began to address the vocabulary concerns of my lowest math students. I included the new vocabulary for each lesson during instruction. The students were given a Math Language sheet (Appendix A) with the new words listed, and I had them individually look up the meaning for each word. Once they had completed the sheet during that same class period or the following day, we would go through the definitions. My goal was to make sure my students understood each word. At times this was an easy task but toward the end it became more difficult as my students did not understand the words that were used in the actual definition or they were not sure which definition to use for the particular word being looked up. The students were then supposed to keep their Math Language pages in their binders so they had them for reference when working on homework. As the year progressed I was not seeing the improvements in understanding the new vocabulary that I was hoping for by just using the Math Language sheets; therefore, I decided to focus my attention on formally studying my teaching using this action research project.

PROBLEM STATEMENT

The National Council for Teachers of Mathematics (NCTM) addresses the usage of mathematical language as part of the Communication Standard for grades six through eight in the

Principles and Standards for School Mathematics. Students should be able to "use the language of mathematics to express mathematical ideas precisely" (NCTM, 2000, p. 268). I do not see my students communicating using the precise language of mathematics. Many struggle with this because previous teachers, in addition to the curriculum, did not expect students to use precise mathematical language. I wanted to make a change. I wanted to encourage my students to not only gain new computational knowledge during the year but also learn and appropriately use the language of mathematics.

By helping my students develop and use mathematical language appropriately, I believed I would give them a stronger foundation to build upon in the future. Knowing the vocabulary used in mathematics during the middle grades would give students a greater base to draw from as they progressed through the more advanced mathematics courses at the High School and College levels.

LITERATURE REVIEW

Upon looking at others' research as I prepared for my own action research study, several common themes emerged. These themes were: the use of note cards to develop an understanding for the mathematics vocabulary, writing in the classroom using the vocabulary to explain mathematical processes, peer evaluations/review of classroom writing, specific vocabulary instruction and purpose, and use of classroom discussions.

NOTE CARDS

Understanding mathematics vocabulary can be challenging for students. This can be especially challenging for those students who do not have a firm grasp on the English Language. Winsor (2007) conducted action research in his ELL classroom along these same lines of thinking. While teaching at a High School in Southern California, Winsor began searching for

ways to help his students learn mathematics. Winsor used Word Squares, among other techniques, to help students learn and understand mathematical terms. A Word Square is a note card that has been divided into four parts: one part containing the mathematical term in a student's primary language, another part containing the term written in English, a third part containing the definition writing in either language in the student's own words, and a fourth part containing an example of the term. Winsor found that using Word Squares "required more of them (the students) than just memorizing a definition" (p. 374). Winsor stressed the importance of not only having a space for the term and definition but also making sure the students have an example that is directly related to the term to help make the connection.

Reading a mathematics text in Middle School can be challenging for many students. Gay and White (2002) also discussed the use of a note card to help students make connections between new vocabulary words and definitions. Their article was more of an informative piece of literature that gave some specific examples of ways to help students learn different vocabulary words in the math classroom. Prior to writing this piece, however, the authors indicated they had done some work in classrooms to determine a few methods that worked with students to help them understand the vocabulary. Again, the authors suggested dividing the note card into four parts: the first part for placing the term, the second part for writing the definition, the third part for the students to draw a picture that would help them remember the term, and the fourth part for a word or picture that related directly to the mathematical usage of the term. This strategy "can be introduced to students who are learning new vocabulary or used by students to review terms needing clarification" (p. 35). The unique quality of these particular note cards was the part where the students could draw a picture of their choice that would help them remember and learn the assigned term.

Each of the aforementioned authors discussed a variation to using the note cards to help students better understand the vocabulary. Both articles stressed the importance of the actual mathematical term and definition. They each also had a space for an example that was directly related to the term. The major difference between the two was that one relates to English Language Learners who also need to have information in their native language whereas the other group already has a grasp of the language and can relate the math term to something else. In my classroom, we have done similar activities where students are required to write the term, the definition, a picture to help them understand the term better, and then a sentence using the term to show understanding. Another use of the note card that I found interesting and am hoping to use in my classroom is to "put a word or phrase in each section and direct students to describe common attributes or name the relationship that exists" (Gay & White, 2002, p. 36). I will try using this as a form of review with my students to see how they are doing with the new vocabulary and concepts.

WRITING IN THE CLASSROOM

Writing can be equally challenging for students, especially within the subject of mathematics. Winsor (2007) used journal writing in his classroom to help students learn the material and language. Students were "allowed to write in the language they felt most comfortable with, but they were required to write the mathematical terms in English" (p. 375). Winsor shared that the first journals of the year held very few mathematical terms when students were expressing their ideas; however, over the course of the year, their journal entries improved and their use of mathematical terms increased.

Stromberg and Ramanathan (1996) conducted research in their own classrooms where they provided notes for their students. These notes were in two-column format where the first

column contained the notes and the second was left for the students to fill in additional notes and thoughts. “At the end of each chapter the journals were collected...the method provided additional feedback from students as to the nature of their understanding” (p. 160). Stromberg and Ramanathan also compared final scores on class projects from the previous year and the current year to see improvements and found improvements in the students’ grades.

Approaching mathematics using reading strategies was the focus of the article by Borasi, Siegel, Fonzi and Smith (1998). The teachers in this study provided their math students with essays and other readings. Each reading was about an actual event in history that required the use of mathematics. Students were asked to read the provided readings, and then write questions about the reading or mathematics behind the work on the note cards, drawing pictures to help clarify the question when needed. The purpose of the cards was not strictly the writing of them but “revisiting and further exploring the student-generated cards in various ways also contributed to the students’ understanding of the text read” (p. 293). The teachers, who used this method, then took the cards and placed them into different categories to continue the development of the math concepts as the students would see them. The researchers found that the students were able to learn the material and the teachers were better able to identify what the students did and did not understand.

Although the forms of writing in the classroom differed, each study resulted in benefits for the teacher(s) as well as the students. By encouraging students to write about the material being presented, students were able to learn the material better, they were able to express their own thoughts on each concept, and the instructors were able to evaluate a students understanding of the material being presented. Winsor (2007) used the writings to help his students process the mathematical terms and lessons that had been presented. Stromberg and Ramanathan (1996)

used the writings as the lessons were being taught, and Borasi, Siegel, Fonzi and Smith (1998) used the writings to challenge students to take what they already knew and expand to gain a greater understanding.

PEER EVALUATIONS OF WRITING

In addition to writing journals in the classroom, Winsor (2007) also had his students read other students' journals. "Students would exchange journals with a partner, assign a score to the journal entry, and give a written rationale for their score" (p. 375). Winsor goes on to share of the benefits of this exercise saying that the students were forced to defend their journals at times, which again helped to reinforce the mathematical content of the journaling.

Using peer evaluations helped to raise student grades and efforts in the study conducted by Stromberg and Ramanathan (1996). In addition to the two-column notes/journals, Stromberg and Ramanathan also had their students write longer papers about various mathematical topics. The papers were evaluated by their peers prior to the final draft being submitted for grading by the instructors. Stromberg and Ramanathan found that "the system was a huge success: it made the students critique themselves so that improvements were self-motivated" (p. 160).

Having peers evaluate writing in mathematics appears to not only benefit the writer but also the evaluator. Many Language Arts teachers have told me that when a student reads a peer's paper, he or she is forced to think differently and evaluate the content, grammar and flow of the work. Likewise, students tend to think differently about their own work when they are writing and editing. Both Winsor (2007) and Stromberg and Ramanathan (1996) stated that the peer evaluation time was beneficial and worth the time taken in class to complete.

SPECIFIC VOCABULARY INSTRUCTION

"Many terms used in mathematics are also used in everyday language, which can present a source of confusion for students" (Rubenstein, 2007, p. 203). Rubenstein went on to share examples of some of the sets of words that are used in both everyday and mathematical language, words with more than one meaning, and words that are commonly confused in math. Rubenstein also emphasized the importance of identifying an appropriate order in which to teach some of these terms keeping in mind the difficulties students have. For example, Rubenstein suggested teaching the radius of a circle in one lesson and emphasizing "the root of radius, which is ray" (p. 205). Then in a different lesson, she suggested teaching diameter and discussing "segments joining two points on a circle. Describe the length of the longest secant as the diameter" (p. 205). By teaching these terms in separate lessons Rubenstein found that some of the confusion between the terms was eliminated.

Jackson and Phillips (1983) also stressed the importance of identifying and teaching specific vocabulary to help students understand and improve mathematically. They conducted research in which "a total of 117 vocabulary terms and 36 symbols" were deemed important and used to help guide instruction (p. 338). For three of the six classes in the study, vocabulary-oriented activities were put into place. These activities were done daily for 5 to 10 minutes and the remaining time was spent in "regular" instruction. At the end of the study, it was found that "those students who received vocabulary-oriented instruction achieved higher verbal and computational scores than their control group counterparts" (p. 341). This finding emphasized the importance of not only identifying important terms but also taking time daily to help the students learn those terms.

Rubenstein (2007) as well as Jackson and Phillips (1983) stressed the importance of identifying terms that may be difficult for students to understand or remember. Finding ways to

help them gain the needed understanding varies from specific word lists and key concepts to teaching more from a Language Arts style of identifying the root of the word. Neither article gave specific activities or lessons that could be used to help students understand the words. In my own classroom, I have been working on this very concept by identifying terms that are new to the lesson or are difficult to understand or remember.

CLASSROOM DISCUSSIONS

McNair (2000) shared that the content of the classroom discussion is just as important as the written text being used. “As students are exposed to and develop more mathematical concepts these concepts can be integrated into their discussions providing a degree of mathematical refinement” (p. 199). This proves to be true in all classrooms, when students learn more they are able to express more, likewise if they hear more in a discussion they are learning more content. McNair goes on to address the importance of the teachers’ directions and questions that give purpose to the discussion.

Forman and Ansell (2001) discussed the changes from past to present when it comes to classroom discussions. In the past a “discussion” was represented by the teacher asking a question, the student responding, and then the teacher affirming or correcting the student. More recently, classroom discussions have moved to where “the teacher’s role is to help students structure their talk” (p. 119). Teachers do this by helping to keep things organized where all students have a chance to participate, asking students to think more on the question at hand and explain their rationale behind their response, and by helping “referee” disagreements to help the students process and come to a conclusion regarding the topic at hand.

In my own classroom I see both McNair’s (2000) and Forman and Ansell’s (2001) points. The more my students talk about the content, the more they seem to grasp the information being

presented. They may not be able to completely grasp the concepts or the “appropriate” use of terms, but they have a better chance understanding the material if they talk and respond to one another and to myself. Forman and Ansell also make a good point about the way my classroom has changed over the years. I no longer repeat a student’s answers; I now try to help the students see further and expand what they already know in order to help them gain a greater understanding of the content.

SUMMARY OF THE LITERATURE REVIEW

Teaching mathematics is more than just teaching numbers. Teaching mathematics directly relates to reading and writing skills as well. My action research focused on improving students’ usage of mathematics vocabulary with more accuracy and fluency, both in oral communication as well as in written communication. Upon reading past research I found that there were many different ways to help improve my students’ usage of mathematics vocabulary. Using note cards to help them visualize what they were learning, writing about math problems and evaluating peers’ writing are ways that have been shown to help students improve. Also, there is a need to focus on specific vocabulary instruction and planning lessons in a manner that will help reduce the confusion (or mix up) of some common terms. As a teacher, one also has to continue to work on leading classroom discussions so there is a definite purpose to the conversation.

PURPOSE

The purpose of my project was to improve student usage of mathematics vocabulary with more accuracy and fluency both in oral and written communication. I examined the research themes of student vocabulary usage in communications with the teacher and the students’ ability

to express themselves in writing using appropriate mathematical terminology, in seeking to answer the research questions:

- After students are presented with vocabulary instruction at the beginning of each Lesson, how will students use mathematics vocabulary in conversations with their teacher?
- After being given instruction on the appropriate use of vocabulary in written form, how will students communicate in writing when asked to solve a mathematical problem and explain their process?
- What happens to my teaching and lesson planning as I revise my lesson plans to focus on math vocabulary?

METHOD

I began collecting data for my action research project on March 17, 2009, and ended on May 1, 2009. I focused my research on my lowest math class, the group of students who were taking seventh grade math for the second year in a row. I conducted individual as well as focus group interviews at the beginning and end of the study. I collected individual writing samples a total of four times. In addition to writing samples, I also kept a weekly journal where I wrote about my thoughts and observations of my students through the research period as well as my teaching and the changes that occurred.

On March 17 one of my paraprofessionals handed out the permission forms and informational letters containing the information about my intended research, as directed by the IRB. My paraprofessional, a retired Language Arts teacher, was familiar with the process of professional research; thus, it was very easy for her to help out and explain to my students what I was studying and why it would be helpful to have the forms returned. My research started with a brief interview with small groups and individuals. I asked them to solve a given problem and

explain what they were doing (Appendix B). These groups and individuals were selected randomly using a random number generator and an alphabetical list of students in the class. In addition, I also collected an individual writing sample given to the entire class where I asked them to explain the process used to solve the given problem (Appendix C). By conducting the group and individual interviews, I was able to determine my students' current usage of mathematics vocabulary in conversation with me as a teacher. Additionally I was able to assess their vocabulary in written form using the individual writing sample.

Through the course of the study I had my paraprofessional field any questions concerning my study, as well as distribute additional copies of the permission forms. Unfortunately out of the 22 students in this class, she only received 8 parent permission forms back. As a result of this, many of my students felt that since they had not brought back the paperwork they did not have to participate. Because of this attitude, a different twist was put on my data that I had not expected. Due to the lack of responses and the randomness of my small group and individual interview participants I did not have a large volume of data to analyze.

On April 3, and then again on April 17, I had my students complete an individual writing sample (Appendices D & E). We had been working on using appropriate mathematical terms when discussing operations as well as formulas. Unfortunately this did not seem to carry through when it came time for them to write about the process. I kept copies of their writing samples throughout the research period to help me determine if they were in fact making progress. Through the course of my study I also kept a journal. I took note of the conversations happening in my classroom and the use or non-use of mathematics vocabulary, what happened in the room and with the students when working on writing using the vocabulary. I also made note of what I noticed about my own teaching and planning when focusing on mathematics vocabulary.

On May 1 I completed my study in my classroom. Once again I conducted a brief, random interview with small groups and individuals (Appendix F). These groups and individuals were selected randomly using a random number generator and an alphabetical list of students in the class. Two of the students in the small groups were students who had been selected for the pre-research interview. Likewise two of the individual students had participated in the pre-research interview process. Additionally I took one final individual writing sample from the entire class (Appendix G). At this point I was able to determine if my students' usage of mathematics vocabulary in conversation with me as a teacher had changed or improved. Additionally I was able to assess their vocabulary in written form using the individual writing sample.

FINDINGS

I began a typical math class period during my study by checking the previous day's homework. Blessed to have technology in my classroom, I used an ELMO Visual Presenter to project the solutions of the daily homework on the screen so my students were able to see the solutions as I also read them aloud. This proved to be very beneficial as many of the students in this class were not only behind a grade level in mathematics but many also had some sort of disability, whether Attention Deficit Hyperactivity Disorder (ADHD), Speech Language Disorder (SLD), or Speech Language Impaired (SLI). Because of these additional issues, many of my students had a difficult time focusing if I was just reading or talking. The use of the ELMO to visually present solutions as well as my verbal communication of the solutions aided my students.

While going through the solutions to the completed homework, I emphasized the correct *readings* of the solutions (e.g., I would read 0.45 as zero and forty-five hundredths, NOT point

four five). By doing this, I tried to emphasize the importance of the mathematics vocabulary. By having the solutions projected, my students were able to see and hear the correct use of this vocabulary. Once we had finished correcting the homework I would try to address any questions that may have arose. This proved to be an interesting time during class as many students would try to keep me answering questions to prevent the next lesson from being presented. Once I finished with questions, we started on the next lesson in the text.

At the start of each new lesson I gave my students a Math Language Page (Appendix A). I allowed between five and 15 minutes to complete this page depending on the number and/or level of difficulty of the words. I asked students to use the glossary in their text or a dictionary to complete these definitions. Once I saw that everyone was done, or had hit a level of frustration and decided to quit, we went through the words together as a class. I highlighted the appropriate definitions and tried to help my students relate the different meanings to specific problems that we had previously worked on or would be working on. Again I used the ELMO as a teaching tool. I either would write the definitions myself or I would take different students' papers and show the class a peers' paper. This proved to be very beneficial for my students with SLD and SLI as they were able see the definitions directly written on the page.

Once through the Math Language Page, we started in on the new lesson. This was often a transition that the students did not even notice as I tried hard to directly tie any new vocabulary terms with the lesson. I also tried to use specific examples to illustrate each of the new terms. Going through the lesson I not only drew attention to the new concepts being taught but also to the new vocabulary related to these concepts. At the conclusion of the lesson, my students were given time to begin working on their assignment. Some days this time was brief while on other days it was closer to 15 minutes. Either way, I gave the class some time to get started on their

assignment. If it was a particularly difficult lesson I tried to have them work on some specific problems first to ensure my availability to provide help and answer questions.

Research Question 1: How students used mathematics vocabulary in conversations with their teacher.

Through the duration of my study I found that most of my students had a difficult time using mathematic vocabulary in discussions with both myself as well as the paraprofessionals. While my students appeared to catch on to the vocabulary and appropriate use of that vocabulary during our Math Language pages (Appendix A), using the vocabulary in conversation did not come naturally. Often the students would attempt to use the terms when having a discussion with me, or one of the paraprofessionals in the room, yet during the discussion many students would wait for a "nod of approval" before continuing through the given problem.

I found in the beginning of my study that my students would express their thoughts about mathematic problems using mathematics vocabulary; however, they were not confident in this. Using my Teacher Journals and observations of class discussions I found that many of my students started off the research period very weak in the area of mathematical vocabulary. I noted one specific example in my teacher journal. As I began discussing the area of a trapezoid and was just about to draw an example on the board, one of my students yelled out "What is a trap – a – whatchamacallit" (Teacher Journal, March 24, 2009). Small group discussions held during class also gave me great evidence of the lack of mathematical vocabulary at the start of my research. While observing one group I heard comments like "…so estimate means guess?" and "…what is area anyway?" I was concerned with these comments as the two terms, estimate and area, have been (or should have been) part of my students' vocabulary for a number of years. Finally when considering the Student Interviews (Appendix B) I found overall that my "students

didn't use much language from math…Just sat, muttered under their breath and did the problem" (Teacher Journal, March 17, 2009).

At the end of my study, some of my students showed improvement with respect to using mathematics vocabulary while having a conversation with me, the teacher. When reviewing my Teacher Journals and observations of class discussions I found one comment that really made an impact on me. I wrote this note after we discussed finding the percent of change. A student, recognizing what the lesson was about, commented "More ratio boxes? At least these we know how to solve, put in the actual and the percents and away we go" (Teacher Journal, April 30, 2009). It was reassuring to hear some vocabulary coming through as well as this student recognizing something we already had discussed.

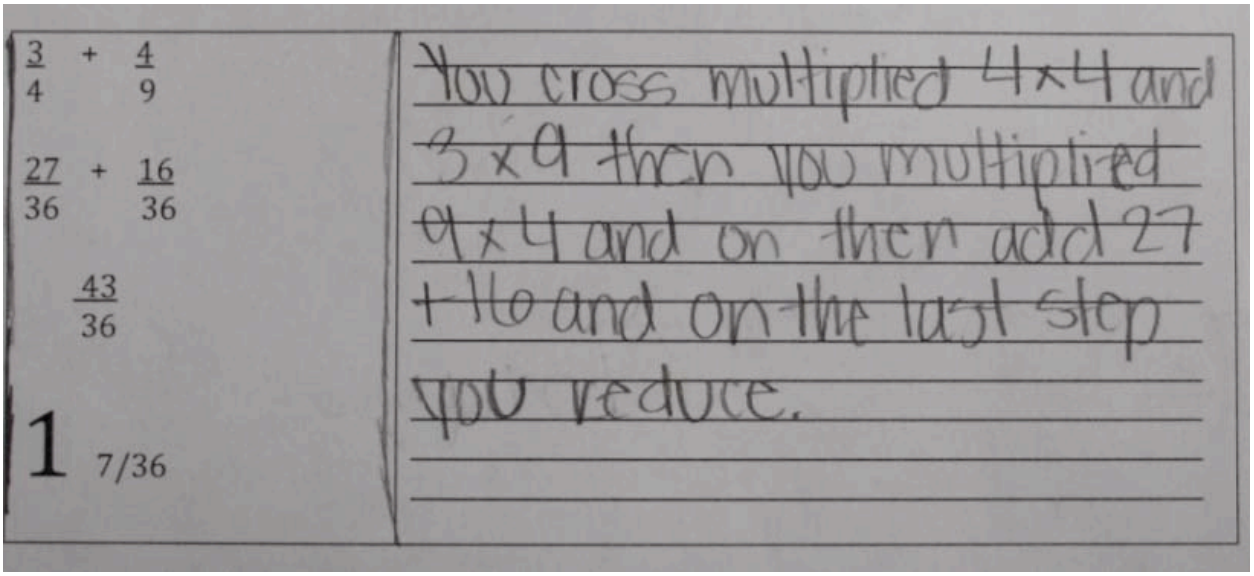
Likewise when looking at comments from small group discussions during class I saw a small amount of improvement. On April 21 we were discussing Diagonals, Interior Angles and Exterior Angles. While working in groups I heard many comments that included mathematical vocabulary. One conversation that I was able to remember when journaling at the end of the day, was part of a discussion between two students; Student 1: "Interior angles, those are like the inside of a room right?" Student 2: "No, Interior angles are inside because it is opposite of exterior which is outside." I was not able to hear the end of this conversation due to other classroom duties; however, it did show me that though they were disagreeing on why interior angles were called interior, both students were on the right track of identifying the angles and they were also using the appropriate terms in their discussion. Finally when considering my Student Interviews (Appendix F), I did not see as much growth. I noted "Most of them are still fearful of talking and didn't say more than to tell me the different units in the problem and mumble through" (Teacher Journal, May 1, 2009).

I found that my students were not using appropriate terms consistently; however, they did show some improvement. When in small group settings, my students would use very few mathematical terms. During both group and individual interviews my students showed very little improvement to their mathematical vocabulary.

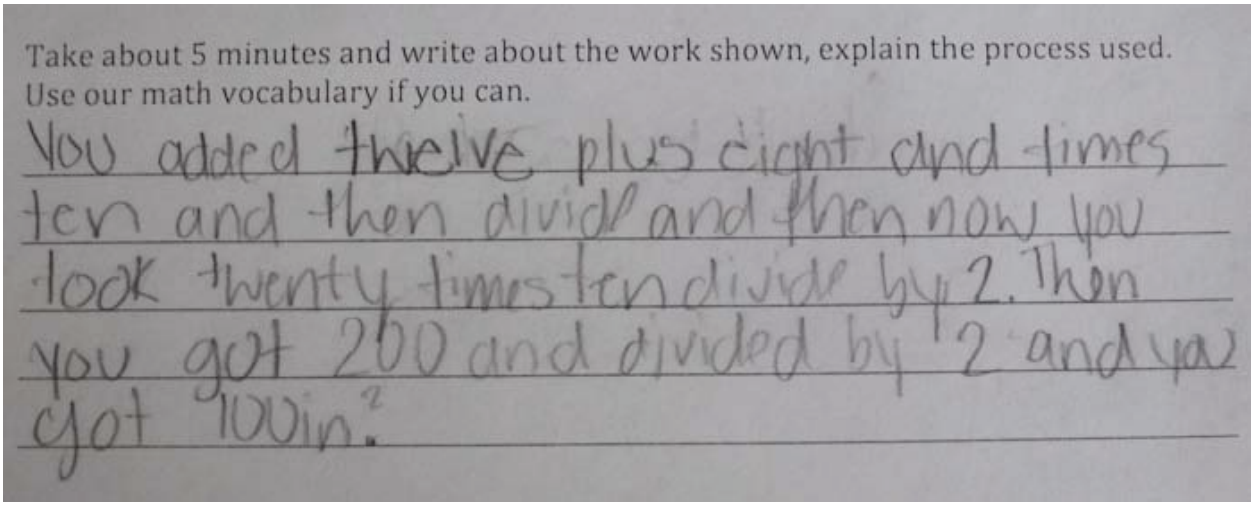
Research Question 2: Students' communication in writing when asked to solve a mathematical problem and explain the process.

In addition to using the vocabulary appropriately in conversation, I also was interested in seeing how my students would communicate in writing when asked to solve a mathematical problem and explain the process they used. I found that some of my students made progress throughout the research period and were able to begin to express themselves with more accuracy during the individual interviews. My students started out a little uneasily about working out problems and writing about their work. When given multiple opportunities to attempt the problems and write about them, my students seemed to have peaked and then digressed. It was difficult to tell if my students had an understanding of written vocabulary usage or not.

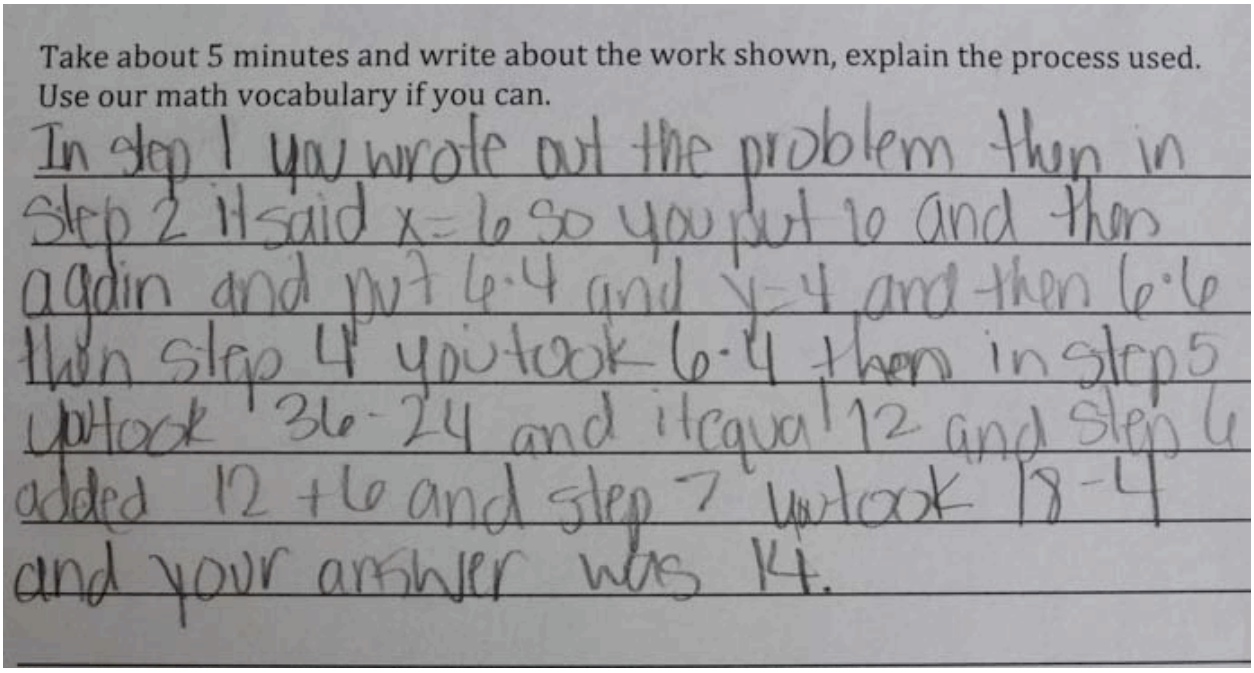
At the beginning of my research I used a Pre-instruction sample (Appendix C) to help determine where my students were prior to changing my instructional methods. I found that their writing was very simple and they did not fully understand the idea of writing about the process used to complete the problem.



Notice that Maria[1] tried to use mathematical terms in her one sentence. I collected various writing samples throughout the research period. Below some samples are shown of the second and third sample taken from class. Maria is very representative of the students in my classroom. She came to me with a minor learning disability that prevented her from passing math last year. She was a good worker and would try hard to please.



[1] All names are pseudonyms.

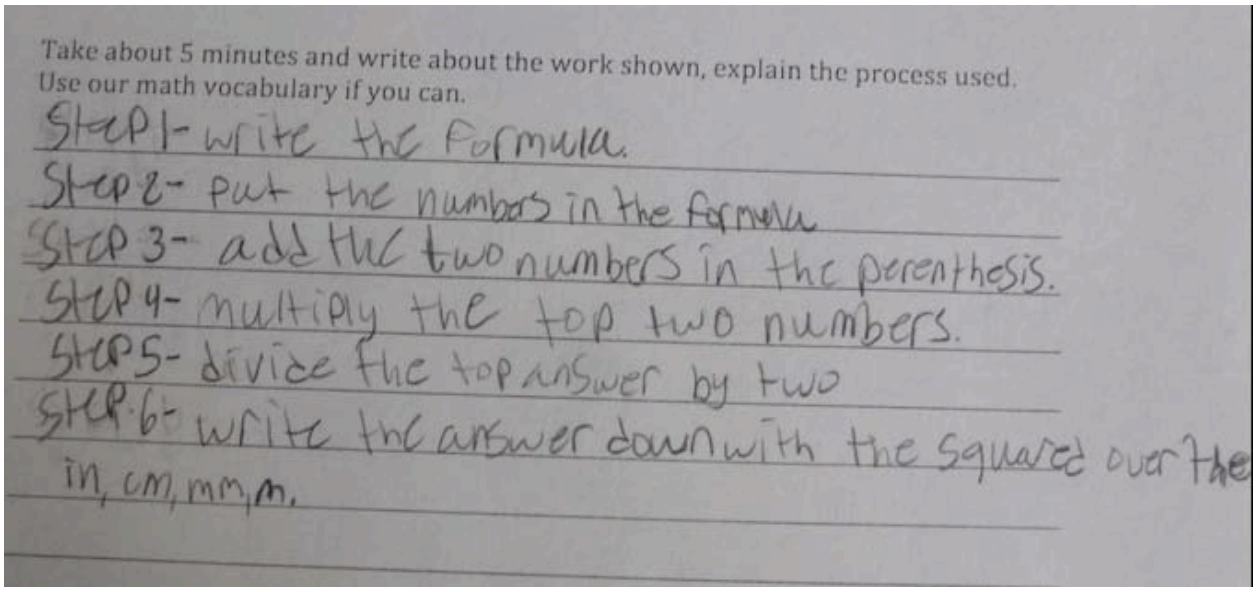


Take about 5 minutes and write about the work shown, explain the process used.
Use our math vocabulary if you can.

In step 1 you wrote out the problem then in step 2 it said x = 6 so you put 6 and then again and put 6·4 and y = 4 and then 6·6 then step 4 you took 6·4 then in step 5 you took 36 - 24 and it equal 12 and step 6 added 12 + 6 and step 7 you took 18 - 4 and your answer was 14.

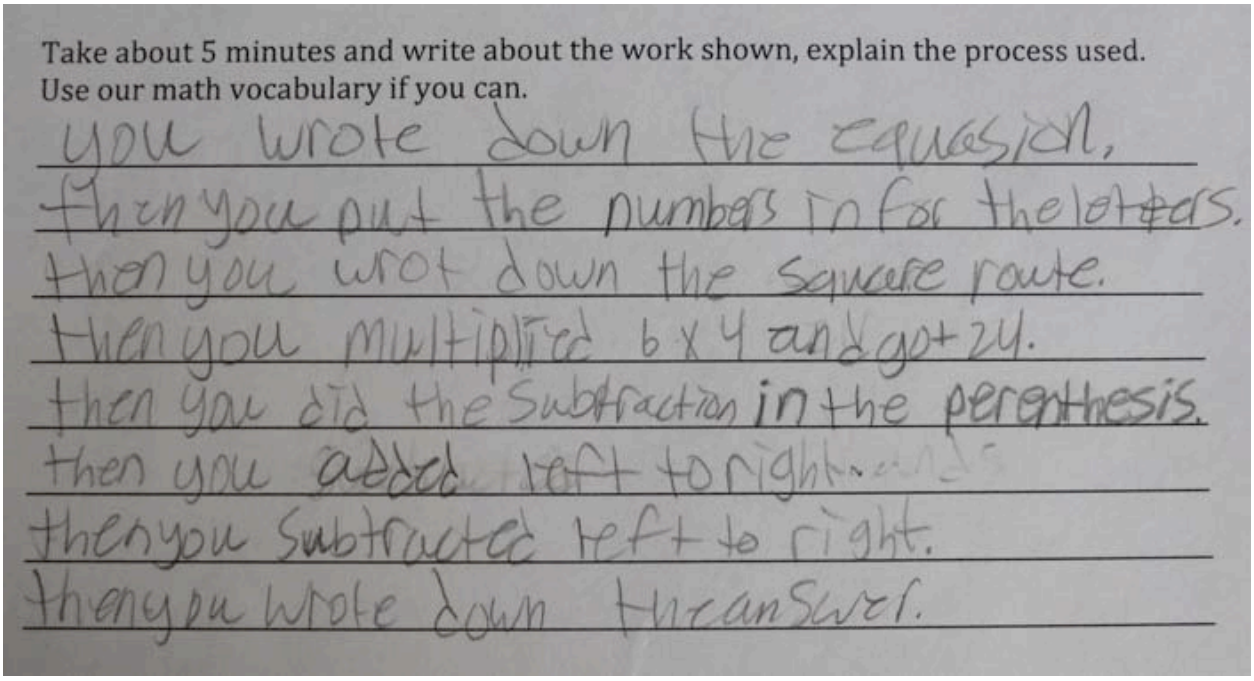
In this third sample Maria had made a step in the right direction for writing in math. She mentioned that x = 6.

Below are two samples from another student who was in my mathematics class. Jim came to me also with a learning disability. Jim was representative of about one-third of the class: he enjoyed math and could do the work but had a very difficult time putting that work on paper.



Take about 5 minutes and write about the work shown, explain the process used.
Use our math vocabulary if you can.

Step 1- write the formula.
Step 2- put the numbers in the formula
Step 3- add the two numbers in the perenthesis.
Step 4- multiply the top two numbers.
Step 5- divide the top answer by two
Step 6- write the answer down with the squared over the in, cm, mm, m.


Take about 5 minutes and write about the work shown, explain the process used.
Use our math vocabulary if you can.

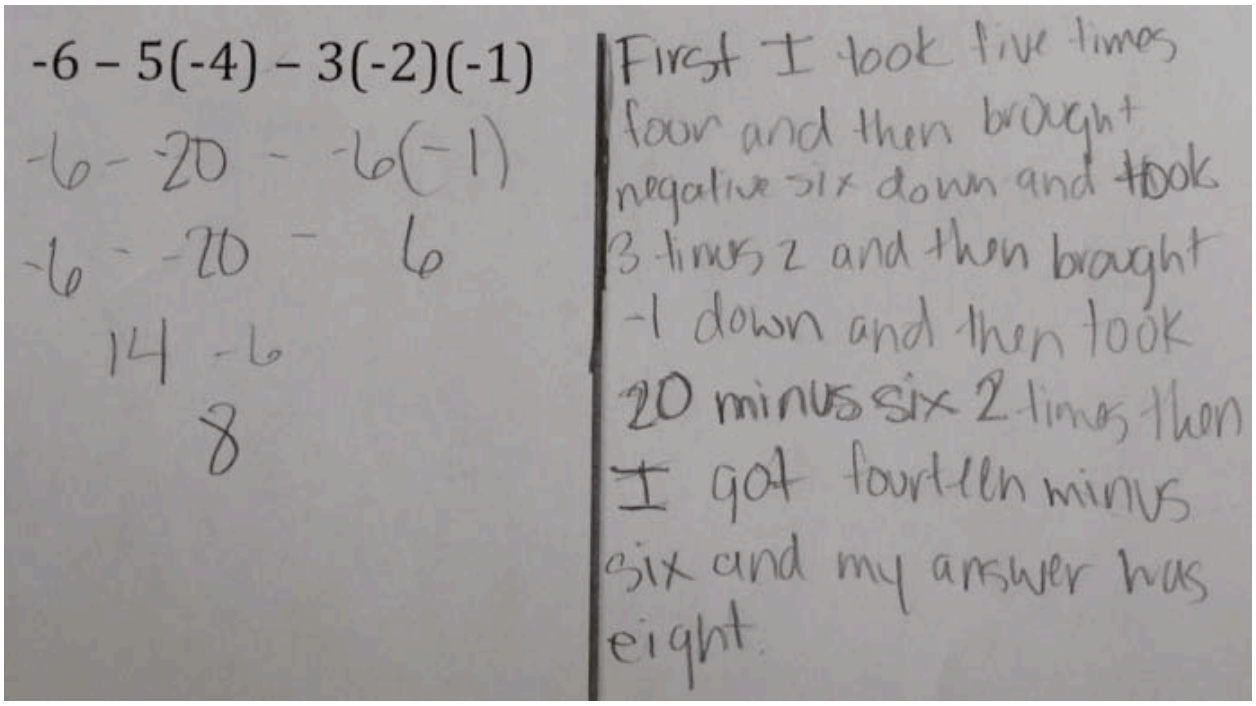
you wrote down the equasion,
then you put the numbers in for the letters.
then you wrot down the square route.
then you multiplied 6 x 4 and got 24.
then you did the subtraction in the perenthesis.
then you added left to right
then you subtracted left to right.
then you wrote down the answer.

In this last sample Jim used an abundance of mathematical vocabulary, which is what was asked. However, one can notice the lack of sentence structure and other grammatical errors. Jim was a very influential student and would do whatever was asked during class; this included the use of math vocabulary in his writing. Notice that in each of these samples Maria and Jim tried to use mathematical vocabulary and there was a small amount of improvement between the samples.

I conducted individual interviews to help assess the writing of my students throughout the research process as well. During these interviews I spoke with random students during class asking them to write about their work. When looking at my journal I made the comment "Students are showing little effort in improving their writing. They seem to feel like math class is not the place for writing" (Teacher Journal, April 16, 2009). Unfortunately, there were very few students who were showing progress.

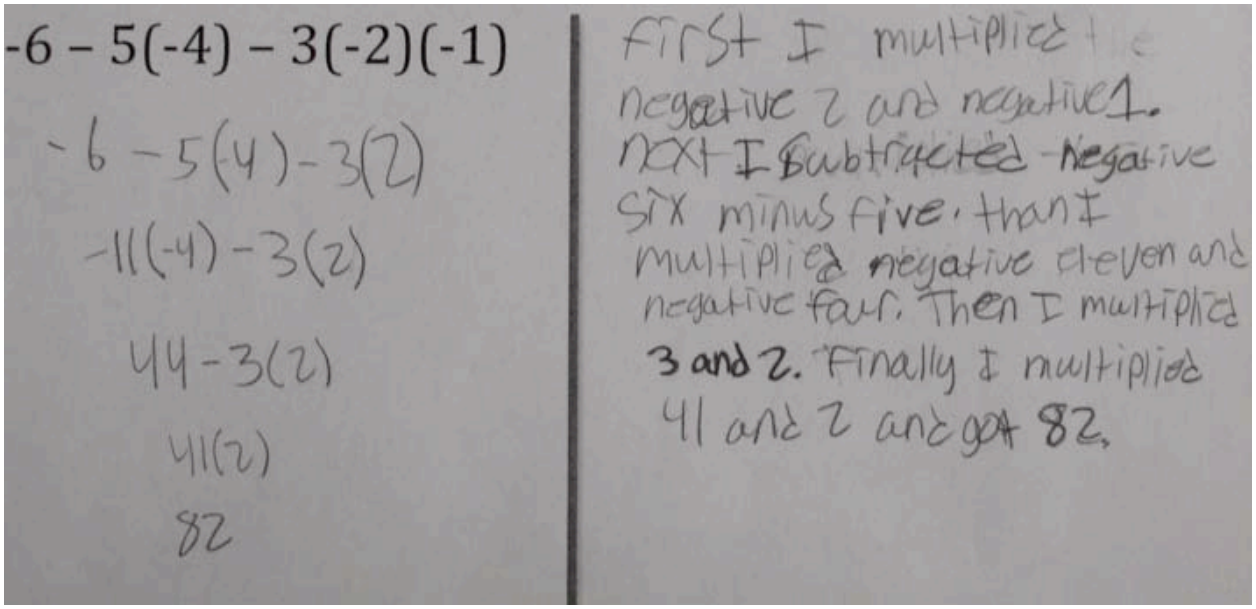
At the completion of my study I collected one final writing sample from my students (Appendix G). Once again as I was looking through these papers I saw that some of my students

were attempting to make improvements and use the mathematical language. Additionally, others were still not showing effort or they were not progressing in the area of writing. Below is an example of Maria's final writing sample.



Through the research period Maria appeared to have made some progress as far as writing out more of an explanation however she did not progress in using the mathematical

terms. This next example is from Jim's final writing sample.



When considering the work of Jim, it is hard to determine if there was much growth. As a class overall, the improvements were difficult to spot and more time would be needed to accurately assess the changes in student writing.

Research Question 3: Changes to my teaching and lesson planning as I revise my lesson plans to focus on math vocabulary.

The last area of interest I studied related to changes in my teaching and lesson planning. Through the course of my study I found that I had to really focus on the task at hand to ensure I gave enough time during my lesson to address the different areas of my study. I found this to be challenging as new vocabulary was not a continuous element in the text. The text reviews many vocabulary terms by the second half of the book, the time frame for my action research study. In some aspects this is a good thing for the students to have review; however, because of the reoccurring vocabulary, many of my students came to believe that they already knew what was going on and therefore shut down. It was difficult to tell by the end of the year if my lesson planning had changed.

At the beginning of my research I found that I was not clear in my lessons when stressing the importance of using appropriate mathematical vocabulary. I also found that I was not leading by example as much as I should have been. In order to address these concerns I reviewed my Teacher Journal and Lesson Plans, my questions during class and my questioning of students at the end of my study. As I looked at my Lesson Plans I saw that at the beginning of the year I did not focus on vocabulary beyond handing out the Math Language Sheets (Appendix A). As the year progressed and I started my action research I found that I was not only taking time during my class period to address the Math Language Sheets but I also was taking time to demonstrate how to write about a problem using mathematical vocabulary. "As I was preparing for this lesson I got to thinking about what the word estimate means to me and to my students…" (Teacher Journal, March 31, 2009). This was a new way of thinking for me. On this same day we worked in class on writing about an estimation problem.

In addition to my own reflections on the lessons I looked at my notes from questioning during class. Through my research process I found that during class my conversations were much better than they had been. Unfortunately I was constantly trying to reinforce appropriate vocabulary due to the fact that my paraprofessional was not reinforcing that vocabulary. On April 7 I made a note directly related to this. We were working through problems concerning the Area of a Circle and having a discussion about the different forms of π. When we got to the form of $\pi = 22/7$ while working with a student I hear my paraprofessional say "top times top and bottom times bottom." This proved to be very frustrating as my students were then getting different messages about mathematics vocabulary. Finally, at the end of the study, I had a discussion with groups of students as well as individual students. Upon reviewing those notes I found that my students did not think I was focusing on the vocabulary. One student I quoted in

my journal as saying “You were always asking us to write even though it wasn’t Language Arts class” (Teacher Journal, May 1, 2009). I do not believe that I was holding up my own standards. I forgot (on more than one occasion) to reinforce the new vocabulary because the book did not consistently introduce new vocabulary. I also found that during class I would slip back into the simplified talk rather than using the appropriate wording.

CONCLUSIONS

I firmly believe that teaching my students language skills in mathematics is something I value. Because of this belief, I need to make some additional changes. Taking time to write in my classroom took time out of my total time to teach. I found that there were many areas where writing or talking were helpful to my students’ understanding of the material. If I had more time to work with my students, I think I would have seen more growth in my students’ writing skills and usage of mathematics vocabulary.

When comparing my work with that of other researchers I find similar points of interest. Winsor (2007) conducted action research in his ELL classroom and found that mathematics vocabulary was challenging for his students. To help his students better understand, he used note cards with the word and definition on it. I likewise found that having my students look up the definitions to unfamiliar or new mathematical words helped them gain a better understanding of its meaning. I also found that if we did not talk about these definitions we had problems. Gay and White (2002) came to that discovery as well and gave some specific examples of ways to help students learn different vocabulary words in the classroom.

In addition to the connection of vocabulary and its definition, I found that it was a very good idea to discuss the use of the word due to many different meanings of the same word. Rubenstein (2007) wrote about this concept in her research. Additionally Rubenstein wrote about

the importance of teaching things in an order that would allow students to see connections. Jackson and Phillips (1983) also addressed the importance of specifically teaching vocabulary words to help students improve mathematically. In my study I found that by taking time to look at the words related to the problems and discussing their meanings in context to the problems, my students had a greater chance of knowing what to do with the problem.

IMPLICATIONS

As I begin to plan for next year I am looking at the curriculum to see where I can focus more attention on mathematic vocabulary from the very beginning. I want to continue to focus on the new vocabulary words in each lesson and continue to have students write in my classroom. I am not sure the best way to go about this as we now have computers for each of our eighth graders. I am considering setting up some sort of folder on the computer that they would have access to rather than having them do all the writing on paper. Unfortunately, until I start the year I will not know which way will be better for my students. I will explore different alternatives until I can find a method that works best for my students. Because of the time it takes to focus on the mathematic vocabulary and the limited time during our class periods, I will need to find a way to either consolidate some of the lessons or not have my students write/type all the definitions. We just do not have enough time to write, discuss, and apply the words and still get to the lessons at hand. This year I felt like I was pressed for time due to the addition of teaching the different vocabulary in addition to the regular curriculum expectations.

Additionally, I am going to continue to try to reinforce vocabulary orally as I go through the given material next year. As a result, I plan to work with the paraprofessional(s) in my room to reinforce with them the importance of consistency and accuracy. I will also have to do this

with the Special Education Teacher to ensure my lower level students are hearing the correct terms and usage of those terms during their Resource period as well.

REFERENCES

Borasi, R, Siegel, M, Fonzi, J, & Smith, C. (1998). Using transactional reading strategies to support sense-making and discussion in mathematics classrooms: An exploratory study. *Journal for Research in Mathematics Education, 29*(3), 275-305.

Forman, E, & Ansell, E. (2001). The multiple voices of a mathematics classroom community. *Educational Studies in Mathematics, 46*(1/3), 115-142.

Gay, S, & White, S. (2002). Teaching vocabulary to communicate mathematically. *Middle School Journal, 34*(2), 33-38.

Hake**,** S**. (**2007**).** *Saxon math, course 2***.** Orlando, FL**:** Harcourt Achieve Inc**.**

Jackson, M, & Phillips, E. (1983). Vocabulary instruction in ratio and proportion for seventh graders. *Journal for Research in Mathematics Education, 14*(5), 337-343.

McNair, R. (2000). Working in the mathematics frame: maximizing the potential to learn from students' mathematics classroom discussions. *Educational Studies in Mathematics, 42*(2), 197-209.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

Rubenstein, R. (2007). Focused strategies for middle-grades mathematics vocabulary development. *Mathematics teaching in the Middle School, 13*(4), 200-207.

Stromberg, A, & Ramanathan, S. (1996). Easy implementation of writing in introductory statistics courses. *The American Statistician, 50*(2), 159-163.

Winsor, M. (2007). Bridging the language barrier in mathematics. *Mathematics Teacher, 101*(5), 372-378.

APPENDIX A

Course 2 Lesson 8

Math Language

1. denominator _____

_____

2. fractions _____

_____

3. mixed number _____

_____

4. numerator _____

_____

5. percents _____

_____

6. vertical tick marks _____

_____

APPENDIX B

Pre-Research Individual and group interview question.

Thank you for helping me out today. You are not going to be graded on your work right now so you can relax.

Please take a minute to look at the following problem. When you are ready, work through the problem. As you are working, please talk out loud so I can hear what you are thinking. While you are working this problem I will be recording what you are saying. I may stop you and ask you questions or I may just let you work through the problem on your own.

Please find the solution

(-3) + |-4| - (-5)

APPENDIX C

Individual Writing Sample #1

Name _____

Please explain the process used to solve the math problem below. Use math terms if you can.

$\frac{3}{4} + \frac{4}{9}$ $\frac{27}{36} + \frac{16}{36}$ $\frac{43}{36}$ $1\ 7/36$	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

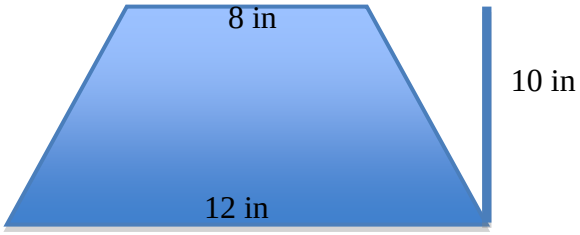
APPENDIX D

Individual Writing Sample #2

Name _____

Please read through the problem and look at the work shown.

What is the area of the trapezoid?



Step 1: $A = \frac{(b_1 + b_2) * h}{2}$

Step 2: $A = \frac{(8 + 12) * 10}{2}$

Step 3: $A = \frac{20 * 10}{2}$

Step 4: $A = \frac{200}{2}$

Step 5: $A = 100 \text{ in}^2$

Take about 5 minutes and write about the work shown, explain the process used. Use our math vocabulary if you can.

_____

_____

_____

_____

_____

_____

APPENDIX E

Individual Writing Sample #3

Name _____

Please read through the problem and look at the work shown.

Evaluate:

$x + (x^2 - xy) - y$

if $x = 6$ and $y = 4$

Step 1:	$x + (x^2 - xy) - y$
Step 2:	$6 + (6^2 - 6\times4) - 4$
Step 3:	$6 + (36 - 6\times4) - 4$
Step 4:	$6 + (36 - 24) - 4$
Step 5:	$6 + (12) - 4$
Step 6:	$18 - 4$
Step 7:	14

Take about 5 minutes and write about the work shown, explain the process used. Use our math vocabulary if you can.

_____

_____

_____

_____

_____

_____

_____

_____

_____

APPENDIX F

Post-Research Individual and group interview question.

Thank you for helping me out today. You are not going to be graded on your work right now so you can relax.

Please take a minute to look at the following problem. When you are ready, work through the problem. As you are working, please talk out loud so I can hear what you are thinking. While you are working this problem I will be recording what you are saying. I may stop you and ask you questions or I may just let you work through the problem on your own.

Use two unit multipliers to convert 81 sq. ft. to sq. yds.

APPENDIX G

Individual Writing Sample #4

Name _____

Please complete the problem shown below. Use the space to the right to explain each step that you took to complete the problem. Keep in mind the Math vocabulary that we have been using as you write your explanation.

$$-6 - 5(-4) - 3(-2)(-1)$$