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Using Math Vocabulary Building to Increase Problem Solving Abilities in a 5th Grade Classroom

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A report on an action research project submitted in partial fulfillment of the requirements
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Abstract

In this action research study of my 5th grade mathematics class, I investigated how students' understanding of math vocabulary impacts their understanding of the curriculum. I discovered math vocabulary plays an important role in a student's ability to understand daily lessons, complete homework, discuss ideas in groups, take tests and be successful on achievement tests. A student's ability to understand the words around him (or her) in math class seem very related to his or her ability to solve word problems. Word problems are what our national assessments are all about. I also discovered that direct instruction and support of math vocabulary increased test scores and confidence in students as test takers. As a result of this research, I plan to continue to find ways to emphasize the vocabulary used in our current math curriculum. This process will start at the beginning of the year. I will continue to look for strategies that promote math vocabulary retention in my students. And finally, I will share my findings with my colleagues, so my research can be used as part of our School Improvement Goals.

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As a teacher in a Title I building, I have faced many struggles in the last eight years. The most challenging struggles have been academic issues brought forth by the needs that come with children of poverty. Children of poverty come with fewer opportunities than the children of the middle class. In addition to battling the issues that many of them face at home each day (hunger, neglect, physical abuse, substance abuse, and non-permanent homes) I also have to deal with the fact that they also come to school less academically prepared than their middle class counterparts. I in no way mean to imply that my students are less able to learn. They have had fewer opportunities. On this uneven playing field we have the same expectations: All students will achieve at grade level or above (according to the No Child Left Behind Act).

One obvious difference in the lack of opportunities between my students and middle class students is the grasp of vocabulary. My students struggle with everyday vocabulary words, especially math vocabulary. This struggle led me to create an action research project focused on the direct instruction of math vocabulary. It was my hope that the direct instruction of math vocabulary would help to level the playing field for my students as problems solvers and test takers.

PROBLEM OF PRACTICE

Problem solving is a problem in my classroom. My students dread problem-solving activities. They have no interest in attempting, in any way, to tackle a word problem. A chorus of, "I don't know," and, "I don't get it," rings out whenever a word problem is presented. This chant begins before the problem has even been read. I would like my students to be competent problem solvers.

There are two Problems of Practice here. The first is an issue of Equity. I believe that I have high expectations for all of my students. However, I don't think all students are being supported in an equitable way. Some students are so deficient in basic skills that being able to problem solve will be a problem until measures have been taken to correct the deficiencies. The new Lincoln Public Schools' math curriculum is a step in the right direction, but how will I help the kids who have made it to the 5th grade without the benefit of this new curriculum? These students need extra support and skill building to be able to become successful problems solvers. They will not get the support they need inside the "regular" planned lesson.

The second Problem of Practice deals with Learning. The students lack many tools necessary to be successful: prior knowledge, basic facts, ability to read, mathematical thinking/interpretation skills and confidence. This bothers me because the ability to solve word problems demonstrates a grasp of learned skills. It shows me students have ownership of a skill when they can decide how and when to apply it. The ability to apply skills to word problems is a demonstration of conceptual understanding. It answers the question: Can you decide when to use this skill outside of the lesson in which the skill was taught? It shows independence. Most of my students do not demonstrate such independence. Part of the reason for this lack of independence is that they have not learned skills with understanding and experience. In some cases, they simply were not exposed to the material necessary for success. How will I remedy this lack of skill? It will be necessary to reinforce and reteach necessary skills to make my students successful with word problems. This lack of skill often results in students

shutting down or acting out. I believe these actions are a result of their lack of understanding. This is not a supportive learning environment.

I would prefer a class with students willing to take risks, try several possibilities and lead themselves to a road of discovery. I would like a math class of students who know how to interpret a word problem and who have the basic skills to be successful as they planned how to solve the problem. To achieve this, I need students willing to put forth the extra effort to learn these skills necessary for success in a new, rigorous curriculum. I also need to think in new ways in order for all students to be supported.

I have several ideas about how to try and achieve this goal. The first involves increasing their math vocabulary for words and phrases. Not only do I want them to know what a divisor is, but I also want them to know what to do when they see the phrase, "What is the product of the two factors?" or "How many boxes will be required to ship all figurines if each box holds 20?" I think improved math vocabulary skills will go a long way toward improving the ability of students to dissect phrases within the context of a word problem and to understand what the problem is about. Treatments I used include:

1) Require use of mathematical language within the classroom
2) Create a glossary of terms that is available to all students and grows with each chapter
3) Use of word walls as a review of terms
4) Daily problem solving activities
5) Pre and Post Vocabulary Inventories

It is my hope that as their vocabulary skills increase, so will their ability to problem solve. As their abilities increase, I hope their confidence and willingness to take risks will improve as well.

This problem is worth knowing and examining for me personally because it is a struggle I've faced for many years. The level of frustration brought to my students and me is unacceptable for all of us. I need to find a way to increase student achievement. This desire is personal and required. The problem is worth knowing for my community of teachers because we are in the second year of out School Improvement Plan. An increase in vocabulary skills is a goal in our building. I know the problem solving issues are not isolated to my classroom. Should some of my treatments be successful, the building as a whole could benefit from my ideas. Finally, this problem is worth knowing for the greater community of educators because most of us deal with these issues to some extent. Lack of problem solving skills is not only isolated to Title I buildings. It would be my guess that this issue affects every teacher in out state and country. In the time of the No Child Left Behind Act, we must work harder to find ways to push our students past their fears, as well as to strengthen their skills. The ability to problem solve demonstrates a child owns a skill. This ownership is my goal for my students.

LITERATURE REVIEW

For the past several years, I have dealt with students who lack proficiency in basic math vocabulary. This lack of skill has prevented my students from being adept problem solvers. As I reviewed action research projects by others, I found that my problem was not one seen in isolation. As Charles and Lester (1984) noted, low achieving students tend to be impulsive problem solvers; they jump into a problem without understanding. Much of the research on problems students encounter in mathematics courses points to the many language-based misconceptions that students develop. In fact, research shows

that one of four causes of confusion in mathematics is the vocabulary (Blessman & Myszczak, 2001). Blessman and Myszczak go on to write, "Much of the research on problems students encounter in mathematics courses points to the many language-based misconceptions that students develop" (p. 13).

This lack of understanding of mathematical terms leads to a break down in the ability to solve multi-step problems. Fletcher and Santoli suggest that the vocabulary of math is not usually taught in schools. If the students aren't reading good textbooks, then they have no place to read math terms (Fletcher & Santoli, 2003). These points seem valid, as students are immersed in literature that contains vocabulary from other subject areas, but rarely have I seen children's literature that uses the vocabulary of mathematics. It is therefore crucial to emphasize vocabulary instruction as part of a mathematics program. In fact, it has been noted that writing and vocabulary development is necessary in all curricular areas, especially math (Schwarz, 1999). It is my goal to improve the math vocabulary in all of my students in an effort to make them better problem solvers.

There are other underlying causes for students' inability to solve multi-step problems involving math vocabulary and higher order numerical operations. These include an emphasis on repetition and rules, inadequate language skills and the lack of prior knowledge of mathematical concepts (Schoenberger & Liming, 2001). Schoenberger and Liming go on to note that mathematical problems have their own unique language. They feel an incomplete understanding of the concepts behind this new mathematical language can make learning the language difficult. One recommendation made by Schoenberger and Liming is the use of student built glossaries. These glossaries

were one treatment that led to vocabulary improvement. Student glossaries that grow with each chapter will be used as a treatment in my action research,

The use of student glossaries was only one suggested solution to the issue of math vocabulary. Blessman and Myszczak (2001) note that the use of writing, children's literature and student created materials provides means for increasing comprehension of key vocabulary terms. Writing in mathematics class seems to demonstrate a student's knowledge of material being taught, and allows an outlet for true, authentic assessment (Blessman& Myszczak, 2001; Huggins & Maiste, 1999). Huggins and Maiste noted that children have an implied understanding of the word order of problems, but that their experience with the verbal forms doesn't connect with their understanding.

In my work with students, it has often been the case that students do grasp concepts in numerical form. Once the same concept is presented in word form, most students feel they lack the skills to solve the problem. As I require students to write about math concepts, I hope to see two outcomes. First, students will become more fluid with the language of math. They will easily use the language required of successful problem solvers. Stahl and Fairbanks (1986) found this generative processing seems to involve more of the student's mental resources because it is a more active process. The second desired outcome is that writing about math concepts will allow students to manipulate word problems based on the concepts they learned in class. Math should no longer be all about the numbers, but the words and vocabulary as well. These goals match the goals set forth by the National Council of Teachers of Mathematics (NCTM, 2000). One research project has shown that through the use of student journals, the students developed a noticeable improvement in the use of mathematical language to

explain the solution to a problem (Roti, Trahey & Zerafa, 2000). Additionally, writing about concepts and vocabulary will allow students to have the opportunity to check and use their mathematical vocabulary, which many students have never had the opportunity to do (Fletcher & Santoli, 2003).

Students will not only check vocabulary in written forms, but in oral forms as well. Roti, Trahey and Zerafa (2000) found that whole group analysis of the language of a word problem appears to have helped students become more confident in their approach to problem solving tasks. This oral discussion was also used to remind students of problems they had solved in the past. Word problems from the past could be reviewed using the student journals created in previous chapters.

Research has shown that vocabulary can be an obstacle to success in mathematical problem solving. This obstacle can be overcome in several ways: the use of student glossaries to monitor vocabulary comprehension, the use of journals to write about mathematical ideas, and the use of literature to immerse children in the language of mathematics. As I plan to implement all of these treatments into my action research, I am excited to see the results. I hope my research project will be important enough that others will use it as assistance when faced with similar issues of learning in their own classrooms.

PURPOSE STATEMENT/ RESEARCH QUESTIONS

The purpose of my action research was to increase my students' ability to solve word problems. Data collection took place during the spring semester, 2006, in the researcher's classroom. This study attempts to answer the following research questions:

1) How can I increase comprehension of math vocabulary in my students?

2) What effects will increased math vocabulary have on my students' ability to solve word problems?

METHODS

I collected data from approximately the end of February to the end of the month of April 2006 in my classroom. The research spanned the end of the third quarter and into part of the fourth quarter of the school year. The class consists of 17 students. While the group is considered to be a heterogeneous mix of students, it should be noted that the differentiated (gifted) learners as well as the special education students are both placed in this class. The differentiated learners are required to be placed together for instruction. The special education students were placed in my room for two reasons. One, we hoped to use the differentiated students as peer models, and two, the special education teacher needed to serve them in one location. Of the 17 students in the class, 14 participated in the research. Eight of the 14 students are male and six students are female. Six of the participating students are identified as gifted (participating in the differentiated curriculum) and four participating students are identified as special education students. The remaining four students range from average to below average achievement. There were two questions that were the focus of my research.

The first question was, ***How can I increase comprehension of math vocabulary in my students?*** Students were given pre and post chapter vocabulary inventories (see Appendix D) at the beginning of each chapter in the math curriculum. The inventories usually consisted of 10 terms that would be used in each chapter. The definitions would appear on the opposite side of the page as the words, and the students would need to

match the definition to the term. The post chapter vocabulary inventory was the same as the pre chapter inventory. Papers were scored by the number correct out of 10 items.

A second form of data collected was a general vocabulary inventory (see Appendix B) at the beginning and end of my research. This inventory consisted of 15 terms that appear in the current math curriculum. Many of the terms were words to which the students had already been exposed, for example, "denominator," "difference" and "mean." A few were terms that would be introduced in chapters that would be covered while the research was taking place. The purpose of this inventory was to monitor the growth in vocabulary, not only in previously learned terms, but in newly learned vocabulary terms as well.

A third method of data collection was student audio interviews (see Appendix C). Five students were randomly selected to be interviewed. The names of students participating in the research project were placed into a cup, and I drew out five names, along with one alternate. (I drew an alternate in case of an absence of one of the original five.) The students were asked to verbally define a few vocabulary words, as well as give opinions about themselves as problem solvers. The vocabulary words were some of the same words on the post-vocabulary inventory. My goal was to see how students' verbal responses might differ from their written responses.

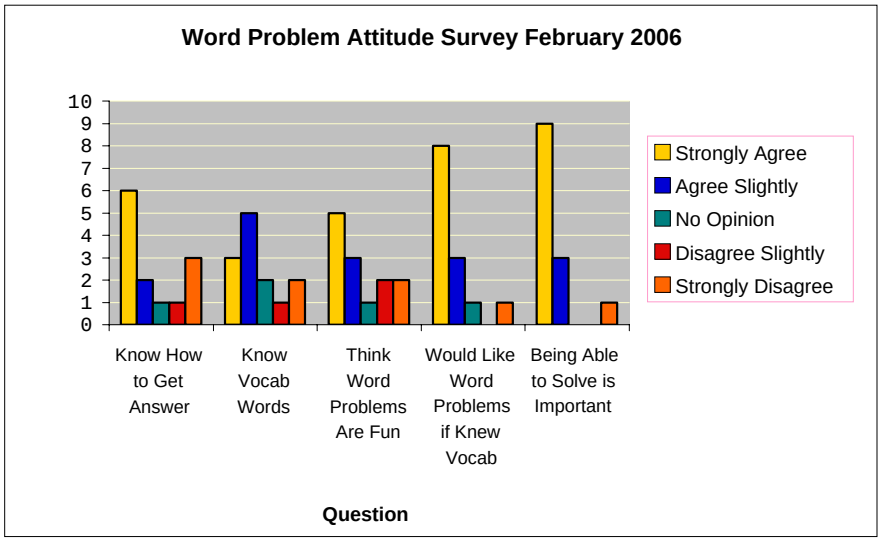
What effects will increased math vocabulary have on my students' ability to solve word problems This final research question also had several points of data collection. The first was a pre and post research attitude survey (see Appendix A) given to the students. This survey attempted to gauge student perceptions about their own ability to solve word problems and to discover their attitudes about math vocabulary. There were

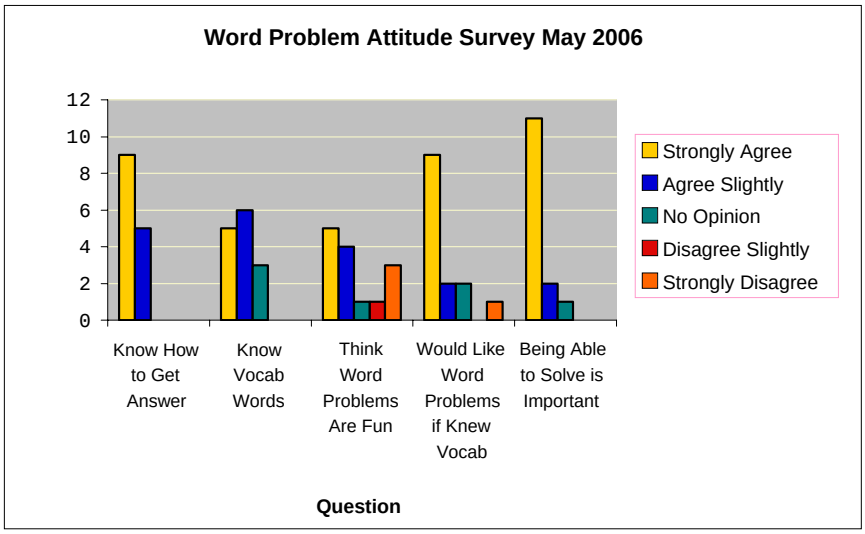
five questions on the survey, and answer choices were multiple choice: *Strongly Agree, Agree a Little, No Opinion, Disagree a Little and Strongly Disagree.*

A second method of data collection used was student journals. Students were given all chapter assignments in packets. These packets serve as a forum for student notes, writings and homework. Notes were taken in class, and the students were instructed to share vocabulary words and concepts with their parents. Parents were then asked to sign packets if vocabulary words or ideas had been shared. A final method of data collection is chapter tests. I am specifically looking at objectives that involve problem solving on the chapter tests. My goal in this collection of data is to look for growth in the students' ability to problem solve as reflected in their ability to perform well on tests.

ANALYSIS

When analyzing the data, the simplest mode of representation for me is a graph. I first created graphs comparing the results of the Word Problem Attitude Survey. I made two graphs; the first displays the results of the survey given in February, which was the pre-attitude survey. The second (post-attitude survey) shows the results of the survey given in May.





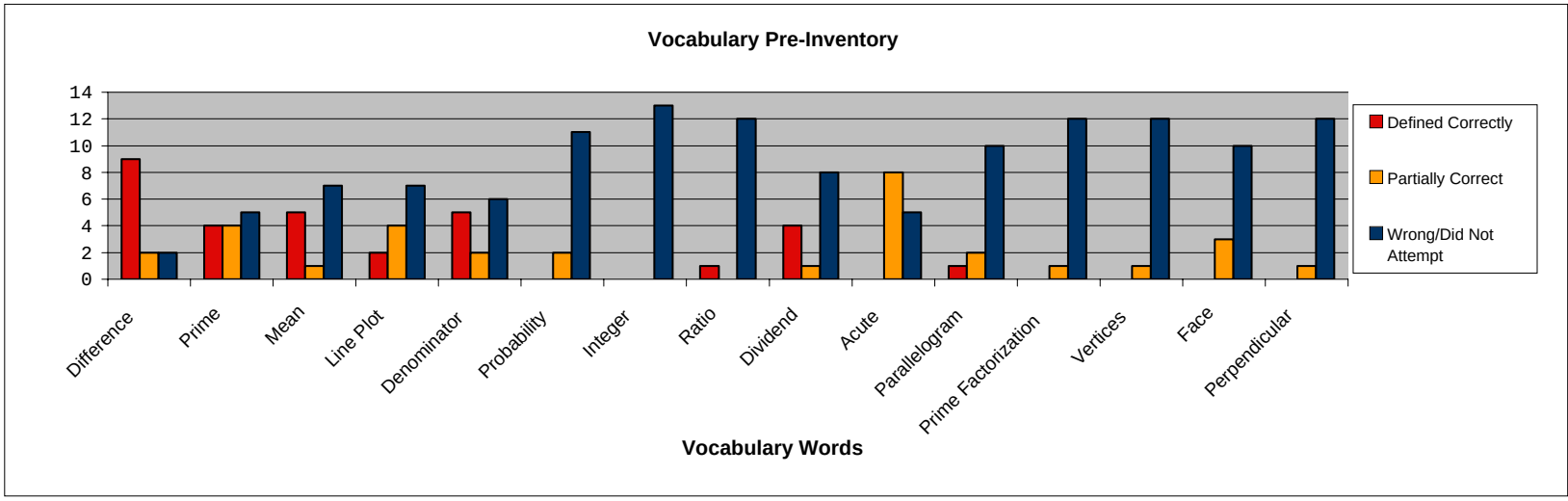
As is evident from the five-question survey given to the participating students, a little more than half of the students either agree strongly or agree slightly with the statement that they, "Know what to do to get the correct answer when solving a word problem." This same number of positive responses also appears for the second question, "When solving a word problem, I usually know all of the vocabulary words in the problem." This data was interesting and surprising. It was my assumption that the students did not know math vocabulary words well. Tests scores and simple classroom conversations with students led me to that conclusion. It was also my assumption that *they* knew this was a problem as well. I assumed the students knew they were lacking in vocabulary knowledge and that this would affect their confidence in other areas. Eight of the 13 students surveyed replied that they *Strongly Agreed or Slightly Agreed* to the question that asked if they felt they knew how to get the answers to word problems. This survey has led me to believe otherwise. It would appear that more than half of my students are pretty confident in their math vocabulary and problem solving skills. Criterion Reference Test (CRT) and MAT test data from the 3rd and 4th grade would

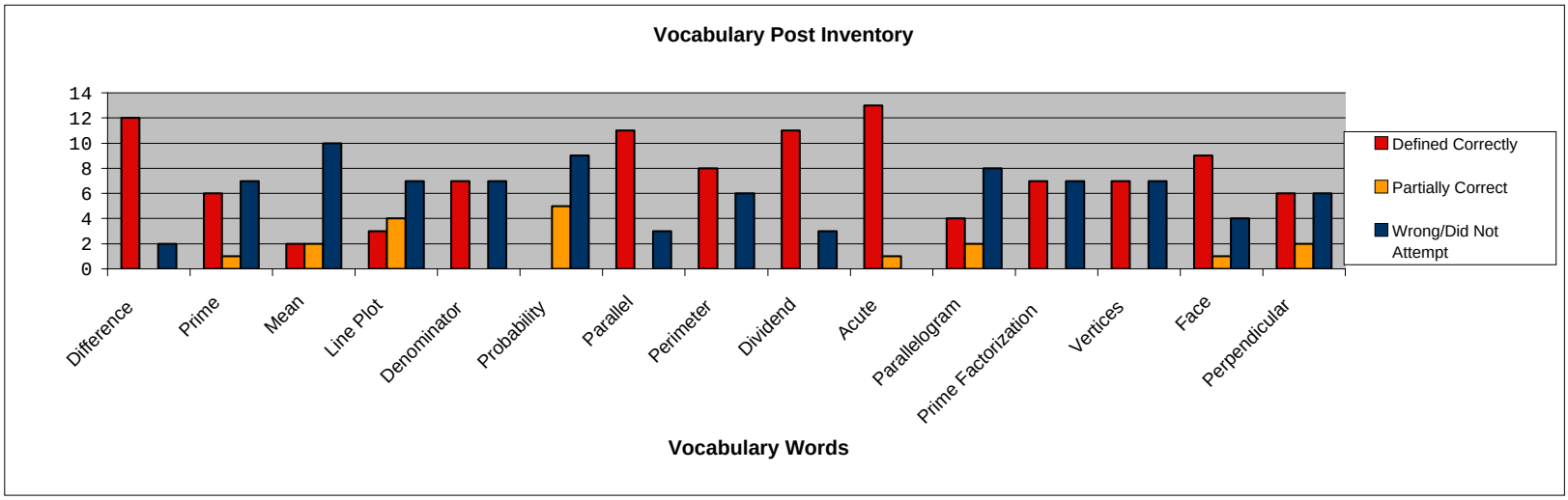
suggest otherwise. Last year's CRT data showed only 50% of this cohort group to be proficient in math. I am perplexed by this confidence in my students. I can only attempt to explain this false confidence with the assumption that the facts have not been presented clearly to my students in the past. I do not believe that anyone has ever told them they are behind.

As you can discern from the post-attitude survey, more students moved into the *"Agree Strongly"* category for all question areas. One student was added to the post-attitude survey. (He was late in returning his parental consent.) When analyzing student-specific data, I found tremendous growth in vocabulary skills among some students, but very little growth for others. I analyzed this data by comparing individual data from this pre and post vocabulary inventories. For example, on the pre-inventory, a student received a score of 5. On the post-inventory, the same student received a score of 13.5 (out of 15). Many other students had only an increase of 3 points. It does not appear that lack of growth had any reflection on their attitudes toward word problems; most students still think they know all the vocabulary words in word problems, and they think they know how to find the correct answers.

This leads me to the math vocabulary inventory. There were 15 words in the inventory. Of the 15, eight terms have been directly taught in previous chapters this school year, five will be coming up during third quarter and have been seen in previous school years, and two are new terms. The results of the pre-inventory were a little startling. Of the 15 words, the most any one student was able to define correctly was five. Two students scored five out of fifteen problems correct. Everyone else scored less than five. The average score is 2.31 correct out of 15. This leads me to another

assertion: My students believe they are good problem solvers based on their strong math vocabulary skills, when in fact, they are poor problem solvers because of their lack of math vocabulary skills. Even my gifted math students are unable to define basic terms we have already learned this school year. This frightens me on an entirely new level as a teacher.





I have been working on a hypothesis as to why this has happened. I believe that the students are learning the vocabulary on a temporary basis. They "hold onto" an idea long enough to dump the knowledge out for the test. Lincoln Public Schools is currently implementing a new, fast-paced math curriculum. I am driven to think that during this implementation year, the kids are temporarily learning terms and then forgetting them as we move on to something new. In my experience, it takes a child multiple times of practice to learn a new vocabulary word. Are our students having several opportunities to learn each new math term? Not at the speed we are proceeding through the current curriculum. More than once, a student has said, "Can we slow down?"

Another possible argument is that the students were presented with the words in isolation and therefore scored poorly. However, my action research was sparked from classroom data that showed my students scoring poorly on homework and test sections that involve word problems. Therefore, I would not agree with that argument due to the fact that students could not demonstrate proficiency with math vocabulary in context or isolation.

Luckily, adjustments have recently been made to the pacing, and we have a little breathing room. More time can now be spent in preparation for the Metropolitan Achievement Test (MAT). Students need to learn test-taking skills, and we need to find time to reinforce basic vocabulary terms, as this survey clearly shows. Test-taking preparatory devices such as the Test Best series are one method I have worked with that prepares students for the MAT. This series also serves as a good medium to review math vocabulary, as terms are imbedded in the word problems found within this practice book.

As we moved through the research period, the pace slowed a bit and we were able to spend time working the chapters at a slower pace. In fact, we worked on one chapter and then worked for several weeks on test taking skills only. This review and slower pace seems to have had a positive impact on the students' general vocabulary knowledge. As you can see from the pre and post research charts, the number of words defined correctly improved dramatically on the post-test. The words on the tests were almost identical. Only two were changed due to the fact that we did not get as far as I had predicted pacing-wise. This was acceptable due to the district's relaxed pacing guidelines. The words I exchanged on the post inventory were introduced during the research period, as I had anticipated the terms I removed would have been. Therefore, I see little difference in the outcome of the results. Students scored significantly higher on the post-test than on the pre-test. Scores ranged from a high of 13.5 (partially correct scores counted as .5) to a low of 3. The mean score was 8.07 out of 15. This inventory was fill-in-the-blank, using words, pictures or symbols to define the terms. To conclude, the pre-inventory mean score was 2.31, and the post mean was 8.07. While not outstanding, this seems to be a significant improvement.

Another assertion that can be made here is that if students and teachers are given more time to study math vocabulary in-depth, there is more connection to what is being learned. During the research period, we began working in geometry. Previously, 5th graders have been focusing basically on computation of whole numbers, fractions and decimals. Therefore, moving into geometry represented a shift in their thinking and opened up a whole new can of vocabulary words. I decided that in order for the first lesson to be successful, the students had to be excited about geometry and directly involved in the discovery of the meanings of the words. During recess that day, I renamed all of my students as vocabulary terms that would be used in that lesson (point, plane, perpendicular lines, etc.) This got them talking a full 2.5 hours before math. During math, I spent the entire lesson manipulating the kids around the classroom plane. They used string, created lines, and positioned each other (other students named "points") on planes they located around the room. If you were named "intersecting lines" you had to go and find two other student lines in the room and make them intersect. Then, they had to name the lines or planes that were created. We also used sticky notes to locate other planes around the room. At the end of the day, the kids had about five minutes left to write down in student math packets, using words or pictures, what each vocabulary term meant. I also gave them an assignment. They had to go home and talk about the seven terms we learned with their parents. If their parents wrote me a note saying they discussed the seven terms, they could earn a sticker for their booster chart. I had 9 notes come back the next day. I was really excited, because I doubt on any given day that any of my kids are talking to their parents about math vocabulary. The students were really excited because they got to move and manipulate their math world for the day.

I did not have time to go over any other instructional material. We did nothing but focus on the seven vocabulary terms. There was no other traditional homework assigned because I did not have the time to present the rest of the lesson.

Allowing time for more in-depth vocabulary study will reflect in higher self-esteem on tests. This is an assertion easily made based on comments heard around the room during lessons and tests given in relation to the geometry chapter. I made notes occasionally, and students verbally showed confidence on this test. This verbal confidence leads me to another assertion.

Another assertion goes well here: Increased vocabulary skills will result in better problem solvers. When we took the test on this chapter, as soon as the students came to this section, I could hear murmurs of confidence around the room, and I noted them in my journal. "This is the part I KNOW." "This will be easy." Even the special education students, who struggle with math concepts, felt successful in this section of geometry. I can think of one student who previously told me every day that he hates math. This student would actually tell me things like, "Math is hard. I hate it. Do I have to do it?" on a daily basis. This same student actually taped a note to my door after class one day that said, "Mrs. Amen, Math was fun today." The strongest piece of evidence I have to support the idea of increased confidence was the test itself. On this particular section of the test, 89% of the students met the district expectation of a 3 or a 4 on a rubric scale of 1 to 4. I had 2 students earn a 2. This was the most successful section of the test. I wish I had the time to teach the entire chapter the way I taught this first lesson. It was a powerful learning experience for me. There was no official "word problem" section on this test. However, there are word problems on the next test.

On the next chapter test, (this chapter involved Perimeter, Area, Solid Figures and Volume) there were two sections that involved word problems. The class scored very well. The first objective, "*Use a Pattern to Solve a Problem"* was passed by 15 of the 17 students in class (88%). The second objective containing word problems, *"Solve problems by first solving simpler problems"* was successfully passed by 14 of the 17 students in class, or 82%. These problems were challenging for the students, and they were confident as they took the test. On a typical test day, I often am fielding questions about what students are supposed to do on particular sections. On this particular test day, the questions were fewer. As I noted on April 17, 2006, "The class is oddly silent as all students are working with confidence on this test!" The success of the students is not typical for previous tests with word problems.

Another assertion that can be made is again based on student confidence: Students gain vocabulary confidence when provided multiple opportunities to experience and work word problems with instruction, with peers, and alone.

For several weeks, we worked heavily with the Test Best series in preparation for the Metropolitan Achievement Test. We work in this series periodically throughout the year, and then I typically try to tie everything together and readdress all that we have learned right before the test. One strategy we worked on this year was to identify the vocabulary words in each word problem and identify their meanings. Vocabulary words were not limited to single words, but sometimes word phrases, such as, "all together," "more than," or "about how many." We talked about key words that often signal a mathematical operation. We worked many Test Best items together, then moved toward allowing the students to solve and participate by holding up their fingers to indicate the

answer choice numerically. I then allowed them to solve problems alone, but share answers in small groups. They had to defend answers when they didn't agree. Usually, the discussion centered on what the vocabulary told them to do. It was interesting to hear student discussion when a disagreement arose. I overheard many students using information presented in class to clarify their interpretations of a problem and justify why their answer was correct. One example of this involved a problem from our curriculum. The problem stated: *There are 32 schools that participated in a statewide trivia tournament. In each round, one school played one match against another school, and the winner continued on until 1 school remained. How many total matches were played?* Two students were debating their answers to the problem. Student A solved the problem only partially (his answer was 16); Student B had solved it completely and came up with 31 for an answer. I overheard and noted on April 21, 2006, Student B explain to A that the problem required them to keep playing until one team remained, and then, "Y*ou have to figure out the TOTAL number of games, until there is just one team left."* The student went on to explain the concept in the terms of the Final 16 basketball brackets, which immediately cleared things up for Student A.

For student journals during this chapter, I imbedded the idea of visual pictures. In each chapter packet, there is always a vocabulary section. For this vocabulary section, I required them to not only use words to tell the meanings of terms, but pictures as well. Students typically do the vocabulary before the lesson is taught. Then, when we reach the lesson in which the term is used, we discuss it as a group. The students who had completed the vocabulary assignments were able to pick up on the concepts more quickly because of their previous time spent learning the vocabulary. It is also important to note

that many students used pictures as a way of explaining a definition of a term on the Post Vocabulary Inventory. The emphasized use of visual images seems to have made stronger connections for some learners. Some examples of vocabulary used this chapter included: vertex, edge, and face.

The student vocabulary quizzes for the chapter were not surprising: the pretest survey had an average score of 42.8% (There were 10 vocabulary words). The post-test vocabulary quiz had an average score of 82.2%. This was a significant improvement which I believe can be attributed to the direct instruction and visual representation of the terms. This direct instruction translates into student confidence when dissecting word problems on tests.

Near the end of the research period, I interviewed five students randomly chosen from those participating in my research. The responses to the questions asked were quite varied. I found the responses to the fourth question the most interesting, "Do you think you are a better problem solver after being in the class? Why?" Most all of the students responded that they felt they <u>were</u> better problem solvers after being in my class, but when I probed them as to why, most of them had a hard time identifying an answer. A few of them were able to say, "Because of all the Test Best stuff you taught us," another was able to say, "All the vocabulary words and the Know Column and things like that." None of them were able to come right out and say, "Well, you really made us learn the vocabulary words over and over again," or, "I really liked that day we spend understanding the geometry terms."

I am hoping they were just nervous about being interviewed and couldn't think on the spot. I also think some of the failure of this interview piece is probably my lack of

experience as an interviewer/researcher. I probably don't know they right way to pull out the information I need without seeming to lead the subject. (I didn't want to seem to put ideas into their heads.)

INTERPRETATIONS

This venture into action research was very enlightening for me as a teacher. The jaw-dropping moment for me came when I gave the pre-vocabulary inventory and the Pre-Attitude Survey. The assertions I was able to draw still frighten me even as the school year has come to a close. How on earth could my students have come to see themselves as competent problem solvers when they could not even begin to complete a basic vocabulary inventory? As a teacher, I want to investigate this confidence in my future students. Is this an isolated event? Or, will next year's fifth graders have the same misconceptions about problem solving? It will be my goal to find out. While it will not be my goal to shatter their self-image, it is necessary to help them achieve grade level or above expectations in math. I do not think an unrealistic image of their problem solving abilities is a step in the right direction.

The research has shown me there is a direct link between problem solving success and vocabulary comprehension. When students were confident, that confidence showed. They displayed it verbally, in written form and statistically on tests. There are advantages and disadvantages of confidence in learning. Advantages to confidence appeared on test taking skills for my students. They scored higher on test sections with word problems after our work with vocabulary. A disadvantage appears to be when confidence is false. When students do not know they are not competent problem solvers, they do not work to resolve the issue. Students in my class thought of themselves as

successful learners in the area of problem solving and math vocabulary prior to being involved in my research.

Talking about math vocabulary and defining the terms is not enough for long-term retention. In fact, my research has shown that terms learned only a few months prior would be forgotten when taught this way. Students need to write, visualize, feel, manipulate and talk about mathematic vocabulary. These types of exposures do more for long-term retention.

One thing I began doing as we moved through the research period was creating posters of the "Big Ideas" in each chapter. I left these on the walls for the remainder of the year, and I often heard students referencing other students to these posters on the wall. Having an entire year's worth of vocabulary big ideas on the wall would be a powerful thing for my students next year. These big ideas are often times visual references of mathematical ideas, for example, the different types of angles and their measurements. This is one thing I plan to do as a result of this research.

Next year will be different. We have a revised pacing schedule, which will help alleviate the huge and stressful time crunch we were all under the first three quarters of this school year. I will take the time to emphasize vocabulary in all its forms. I will not go back to defining a term and then leaving it in the dust. I know my students have little to no chance of actually using the term in the future if I choose to teach in that way. I need to give my students a fighting chance on standardized achievement tests. Learning math vocabulary, really learning it, is one way my research has shown will help.

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APPENDIX A
(Pre Attitude Survey looked the same. Only the date was changed.)

Word Problem Attitude Survey

May. 2006

You will be asked some questions about your ability to solve word problems. Circle the box that best describes your feelings about each question. Be as honest as you can.

1. When solving a math problem involving words, I usually know what to do to get the correct answer.

Strongly Agree	Agree a little	No opinion	Disagree a little	Strongly Disagree

2. When solving a word problem, I usually know all of the vocabulary words in the problem.

Strongly Agree	Agree a little	No opinion	Disagree a little	Strongly Disagree

3. I consider solving word problems fun.

Strongly Agree	Agree a little	No opinion	Disagree a little	Strongly Disagree

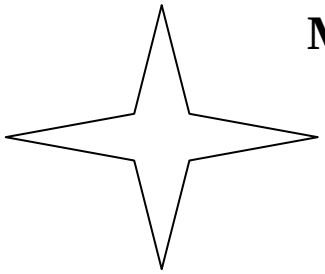
4. I would like to solve math problems with words if I understood all the vocabulary words.

Strongly Agree	Agree a little	No opinion	Disagree a little	Strongly Disagree

5. I think being able to solve word problems in math is important.

Strongly Agree	Agree a little	No opinion	Disagree a little	Strongly Disagree

APPENDIX B
(Note: pre and post-inventories are similar except for two terms noted previously.)



Math Vocabulary Post-Inventory

Name_____

Please define the following math terms to the best of your ability. You can use words, pictures and examples to describe the meaning of each term.

1. difference

2. prime

3. mean

4. line plot

5. denominator

6. probability

7. parallel

8. perimeter

9. dividend

10. acute

11. parallelogram

12. prime factorization

13. vertices

14.face

15.perpendicular

APPENDIX C

Student Interview Questions
April 2006

Questions:

1. When working a word problem, do you think you know the meaning of most of the vocabulary words in each problem?

2. Why is it important to know the meanings of vocabulary words you see in math?

3. Did you enjoy working word problems before this school year?

4. Has your attitude about working word problems changed during your 5^{th} grade year?

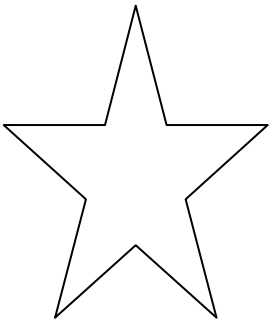
5. Do you think you are a better problem solver after being in this class? Why?

6. Please define the following terms:

    a) difference
    b) area
    c) parallel

APPENDIX D

(Sample of Student Chapter Vocabulary Inventories. Pre and Post Inventories are the same)



Vocabulary Quiz

Chapters 16-17

Name_____

Match the term to the definition.

1._____ perimeter

2._____area

3._____edge

4._____pyramid

5._____ vertex

6._____prism

7._____cylinder

8._____volume

a. A solid figure whose base can be any polygon and whose faces are triangles.

b. A solid with two circular faces that are congruent and a cylindrical surface connecting the faces.

c. A unit for measuring volume. A cube with sides one unit long.

d. the distance around a plane figure

e. a square with sides one unit long.

f. the number of square units to cover a surface with no overlap.

g. A point common to the two sides of an angle.

h. The segment where two faces of a

solid meet.

9._____cubic unit

parallelogram

10._____square unit make

i. a solid figure with 2 parallel and congruent bases, and

faces.

j. the number of cubic units that up a solid figure