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Exploring the Influence of Vocabulary Instruction on Students' Understanding of Mathematical Concepts

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ABSTRACT

In this action research study of my classroom of 8th grade mathematics, I investigated the influence of vocabulary instruction on students' understanding of the mathematics concepts. I discovered that knowing the meaning of the vocabulary did play a major role in the students' understanding of the daily lessons and the ability to take tests. Understanding the vocabulary and the concepts allowed the students to be successful on their daily assignments, chapter tests, and standardized achievement tests. I also discovered that using different vocabulary teaching strategies enhanced equity in my classroom among diverse learners. The knowledge of the math vocabulary increased my students' confidence levels, which in turn increased their daily and test scores. As a result of this research, I plan to find ways to incorporate the vocabulary teaching strategies I have used into current math curriculum. I will start this process at the beginning of the next school year, and will continue looking for new strategies that will promote math vocabulary retention.

INTRODUCTION

I have been in the teaching profession for twenty-two years and have always seen students of all ages struggle with mathematics. For the last four years, I have been faced with junior high students struggling on their daily assignments, problem-solving skills, and tests. I teach the below grade level students and higher functioning special education students who struggle with even basic mathematical operations. These students have had fewer opportunities to grasp the meaning of the vocabulary. The focus of their learning has been on the basic math concepts and operations. I believe this lack of knowledge for even the basic math vocabulary is the culprit of their struggles.

With the implementation of a vocabulary program known as L to J, which is a program where each teacher develops a list of essential words they believe the students need to know for their class, and the struggles my students have had on their problem-solving notebooks, I was led to create an action research project that would focus on whole-group direct instruction of math vocabulary. I hoped the direct instruction and use of different teaching strategies for the vocabulary would increase the students' knowledge of the mathematic concepts. With this increase of knowledge, I believe the students' daily homework assignments, problem-solving skills, and test scores would improve.

PROBLEM OF PRACTICE

"I don't know how to do this!", "I hate this!", and "Why do I have to do this?" are some of the negative comments I hear from my students whenever I mention the Habits of Minds journals. My assignments for this journal are all problem-solving type problems. I expect my students to solve the problem and write out an explanation on how they solved it. This is a real

struggle for students in my classroom. My students dread doing their journals and often do not attempt them. This year, my school has implemented a type of L to J program to try to improve our students' vocabulary. Along with every other content area teacher, I have given my math students a list of one hundred-fifty essential words that we will be learning. I introduce some of the essential words with each chapter I teach and hopefully by the end of the year will have gotten to all one hundred-fifty of them.

With looking at the vocabulary program my school implemented and the struggles my students have had with their problem-solving notebooks, I have decided to focus my action research project on math vocabulary instruction. I hoped that by improving my students' math vocabulary it would help them become more confident and improve their daily math grades and test scores.

I believe this problem of practice relates to three overarching NCTM Principles with the first one being the issue of equity. I think that I have high expectations for my students and strong support for all of them. Even though my students are at the lower end of the academic spectrum, I trust that they all have potential. I believe that the school staff may be the only support that some of them receive and that this plays a part in the deficiency they have in basic skills.

The second issue is teaching. I need to have the knowledge of what my students know and need to be able to learn. I also need to be challenging and supporting them every day to learn. If they believe that I do not think they can do something, they are going to lose any self confidence they might have. As the teacher, part of my job is to provide students with hope.

The third and final issue is learning. According to the issue of learning, students must learn with understanding and actively build new knowledge from prior experience and

knowledge. When learning the vocabulary, students should see how mathematical concepts build on each other, such as multiplication and the way it builds on addition. I hoped that by learning the math vocabulary it would help them with the understanding of the concepts and eventually with the computation part of mathematics.

To go a little deeper I believe the two NCTM processing standards that the problem of practice relates to are communication and connections. If the students understand the math vocabulary better, maybe they will be able to communicate it. I hoped that students would be able to use the language of mathematics to express their mathematical ideas precisely, as stated under the communication sections of the NCTM process standards.

Secondly, if the students are able to communicate better, they should be able to make the connections between the different math concepts. They also should be able to apply this mathematical knowledge to other content areas. With this knowledge, I had hoped the students would be able to express and explain themselves better in the Habits of Minds journals.

My ideal classroom would be a room full of students who are willing to take risks and try tasks on their own. I would like the students to be able to interpret and solve a word problem. I know to achieve this that the students will have to have the basic skills needed to successfully plan an action of attack. I also need students who are willing to put forth the extra effort to succeed.

I believe that this problem is worth knowing because my classes over the past few years have really struggled with their daily assignments and tests. The level of frustration that the students and I feel is not acceptable. I want to give my lower students hope and support in order to increase their achievement and building their confidence. If learning and understanding even a part of the math vocabulary helps improve their work and scores, then this project would be very

worthy of my time. I also believe that the results I come up with would help my school decide if the L to J program is really working and worth keeping as part of the school curriculum. Finally, the struggle of making mathematical connections to other content areas and to real life is not exclusive to my classroom. If students can obtain the ability to make the connections from the classroom to real life, then they have demonstrated a life skill.

LITERATURE REVIEW

With my school implementing a program this year to try to improve our school body's vocabulary, I realized that my students over the years have struggled with this and this notion made me start thinking that not knowing the correct vocabulary may be part of the problem. In preparation for my research project, I found eleven research articles/projects. Seven of the research projects took place within the last ten years, one took place twelve years ago, one took place twenty years ago, and the last two took place seventy-five years ago. Even though the last two were researched that many years ago, the findings were still some of the same as the newer projects. All the articles/projects I looked at used a few different strategies to help improve the mathematical vocabulary of the students. In analysis of the research articles, I focused on four separate themes: research background, teacher knowledge/attitudes, student knowledge/attitudes, and strategies/solutions.

RESEARCH BACKGROUND

Many of the research projects I read included quite a bit on the background of why the knowledge of vocabulary is important to the mastery of the math content. Even in 1932, Pressey and Elam's investigations of the matter seemed to show that knowledge of subject matter and mastery of technical vocabulary goes hand in hand. Pressey was associated with Ohio State

University at the time and Elam was at Ironton High School in Ironton, Ohio. They came up with a list of 117 essential words for the subject of mathematics and tested some high school students on the knowledge of the vocabulary, not just the definitions.

The problem of poor mathematical vocabulary has come into the spotlight again with the concern being at the state, national, and global levels. The language of mathematics is more difficult to read than any other subject area. The mathematics material is so difficult to read, "with more concepts per word, per sentence, and per paragraph than any other area", it is particularly crucial to emphasize vocabulary instruction in this content area (Monroe, 1997, p.4). Monroe's study investigated the effectiveness of graphic organizers in teaching the vocabulary of mathematics. The results he found were that graphic organizers can help develop conceptual understanding. Vocabulary research has been done at all levels and social settings. Stahl's and Fairbanks' (1986) study looked at the concerns with the effect of vocabulary instruction on the learning of word meanings and on comprehension. They looked at the curriculum and teachers; Stahl and Fairbanks found two setting factors that have an effect on vocabulary learning and comprehension. These factors are: a) whether instruction is largely individual or done at least partly in a group setting and b) the amount of time allocated to instruction.

As for the curriculum, Schwarz (1999) states that mathematics curriculum needs to focus more on content vocabulary and its usefulness to communicate mathematically through both written and oral means. Schwarz targeted a fifth grade class in a K-12 school district, who exhibited poor understanding of content vocabulary for mathematics. In her study, some of the strategies that helped her target group increase their mathematical vocabulary knowledge were: vocabulary journals, math journals, and word walls.

Bromley (2007) states in her article that teaching vocabulary well is a key aspect. Bromley teaches at Binghamton University in Binghamton, New York and actually came up with this list to develop engaged and successful readers. Along these same lines, Bromley (2007) states that vocabulary is a principle contributor to comprehension, fluency, and achievement.

After analysis of these research articles and projects, I realized that the subject of vocabulary has been an area that has drawn quite a bit of attention from people over time. Back in 1932, Pressey and Elam came up with a list of "essential" words for mathematics that have some still included in the study of Schwarz (1999). Bromley's (2007) article shows that even though the list she came up with was for improving reading, some of the same strategies can still be used in other content areas. This is also what Monroe (1997) was trying to show with his work with graphic organizers. By doing my research project, I found that my results also proved that knowing the meaning of the vocabulary, not just the definition, improved overall the knowledge of the mathematical concepts. I am using some of the same strategies that were used by these researchers.

TEACHER KNOWLEDGE/ATTITUDE

The teaching of vocabulary has been studied for quite a few years with the majority of researchers finding that teachers assume that the students know and understand the vocabulary needed to do the work. In each paper that I read, almost every one stated that teachers do not teach enough of the vocabulary of the content. According to Schwarz (1999), who did her action research as part of the requirements for the Degree of Master of Arts in Teaching and Leadership at Saint Xavier University, there is little evidence that classroom teachers teach content vocabulary as it relates to mathematics. Schwarz used in her research study a program that enhanced vocabulary development and communication within the content area of mathematics.

She also goes on to state that the teacher's attitude toward mathematics influences students' attitudes.

Blessman and Myszczak (2001) also did their action research project on the effects of mathematics vocabulary and student comprehension. They targeted two classes of fifth graders located in two elementary schools in the suburbs of a metropolitan area in Illinois. When it comes to teacher's attitudes, Blessman and Myszczak state in their research that teachers who are curious and passionate about words inadvertently share their enthusiasm with students, and it becomes contagious.

Monroe (1995) came up with four categories of vocabulary that teachers should teach to help students develop mathematical concepts. They are: technical, sub technical, general, and symbolic. Technical vocabulary is generally viewed as mathematical terminology that has one meaning, whereas sub technical terms have more than one meaning. General vocabulary is the everyday language and symbolic vocabulary is viewed by some to be the real vocabulary of mathematics. Teachers agree that math vocabulary affects student achievement and is important to teach. They also need to be aware of the "big picture" when deciding what to teach and how to teach it. Everyone needs to understand mathematics (Blessman & Myszczak, 2001).

Schoenberger and Liming (2001) found in their research that teachers need the following pre-existing knowledge: they must develop instruction that continually spirals, they should not proceed with mathematics instruction until they have considered the students current understanding and how that links to the new material, and that new instruction should also be related to previously learned information. Schoenberger and Liming targeted a sixth grade general education mathematics class and a ninth grade special education mathematics class in

their research. They also used a type of mathematical vocabulary journal and pair-share as part of the strategies.

Each research project had findings that could be valuable to a classroom. The ones that touched on teacher knowledge and attitude have all stated that teachers need to become more aware of teaching the vocabulary along with the mathematical concept. Schwarz (1999) and Blessman and Myszczak (2001) found that when teachers show they are really excited about the subject that students will become more excited also. Monroe (1997) along with Schoenberger and Liming (2001) state that teachers need prior knowledge of the vocabulary to be able to teach it. I plan to use my research project to learn how focusing more on vocabulary instruction will benefit the students' in their understanding of mathematical concepts. I also realize I need to better prepare myself to teach the vocabulary in a way that the students will get excited about it.

STUDENT KNOWLEDGE/ATTITUDE

In the articles and projects that I analyzed, students' knowledge and attitudes were another recurrent theme. Rubenstein teaches preservice students and Master's degree candidates at the University of Michigan—Dearborn, Dearborn, MI. She is interested in making mathematics accessible to all students and in mathematics communication. According to Rubenstein (2007) students see mathematics as a foreign language because of the vocabulary that is used solely in that content area.

Another person who did some research on this was Dresher (1934). He also found results that showed mathematics, like other school subjects, have a technical vocabulary. According to Dresher (1934), pupils cannot work problems if they cannot read and understand them; they cannot understand the explanation of a problem if they do not understand the terminology used. He made these claims almost seventy-five years ago, and just six years ago Blessman and

Myszczak (2001) had basically the same finding. Students must understand the language of math in order to fully comprehend concepts being learned. Also, Schwarz (1999) states in her research that if students are unable to read and understand the directions to a mathematics problem, they will be unable to answer the problem.

Reading these articles shows that the research I am thinking about has been the focus of some researchers for a long time with the findings coming up the same. Students need to be aware that the mathematical vocabulary that their teacher is teaching is something that will be important throughout their lives. Schwarz came up with the conclusion that for students to better understand mathematical vocabulary they must learn to recognize symbols, recognize vocabulary words that name symbols, remember that symbols and words have the same meaning and are pronounced the same, and they need to understand concepts expressed by the symbols and words.

According to Kotsopoulos (2007), students must continually and actively negotiate among the mathematical meaning of a word, its everyday language meaning, and its new meaning as well as its alternative meaning within the mathematical register. Kotsopoulos is an assistant professor in the Faculty of Education, Wilfrid Laurier University, Waterloo. Her research has spanned elementary and secondary mathematics education and she is currently focusing on peer communication, mathematics and special education, and teachers' perceptions of student thinking.

Rubenstein (2007) and Dresher (1934) both found results that proved that mathematics has its "own little" vocabulary even though one did the research in 1934 and one did it in 2007. Blessman and Myszczak (2001) along with Schwarz (1999) found results showing that students need to understand the vocabulary before they can do the work. Teachers and students alike need

to realize that all students need to have a strong understanding of mathematical vocabulary in order to be successful math students. With my research project I wanted to have the students in my eighth grade class find what strategies work best for them to be successful.

Strategies/Solutions

Every research article and project stated different strategies to help students increase their knowledge of mathematical vocabulary. This is showing that the research articles and projects all came up with the same general findings – students need to understand the vocabulary to understand the concepts. Direct instruction in vocabulary influences comprehension more than any other factor (Bromley, 2007), but other researchers found that the strategies used in a language arts classroom can also be used in the mathematics classroom. Word Walls are a good example of a language arts strategy that can work well in mathematics also. Schwarz (1999) states that word walls are useful in the aspect that they provide a space that students or teachers can post key words that may need to be referred back to. With mathematics having so many words that are only used in its content area, Rubenstein (2007) suggests that to focus on the meaning of the roots and to relate them to familiar English words sharing the same roots may help students' understanding.

When looking at the research of Schwarz (1999), Schoenberger and Liming (2001), Monroe (1997), and Blessman and Myszczak (2001) give the following suggestions to help students increase their mathematical vocabulary range by using games, word webs, graphic organizers, and even 3-D pictures. It is very important to use a variety of techniques that hold the students' interest, so that the students' skills will improve. Although each of the research articles and projects that I studied came up with the same general findings, I believe more research would be beneficial. I believe that direct instruction of different types will have a variety of

benefits on my students. I hope to provide my students with the knowledge that will be useful for them throughout their high school and college years. I agree with Stahl and Fairbanks (1986), who found that the effects of vocabulary instruction are subtle and complex, but, given their potential effects on comprehension, they are worthy of further investigation.

PURPOSE STATEMENT

The purpose of this study was to discover how direct instruction of math vocabulary would influence students' understanding and knowledge of the mathematics concepts. In addition, my research assessed how using different strategies affected my teaching. Data collection took place during the spring semester, 2007 in my eighth grade mathematics classroom. This study attempted to answer the following research questions:

- What will happen to students' mathematical understanding after they receive instruction in vocabulary?
- How will students' questioning on homework assignments change after they receive instruction in vocabulary?
- What does my teaching look like when I challenge and support students in vocabulary instruction?

I believe my research is of interest to other teachers in all subject areas. My findings provide other teachers with data that will show knowing the vocabulary does influence the understanding of the concepts being learned.

METHOD

The time period for my data collection was approximately the end of January to the middle of April, 2008. This period spanned from the mid-term of the third quarter to the mid-term of the fourth quarter of the school year and was implemented in my eighth grade

mathematics classroom. The research involved a group of eleven students consisting of ten below grade level students and one special education student.

In my research, I used a variety of data collection instruments and procedures. In order to see how direct instruction of the vocabulary influenced the students' understanding, I did a pre- and post- vocabulary quiz over the chapter's vocabulary (Appendix A). I used the same quiz for both the pretest and posttest. The quiz had ten terms listed that would be used in the chapter, with a sheet containing four squares on it for each word. The students would write the word in box 1, write the definition in box 2, use the word in a sentence in box 3, and draw a picture or diagram that visually represented the word in box 4.

The second method of data collection was student audio interviews (see Appendix B for interview questions). I conducted interviews at the beginning, midpoint, and end of the research. I used the same questions for all three interviews with the exception of adding the final question for the third interview. I interviewed all eleven students all three times. My goal was to see if the students felt more confident in their knowledge of the vocabulary.

A third method of data collection was students' daily work, assessments, and weekly journals. On a daily basis, I collected homework assignments and looked for any major changes. The assessments consisted of chapter tests, state standard assessments, and weekly vocabulary quizzes. With the assessments, the goal was to look for growth and improvement in their grades. The weekly journals were a problem-solving question that the students answered. Each student had to solve and write out their procedure for solving the problem. I used a rubric (Appendix C) to grade the journals. The goal of the journals was to look for the students' ability to use the vocabulary correctly in their paragraph writing (see Appendix D for an example of a student's paragraph about a probability problem). Another form of data collection I used was my weekly

teacher journal. I would review it on a regular basis to watch for any quotes or thoughts that would give me any insights.

FINDINGS

At Garden County Junior High, math classes are grouped homogeneously. I teach the below grade level and higher functioning special education students. My 8th grade math class lasts fifty minutes, five days a week and consists of eleven students. My classroom is an old high school home economics classroom which still has the stoves, refrigerator, coffee maker, washer, and dryer in it. This means the classroom is used by all the school staff, even during my class periods, which causes quite a few distractions that make it hard to keep the students focused. I have the students desks arranged in four pods of five desks and five desks standing by themselves. Three boys sat at the front pod, four girls at the next pod, and the pod right behind the girls sat the other four boys.

On a typical day, class begins with bell work. I put four review problems on the whiteboard that the students do as soon as they enter the room. Since my students still struggle with the four basic operations, these are the type of problems I place on the whiteboard. An example of the review problems are:

1. 34x27 2. 3409-2678 3. 678/43 4. 213089+56732

When the students are finished, for the next five to seven minutes, we go over the four problems together as a group with a different student explaining the mathematical process step by step. The only exception to the beginning of class is on Fridays, when we take the weekly vocabulary quiz instead. After the bell work and discussion, I go over any questions that the students may have on the previous night's homework. This usually takes approximately ten minutes to

complete. Next, we do one of the following vocabulary activities for approximately ten minutes:

Vocabulary bingo – bingo game using the vocabulary terms

Picture words – students draw graphics/pictures representing the vocabulary terms

Ball toss – vocabulary term written on the board, student who catches the ball state the definition

Flocabulary – students make up hip hop, raps, or songs to help them remember the vocabulary terms

Next is the presentation of the day's lesson. I typically lecture about the concept for approximately fifteen minutes. After I have lectured and modeled some examples of the problems, each student gets a small whiteboard to work some problems. The whole class would do the same problems and hold up their answers for me to check. Finally, I assign a homework assignment that usually is ten to fifteen problems involving practice on the day's lesson. I allow the last ten minutes of class for student work time. Since the students are in pods, they can work together on the assignment along with asking questions of me. Even though the last ten minutes are student work time, I spend it explaining the new concept and directions over and over to individual students.

How my "average" day in my classroom went and the implementation of the L to J program this year is why I chose the topic for my research and how my research questions and how this inquiry came about. Even though I did not get through as much material as I had hoped, I believe I did unearth some findings that will cause my teaching to change. Overall, my findings show that receiving vocabulary instruction did improve the students' understanding of their homework and test scores. Also, after receiving instruction and doing the vocabulary activities, the majority of the students asked fewer questions on their homework assignments.

Daily Homework and Test Scores

When gathering the data to see what would happen to students' mathematical understanding after they received instruction in vocabulary, I heavily relied on my teacher journal entries and grade book. The first thing I started noticing was fewer redoes on the daily homework assignments. Also, the discussions during the lecture time were involving more students.

Evidence from my journal supports this finding. On February 8, I stated:

Student W.B. and B.I. really got into the picture drawing activity and both passed the vocabulary quiz that week with 9 out of 10 correct.

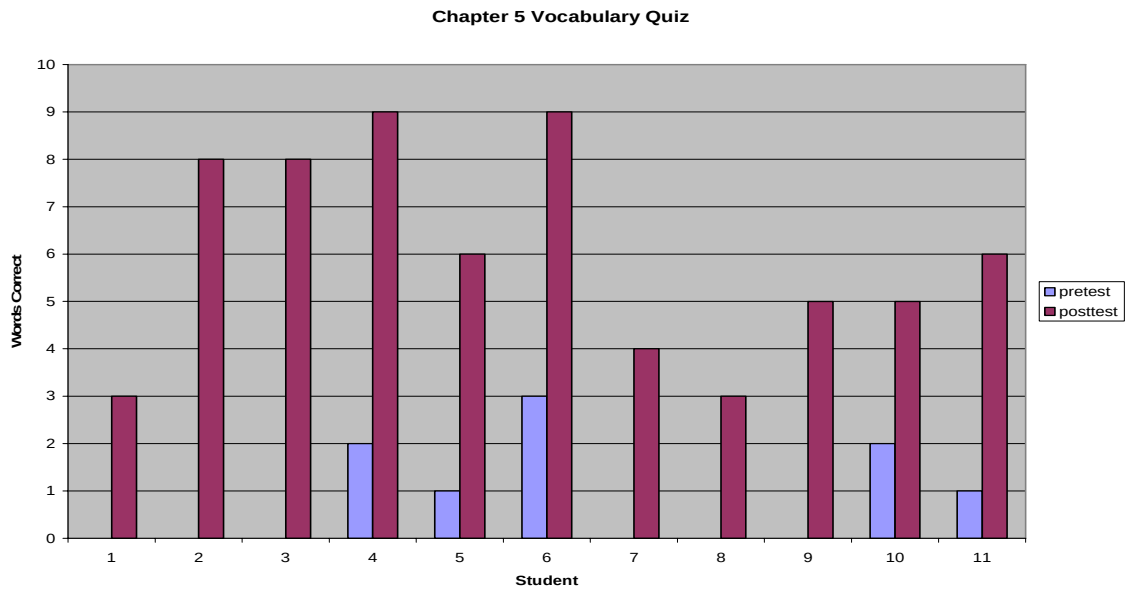
On February 15, I stated:

Every student took their time on trying to do the chapter 5 vocabulary pretest.

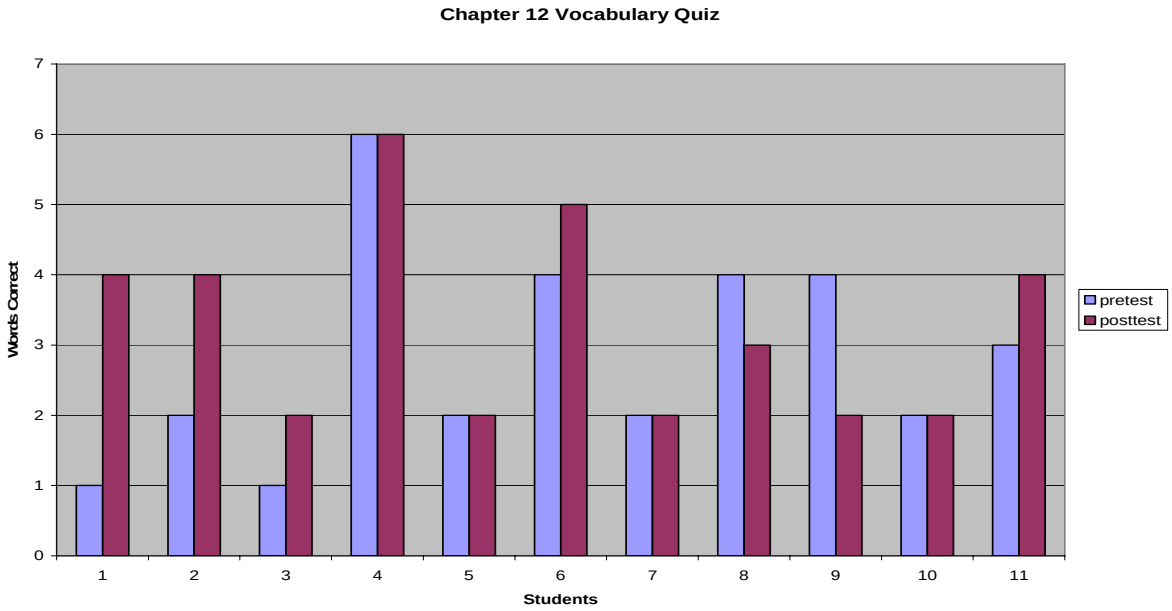
On February 29, I wrote:

My students took a standard test over all the vocabulary and concepts we studied in chapter 5. Ten out of the eleven received an advance on the assessment which shows me that knowing the vocabulary helped them understand the test.

The following graph illustrates and supports that the majority of the students increased their knowledge of the chapter 5 vocabulary terms. In fact, 81% of the students improved or stayed the same, and only 18% went down. On the graph, students who appear to have no score for the pretest all got zero problems correct.



I taught the students chapter 5 for seven to eight weeks of the research period due to so many missed days for one reason or another. The next chapter I taught was chapter 12. Just like in the previous chapter I gave a pretest at the beginning, and at the end of the research period I did a posttest even though we had not concluded the chapter. The following graph again shows an increase in five students and four staying the same.



The next type of data collection I used was student interviews (see Appendix B for interview questions). After analyzing my second interviews, I noticed an increase of four students who knew the definitions of the words I questioned them about. For my final interview, I added an eighth question that asked the students if they thought the vocabulary activities were worthwhile. Eight of the eleven students believed that the vocabulary activities were worthwhile. Some of the students' responses to the last question were:

"It helps a lot because I'm not so confused in math class now."

"I think it did help because it made me understand the problems better."

"Good, I think it helps you understand what is going on in and out of class."

These statements show that the students understand the importance of knowing the meanings of the vocabulary terms.

The final data I collected were scores from daily homework and tests. I was really excited when the students completed the chapter 5 review without anyone needing to redo it. During the previous chapters, there were three to four students that had to redo the reviews. Also, on the chapter 5 test, all eleven students passed with a 79% or better. Student M.H. received a 100% and student M.M. received a 96%. These two students were able to tell me the meanings of the vocabulary in the directions when I questioned them.

The improved scores on the students' work and post-tests, the comments from the student interviews, and my teacher journal entries support my assertion. Students' mathematical understanding did improve after receiving instruction in vocabulary.

Students' Questioning

The next research question I looked at was to see if student questioning on homework assignments changed after they received instruction in vocabulary. An obvious finding in terms

of students' questioning is that the student work time is not being used up with individual students asking me to explain the concepts or directions to them again. Evidence to support this can be found in my teacher journal. The entry on February 29, stated:

When the students were working on the chapter 5 review the most questions asked were two. My special education student was the only one that didn't feel confident enough for independent work time.

On March 14, I stated:

Student S.L. used the correct vocabulary terms correctly 100% of the discussion time. I also state that I only had to correct three out of the eleven students once each on the use of the correct vocabulary terms.

On April 11, I stated:

The students didn't need to ask any questions on the homework assignment directions and there was no redoes.

The students' interviews again gave evidence to support this finding. When the students were asked on the second interview, if they had to ask questions because they did not understand the vocabulary, three fewer students said they had to ask questions.

Finally, online state standardized assessment scores support students understanding the vocabulary without the need to ask questions. Since the teacher is not allowed to answer any questions during the test, this demonstrates to me that knowing the vocabulary did help the students understand the test questions.

Again student interviews, my teacher journal entries, and classroom observations support that students' questioning on homework assignments did change after they received instruction

in vocabulary. The change was a positive one in the fact that students work time was not being used up with endless questions.

My Teaching

The final question I attempted to answer was what did my teaching look like when I challenged and supported students in vocabulary instruction. I believe I am being more creative in how I teach new vocabulary to my students and I have come to appreciate the fact that instruction in vocabulary does play an important role in the understanding of the mathematics concepts.

My evidence to support this finding came from my teacher journal entries. On February 8, I stated:

> *I used a creative strategy to teach the vocabulary words for chapter 5. The students drew pictures of the vocabulary terms (Appendix E). I was really excited about the two students that usually don't participate in class because they did so well during this activity*.

I used this strategy once every two weeks. I would give each student one of the vocabulary words to draw a diagram or picture to define the word. After the students completed their drawings, I displayed all eleven and the students would first write on a sheet of paper which word they believed went with each picture. After about 7-10 minutes, we looked at the drawings together. I would have the students take guesses and state why they chose the word they did. I would then have the "artist" tell which word he or she illustrated. Doing this strategy made me realize people have their own personal way for remembering a word. It also would show me if a student really understood the meaning of the vocabulary term.

On February 22, I stated:

I used the strategy of the four boxes. This strategy involved me giving the students a sheet with four boxes on it. In box one the students wrote the term, in box two they wrote the definition, in box three they wrote a sentence with the term in it, and in box four they drew a picture to go with the term. Only three out of eleven students struggled with doing all four boxes. Eight of the eleven students were successful.

This strategy was used as part of the pre-test and posttest of the chapter vocabulary. I would go through the chapter beforehand and choose ten words that I believed were the essential words. Some of the words would have been introduced in other chapters but most of them were just introduced. The thing that I found interesting with using this strategy was to see the growth, if any, from the first attempt to the second. The students usually were not able to draw anything on the first attempt but by the second time seven to eight of them were able to draw a picture for all of the terms.

Finally, on March 28, I stated:

I played two different games in two days that went with the vocabulary. One was vocabulary bingo and the other was a number cube game dealing with experimental probability. The students really enjoyed these games.

The strategy of game playing was of course the most popular. The game I played the most was vocabulary bingo. I would have the students fill in the boxes on a blank bingo card, then I would read a definition of one of the vocabulary terms and the students would find it on their cards. Before a student could claim the prize for a bingo, he/she would have to tell me the definition for each word covered up. The number cube game was one that went with my math course series that is provided at the end of each chapter. These games did not always go with the vocabulary but over the concepts, so I was able to see if the students understood the concepts.

The reason I liked this strategy was because I would get instant feedback on whether the student knew the vocabulary definition or not.

CONCLUSIONS

If the students cannot understand the mathematical vocabulary, they will be unable to solve the problems presented to them. I believe that instruction in the vocabulary improves the students' understanding of the mathematical concepts. I believe after the instructions and use of the vocabulary activities, the students asked fewer questions and the majority improved their daily homework and test scores. Also, the use of different teaching strategies allowed for the range of learning styles in the classroom and allowed math class to be "fun", even if for a little while. The data in my findings may not be anything extraordinary, but they did show some change.

In a study by Dresher (1934), he found that pupils cannot work problems if they cannot read and understand them; they cannot understand the explanation of a problem if they do not understand the terminology used. In my action research I also found that students did do better on problems that they understood the vocabulary. Blessman and Myszczak (2001) had basically the same finding stating that students must understand the language of math in order to fully comprehend concepts being learned. This study was also comparable to the findings I uncovered in my action research. My students did improve their daily work and test scores after they developed an understanding of the language used in mathematics.

In other studies, the uses of different strategies were researched with findings paralleling mine. When looking at the research of Schwarz (1999), Schoenberger and Liming (2001), Monroe (1997), and Blessman and Myszczak (2001) the suggestions to help students increase their mathematical vocabulary range from games, word webs and graphic organizers, to 3-D

pictures. Using a variety of techniques to hold the students' interest is a very important strategy to improve the students' skills. During my "average" day in class, I observed this first hand and saw that the students retained the vocabulary terms and meanings better when the instruction was done in a "fun" way. Overall, my research concludes that when students are instructed directly on the language of math in a variety of ways, they develop a better understanding of the mathematical concepts.

IMPLICATIONS

As a result of my study, I can conclude that in my future teaching of mathematics, I will plan into my lessons time for direct vocabulary instruction. I will use the various vocabulary activities that I learned during my research and will continue to look for new ones. During the final students' interviews, eight of the eleven students stated that they believed learning the vocabulary was worthwhile and did help them on their assignments and tests. As a teacher, I am always looking for new and better ways to assist my students with their learning, and sense that I have came across one way to do just that.

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APPENDIX A: ***CHAPTER 5 VOCABULARY PRETEST***

Using one of the attached sheets, do the four boxes for each of the following words.

1. RATIO
2. RATE
3. UNIT PRICE
4. POLYGON
5. PROPORTION
6. SCALE
7. CROSS PRODUCTS
8. FACTORS
9. INTEGERS
10. MULTIPLES

NAME:_____ DATE:_____

Box 1 – Write the word

Box 2 – Write a definition for the word

Box 3 – Use the word in a sentence

Box 4 –Draw a picture or diagram that visually represents the meaning of the word

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1. 2.

3. 4.

APPENDIX B: Student Interview Question

I asked the same questions during all three interviews.

1) Do you think you know the meaning of most the math vocabulary terms discussed in class and on the homework assignments? Can you give some examples? Are there any vocabulary terms I use that you don't know?

2) Does knowing the meaning of math vocabulary terms help you know and understand your math assignments? Why do you think so? Or Why don't you think so?

3) To what extent is it important to know the meaning of vocabulary terms you see in math?

4) How often do you ask questions because you don't understand the vocabulary in an assignment and the directions?

5) Please define the following terms:

A) - cylinder

B) - area

C) - denominator

D) - product

6) Please give me a vocabulary word that fits each definition:

- The answer to an addition problem is
- Lines that never cross and stay the same distance apart are
- The number that appears the most in a set of numbers is known as the

7) Is there anything you would like to ask me about vocabulary in

math class?

8) How do you feel about learning the vocabulary? Do you think it helped or that it was a waste of time? Whv?

APPENDIX C

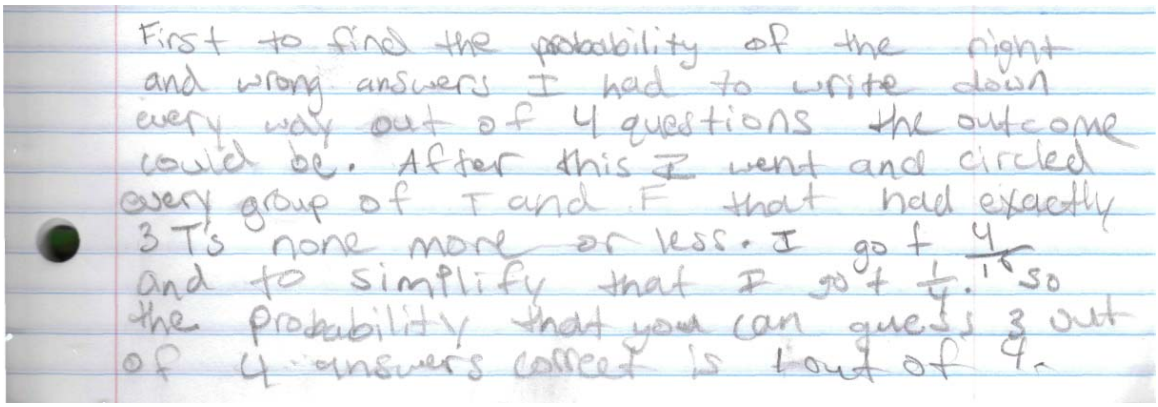
Weekly Journal Rubric

	0	1	2	3	4
Mathematical Knowledge	Shows no understanding of the problem.	Shows very limited understanding of the problem, major computational errors.	Shows understanding of some of the problems' mathematical concepts, may contain computational errors.	Shows nearly complete understanding of the problems' mathematical concepts and principles, no computation errors.	Shows complete understanding of the problems' mathematical concepts and principles, no computation errors.
Communication	Words don't reflect the problem, may include drawings which completely misrepresent the problem. Vocabulary terms are not used at all.	Has some satisfactory elements, but fails to complete or may omit significant parts of the problem. Vocabulary terms present but not used correctly.	Makes significant progress towards completion of problem, but ambiguous and unclear. Minor errors of vocabulary term usage.	Gives a fairly complete response with reasonably clear explanations or descriptions. Also correct use of vocabulary terms.	Gives a complete response with clear and appropriate diagrams. Also correct use of vocabulary terms.
Writing	No/little attempt to write a paragraph with 3-5 complete sentences; excessive mechanics and convention errors.	Some complete sentences, but not a 3-5 sentence paragraph; many mechanics and convention errors.	Complete sentences, but not a 3-5 sentence paragraph; some mechanics and convention errors.	3-5 complete sentence paragraph; minor mechanics and convention errors.	More than 3-5 complete sentences with accurate mechanics and conventions.
Solution	No solution stated.	Attempts of a solution showed, but incorrect.	Solution is stated, and is incorrect.	Incorrect solution is stated, but is reasonable.	Correct solution is stated.

For the daily work and assessments I collect, I will take a percentage grade on each one.

APPENDIX D

One student's habit of mind entry where she used the vocabulary.


First to find the probability of the right and wrong answers I had to write down every way out of 4 questions the outcome could be. After this I went and circled every group of T and F that had exactly 3 T's none more or less. I got $\frac{4}{16}$ and to simplify that I got $\frac{1}{4}$. So the probability that you can guess 3 out of 4 answers correct is 1 out of 4.

Author's Notes

This is a very rough draft. Like always I need help with my grammar, sentence structure, etc. Please look over my findings section - this is the one I struggled with on how to write. I didn't include my appendices because the scanner at school was broke and I forgot to bring the items home that I needed to scan. I am totally lost on if I did any of this correctly. During all my school years, I have had trouble with writing any type of paper especially one that has to be a certain length. Thank you in advance for all the help you have and will give me.

I have changed some of the things that my buddy has suggested, especially the grammar part. I didn't have a scanner for a while so my buddy didn't get to see my appendices, but I think I did it right. Even though you may not see two responses here between my buddy and me, we did personally email each other with questions and answers. As I have always stated I do not feel that I am very good at writing, so I hope I have everything that there is suppose to be and that it is long enough.