What Strategies Strengthen the Connections Between Literacy and Math Concepts for Higher Math Achievement with Culturally Diverse Students?

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Introduction

Growing up in a small, suburban, mostly Caucasian community in Connecticut did little to prepare me for the cultural diversity of the real world. I had no idea what the acronym "ESL" meant until I was a high school senior. Back then my concept of an ESL (English as a Second Language) student was based on a group of about four students (from Asian descent I believe) who were housed in one classroom in our high school. They were never mainstreamed. I never learned their names. It was always a mystery to my classmates and me what occurred behind the door of that classroom. Unfortunately, my college experience in rural Virginia was not much better. I was exposed to a handful of ESL students during my tenure as a student teacher. These children for the most part were children of Hispanic migrant workers. Moving to the northern Virginia area approximately two years ago opened my eyes to genuine diversity.

I am in my second year of teaching at Ellen Glasgow Middle School in Alexandria, Virginia, which is a true microcosm of our culturally diverse society. My students have names I can barely pronounce and celebrate holidays of which I have never even heard. Glasgow educates students who represent 56 countries and speak 32 different languages. Ethnically, we do not have a majority population. Over 30% of our children are served through our ESL program. An even larger percentage of our students have recently progressed from an ESL program or are former ESL students.

Rationale

Due to the high ESL population of our school, language difference is a barrier many of our students struggle to overcome. Many master English and are mainstreamed into general education English classes. Yet reading and speaking the English language does not equal comprehension. A great deal of our students still read below grade level. The language barrier is particularly evident with highly technical content material such as in my current teaching assignment, mathematics.

My study originated when I realized that my sixth graders did not understand the difference between a sum and a product. Perhaps my students recognize the word product but associate the word with a crop from their home country. I quickly became frustrated with the level of math communication occurring within my classroom. After completing a unit on decimals, I found it

appalling that a student referred to decimal points as "those dots." Furthermore, I was shocked when even my brightest students did not know how to answer the problem written as follows: "What is one less than one thousand?" Yet when I demonstrated this same problem numerically, every one of my children could quickly complete this exercise.

In addition, word problems are a weakness for the majority of my students. They struggle with decoding the problem, become frustrated, and give up. Many students do not even attempt to solve word problems. Peter Fuentes (1998) states, "A word problem is an instant turn off for many students; they automatically assume they can't possibly understand it, much less find a solution."

As a result of instances such as these, I decided to focus on the language and vocabulary of mathematics in order to help my students achieve higher. Specifically, I am trying to answer the question, "What strategies strengthen the connections between literacy and math concepts?"

Literature Review

An abundance of literature exists on reading in the content areas. No doubt this is an essential skill for every student. However, before students can be expected to read in the content areas, they must first understand the vocabulary of that content in order to comprehend the reading. A review of the literature revealed a dearth of literature focusing specifically on vocabulary in the math classroom.

According to Schell (1982), "Mathematics is arguably the most difficult content area material to read; it presents more concepts per word, sentence, and paragraph than any other subject." The language of math is comparable to a foreign language; math is a combination of symbols, numbers, and words. Therefore, it should not be a surprise that students detest reading math textbooks and skip straight to the problems (although they might not have the necessary background information to complete these problems). "The mathematical achievement of children correlates highly with their ability to read mathematics" (Siegel, 1989). Also, strong reading skills are essential in the area of problem solving (Tanner, 1998). These are just a few reasons why math teachers need to take a more active role in helping their students prepare to read.

Additionally, students are confused even further with math terminology when they see a familiar word with an unfamiliar definition in the math classroom. "Many words have meanings in mathematics quite different from their meanings in everyday usage in conversation" (Reehm & Long, 1996). Words such as factor, product, mean, and origin are just a few terms that would fit into this category.

Finally, students' mathematical literacy will increase if they practice writing about concepts and processes. According to Ediger (1996), "Mathematics content is retained for a longer period of time if it is used in written work." Math educator Marilyn Burns (2001) recommends math journals which can be employed in a variety of manners. Students may use journals for personal

reflections about learning, class notes, questions to the teacher, to name just a few.

Methods

Although many ideas sprang to mind when I tried to figure out how to introduce and stress vocabulary in my classroom, I chose to focus my study on the following three strategies because they fit naturally with my curriculum and teaching style: vocabulary units, math journals, and exit slips. In addition, I personally kept a journal over the course of this study where I would record instances of vocabulary usage (or misusage) by my students in our daily lessons.

Vocabulary Units

In collaboration with the language arts teacher on my team we created vocabulary lists, demonstrating both the math definition and the "real life" definition of the same term (see Appendix A). This approach helped illustrate to my students that a word can have multiple meanings, depending greatly on context.   Furthermore, the math definition is frequently related to the "real life" definition. For instance, the standard definition of the word *origin* states "the beginning of something." When coordinate graphing, the origin is where one *begins* when plotting each and every point. I have found that connecting words in this manner to a definition that the students may already be familiar with helps their retention tremendously.

These lists were distributed and reviewed in both the math and language arts classroom. Additionally, vocabulary homework was assigned to reinforce this terminology. In the classroom, vocabulary games were created to aid the students. For example, the familiar childhood game "Memory" was adapted matching words and symbols or matching math definition to standard definition. Another method to easily review terminology is through "zip around cards." Zip around is an oral activity where one student describes a term or problem and the answer is found on another student's card. For example student A says, "What is x plus seven, if x equals 2." Student B replies, "I have 9," and then proceeds with the question found on his card. (See Appendix B). The beauty of this game is that all students must be listening (especially if they are holding several cards) and they are practicing their oral language.

Math Journals

Before I even began this study, my classes always started with a daily warm-up to be recorded in each student's "math journal." Typically warm-ups consist of about five practice problems to help spiral curriculum (McFadden, 1993). These daily warm-ups usually include at least one word problem. As a result of this study, I often rotate my own warm-ups, based on writing, into the start of our lessons. My favorite is a "word splash" (Allen, 1999). In a word splash, I provide the students with a group of related vocabulary words (which are also posted in my classroom). The students are to construct a meaningful paragraph using as many of the words as possible. For instance, during our statistics unit I gave the students the following list: analyze, bar, circle, collect,

data, display, frequency, graph, pictograph, question, statistics, tally, and title. (See Appendix C for student responses.)

Exit Slips

When possible, I try to conclude my classes with an exit slip focusing on vocabulary. The purpose of an exit slip is to review the content of the day's lesson and is an excellent method for teachers to quickly check student understanding. The exit slips I use in my classroom may ask students to define a new term in their own words. Or, a problem may be written out in words and the students need to extract the math problem from the written language. Providing exit slips daily would be ideal, however close to impossible in a typical middle school classroom which demands flexibility.   Therefore, I have tried to utilize exit slips on a weekly basis at the minimum. (See Appendix D)

Using the aforementioned strategies of vocabulary units, math journals, and exit slips my hope is that students will gain a deeper understanding of the language of mathematics, written and orally. Furthermore, I expect this understanding will improve students' math performance. Teacher observation, written work of students, and test scores (particularly those on the Entry Assessment Mathematics Evaluation (EAMES) designed for ESL students) will be factors in measuring the success of these strategies.

Findings

The results of the EAMES test were largely inconclusive. The EAMES provides both a raw score as well as an estimated mathematical grade level. This assessment tool was designed by Fairfax County in conjunction with its *FAST Math* program, geared toward students with limited English proficiency. The EAMES was administered in September and again in June. A comparison of scores indicated that of the 37 ESL students who were tested approximately 14% increased by two grade levels, 24% increased by one grade level, 14% decreased by a grade level, and 49% remained on the same grade level. However, of this latter 49%, 78% of these students improved their raw scores significantly.

Improvement cannot be merely defined by test scores. More important to me, which the numbers cannot indicate, is the higher level of communication achieved in my classroom. Class discussions involve math terminology; on the topic of fractions my students use words such as numerator and denominator instead of "top number" and "bottom number."

Self-confidence of my pupils is another area where I have seen growth. Those vocabulary units that were co-taught both in the math and language arts classroom greatly helped certain students. Children who did not speak unless called upon in my class were suddenly volunteering answers.

Analysis

Written work of my students proved to be the most valuable indicator that my students were indeed mastering the language of math. For example, on quizzes and tests instead of merely providing numerical problems for my students to solve, I often ask for definitions, written comparisons, or answers with written defense or explanation. For example, a geometry test asked students, "What is the difference between a regular and an irregular polygon?" Oliver, an ESL student responded, "A regular polygon has equal sides. And an irregular polygon has no equal sides." Another question asked, "Is a circle a polygon? Why or why not?" Maskuri, an ESL and learning disabled (LD) student, replied, "No, because it has no line segments." To the same question, Katherine (ESL) wrote, "No because it doesn't have sides and no angle."

My classes have also created "flip books" on several topics. In a flip book students describe a mathematical procedure or a fact in words and then give numerical examples. In order for a student to explain a process or information in his or her own words, he or she must have a solid understanding of the content. I encourage my students to share their products with their peers. According to Karen Wood (1992), "Frequently the best way to learn a subject is through another student."

Implications for Further Study

While I am pleased with the achievements of my study, I feel that if I was able to incorporate vocabulary more consistently and frequently I would have had stronger results. Due to the short duration of this study, as well as the pressure to meet both state and county standards, I was unable to create vocabulary links to all of the topics in my curriculum. Literature indicates that strategies which are used more frequently produce more meaningful learning experiences (Daisey, 1994). Furthermore, I also would have liked to experiment with additional strategies such as content reading, an ongoing math glossary, and graphic organizers. An extension of this study could be to compare the effectiveness of various vocabulary strategies. A further step could also be to compare the achievement of ESL students versus general education students when provided with the same vocabulary building strategies.

Summary

Due to the many demands placed on today's math teachers, such as the need to incorporate technology into instruction, the drive to provide a hands-on approach with the aid of manipulatives, and the pressure to achieve certain scores on standardized tests, just to name a few, integrating vocabulary units into math instruction may not rank high for many. However, in order for students to read and comprehend math problems and texts, and then complete problems, vocabulary knowledge is essential. While many strategies exist to build vocabulary, the results of the present study indicate that vocabulary units, math journals, and exit slips were beneficial in improving oral and written expression in mathematics by sixth-grade, second language learners.

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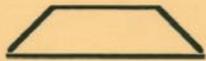
Appendix A

Name _____
Date/Block _____

Vocabulary List
Unit 1

Word	General Definition	Math Definition
Addend (n)		A number that is added to other numbers to find the sum.
Sum (n)	The full amount or total.	The answer in an addition problem.
Difference (n)	The way in which things are different.	The answer in a subtraction problem.
Minuend (n)		The larger number in a subtraction problem.
Subtrahend (n)		The smaller number in a subtraction problem.
Factor (n)	One of the causes that help produce a result.	A number that is multiplied by another number to find a product.
Product (n)	Something produced, as by growth, labor, study, or skill.	The answer in a multiplication problem.
Divisor (n)		A number by which another number is divided (the number on the *outside*)
Dividend (n)	A sum of money to be given out, as profits to be divided among owners of a company.	The number to be divided (the number on the *inside*)
Quotient (n)		The answer in a division problem.

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Appendix B

I have **trapezoid.**

Who has a line segment with both endpoints on a circle?

I have **chord.**

Who has a solid figure with one vertex and one circular base?

Appendix C

January 2, 2001

One day a boy wanted to make a circle graph, a bar graph, and a pictograph. First he had to collect and organize data. But first he needed a subject and the question to ask. He then chose a subject, title, and question. Then he went around his school collecting data and put down a tally mark for each vote. He finally collecret the data and then analyzed it. Then he made a pictograph, circle graph, a bar graph, and frequency chart. His statistics show that people likes Fiction books the most. He later displayed this graph.

January 23, 2001.

The diffrence between lineplots. box 3 wisher plots, and stem 3 leaf plots is not all of them use numbers. The simmalaraties are that they all have a scale. They all show data. The stem 3 leaf plot uses nimlers to display data. The line plot uses x' to display data. The bar and wisher plot uses a number line ~~one~~ to display data.

Appendix D

Exit Slip

Write the steps you would follow to solve this equation using only WORDS, no numbers!

$$7 + (5 - 3) = 9$$

Exit Slip

Write the following equation using only NUMBERS, no words!

First, divide nine by three. Take the quotient and multiply it by eight. The product is 24.