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The Effects of Focused Academic Vocabulary Instruction on Underperforming Math Students

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The purpose of this paper is to summarize the process and results of a research project studying the effects of focused academic vocabulary instruction on underperforming math students. The research was based on the assertion that student achievement on standardized tests will increase when classroom instruction includes a focus on content-specific vocabulary. The study was designed using the book *Building Academic Vocabulary: Teacher's Manual* (2005) by Robert Marzano and Debra Pickering as well as research by Marzano, John Kendall, and Barbara Gaddy from the book *Essential Knowledge: The Debate Over What American Students Should Know* (1999).

Background

The study was done in a Tennessee school where math students are grouped according to their math ability; specifically, the focus was on the lowest-performing math group out of the school's seven 6th grade classes. Because it is an inclusion school, a large percentage of the underperforming math students also have special needs. In the first year, the underperforming math students demonstrated the ability to work hard and master content, making huge strides toward achievement. But that year, the Tennessee Comprehensive Assessment Program (TCAP) math test consisted mostly of word problems, rather than strict computation. Reading was most of the students' biggest weakness and one of the main reasons they struggled in school. They went into the test feeling confident and came out disheartened.

Despite understanding the mathematical concepts, the students did not understand the wording of the questions. No matter how huge these students' gains were, when the test scores came back, all the students would see is that they were still below grade level. Because self-confidence has an enormous effect on success, it became imperative to find a way to help the students score higher and feel more successful on these tests and, most of all, begin 7th grade feeling confident that they could succeed in math.

The Study

The purpose of this study was to determine the effects of Robert Marzano’s program of teaching academic vocabulary on students struggling in math. Two areas were examined: (1) the students’ normal curve equivalent (NCE) scores on Tennessee state standardized tests and (2) the students’ perception of their potential for success. The research population comprised males, females, African Americans, Hispanics, whites, special education students, and economically disadvantaged students. For one reason or another, they were the 15 lowest-performing math students out of a class of 175 6th graders.

The study began with teaching Marzano, Kendall, and Gaddy’s focus on academic vocabulary to the 2005–06 school year’s math class. The students’ perceptions of their mastery of skills were surveyed early in the school year and then again after TCAP testing was finished. Gains made on the TCAP tests by the 2005–06 math class were compared to gains made by the 2004–05 class, who did not receive academic vocabulary instruction.

In August 2005, the lowest-performing class of the grade level’s seven math classes began to use focused academic vocabulary instruction. The class had the same teacher as during the 2004–05 school year, and it was the same size as and had similar demographics to the previous year’s class. The same lesson plans and learning activities were used with both groups. Only one variable was changed—the focus on academic vocabulary.

The focus on academic vocabulary was designed following the program outlined in *Essential Knowledge*, which designated lists of academic vocabulary and grouped the lists according to grade levels (K–2, 3–5, 6–8, and 9–12) for each subject area. Several 6th grade teachers were consulted to determine which of the words on the math list for grades 6–8 were appropriate for 6th grade. Ultimately, they decided to use most of the vocabulary words listed in the 6th grade textbook and cross-reference them with the provided list.

The entire list was introduced at the beginning of the year. The classroom featured a word wall display of the math academic vocabulary, and on the first day of school the students were given a brief definition of each term and its associated math concept. This way the students got a preview of the vocabulary and which math concepts they would be learning during the school year.

Throughout the year, as the students began a new chapter of the textbook, they were “reintroduced” to the vocabulary used in that particular chapter. The teacher would demonstrate what the word meant in relation to the concept the students were about to study by giving an example; explaining a concept by using pictures, diagrams, and other aids; and leading brainstorming and discussion until students formulated definitions in their own words. Student definitions

deemed valid (by class consensus, with teacher probing or guidance during further discussion as needed) were posted on the board, and the students wrote each vocabulary word, underlined it, and copied one of the brainstormed definitions into their vocabulary journals. Students chose the definition that made the most sense to them. Afterward, the class brainstormed various ways to illustrate the word. Students drew illustrations on the board before choosing the one that made the most sense to them and including it in their vocabulary journal underneath the definition. The class also used many “nonexamples” in their illustrations because some of the students understood the concept better by relating what the illustrations did not mean. Students used the symbol of a circle with a slash through it to demonstrate “not an example.”

Although the program outlined by Marzano, Kendall, and Gaddy called for students to write definitions in their own words and illustrate vocabulary independently, the group brainstorming activity worked better for the students in this study because of their struggle with language arts skills.

Whenever a vocabulary word came up in a lesson, the teacher would ask, “And that means what?” If a student used the “official” book definition, the teacher would ask him (or another student) to put it into his own words. Students were not corrected or told “no” if they came up with flawed or inadequate definitions; rather, the teacher would ask for someone else to “clarify” that definition, with further discussion sometimes ensuing about why the first definition was not complete. Encouraging students to use their own words but avoiding the labeling of their words as somehow “wrong” (in favor of further discussion about the definition) served to reinforce a deep understanding of the academic vocabulary and to make students more comfortable formulating their own definitions.

To review the academic vocabulary, students periodically played vocabulary games, many of which are featured in *Building Academic Vocabulary* and in Janet Allen’s *Words, Words, Words: Teaching Vocabulary in Grades 4–12* (1999).

The students were also given periodic academic vocabulary tests. At the beginning of the school year, when the vocabulary lists in their journals were shorter, they were given a list of the academic vocabulary and were asked to define each in their own words and to illustrate. As the vocabulary lists in their journals got longer, tests included word banks; students would match vocabulary words with student-drafted definitions, and they would also illustrate each word. The students did remarkably well on these tests; they all passed with scores of 70 percent or higher, and most scored 80 percent or higher. Students were less intimidated by defining concepts in their own words than having to regurgitate official book definitions. Many students who did not understand, or could not remember, the official book definition of a word had no problem remembering what it meant in their own words.

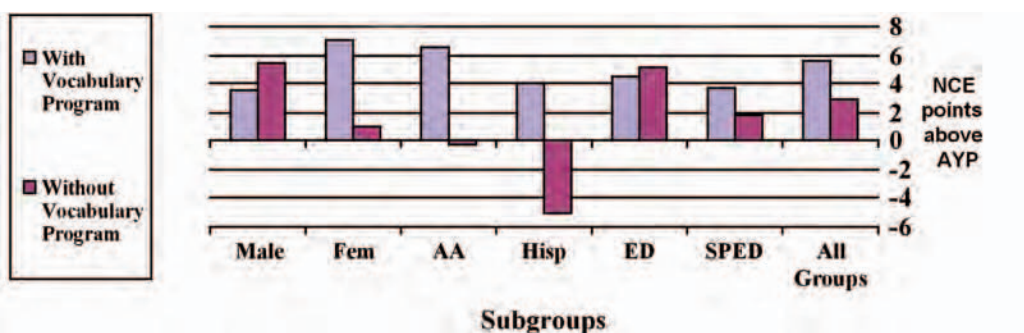
The second aspect of this study involved students' perceptions of their potential for success. Several months before the TCAP tests, students filled out surveys related to their feelings about TCAP math tests in prior years. Survey items focused on areas such as overall feeling of preparedness, eagerness to take the test (i.e., looking forward to it), expectation of scoring high, general understanding of questions and vocabulary used on the test, test-taking habits (e.g., finishing within time limits and rechecking answers), anticipation of results, and enjoyment in taking the test. Each survey item was worded as a statement; students were asked to respond to each statement according to a scale that ranged from "strongly agree" to "strongly disagree."

Once TCAP testing was completed, the students again filled out surveys on the same areas. Pre- and post-test responses were compared for each survey question.

Findings

This study found that the teaching of academic vocabulary can benefit all types of learners. However, we found that it is even more beneficial to struggling learners than it was to the students studied by Marzano, Kendall, and Gaddy (1999). Where Marzano had determined that teaching academic vocabulary could facilitate at least a 33 percent increase in gains on standardized tests, this study found that this group of students' NCE scores experienced a 93 percent increase above adequate yearly progress (AYP). See Figure 1.

Figure 1. NCE Points Above AYP



Fem = Female; AA = African American; Hisp = Hispanic; ED = Economically Disadvantaged; SPED = Special Education

In the class using academic vocabulary, every subgroup made AYP. In the previous class, without academic vocabulary instruction, two subgroups failed to make AYP. Although all subgroups achieved AYP using the academic vocabulary program, the Male and Economically Disadvantaged subgroups experienced a decrease in points achieved above AYP. A closer inspection of the data revealed that one student's gains in the 2004–05 class without the vocabulary program

may have skewed results. His gains also affected the Special Education data. As a whole, however, the 2005–06 class that used the academic vocabulary program experienced a 93 percent higher gain in points above AYP than the class that did not use the program.

Pre- and post-test surveys given to the students participating in the study yielded information regarding the students’ perceptions of their potential for success on the TCAP math test. Survey results were just as impressive as the actual TCAP test results. Prior to understanding the academic vocabulary of math, students went into the TCAP testing feeling well-prepared, but they did not look forward to having to take the tests. The majority expected to achieve a high score going into the tests but felt the opposite coming out. Additionally, students had no desire to learn their results. Because they felt they did not understand the vocabulary used on the tests, they did not know what the tests wanted them to do. Although most of them finished the tests before time was up, they did not go back and check over their work or revisit difficult questions.

In contrast, the students in the 2005–06 math class that received focused instruction on academic vocabulary went into the tests full of confidence. They looked forward to the tests and felt well-prepared. These students felt like they would score high and were looking forward to finding out their results. After the tests, they were even more confident. They reported that they had no problem with the vocabulary and understood all of the questions. They perceived that it took longer to finish the timed test; when they finished early, they reviewed questions and checked their work, an action that none of them reported (on the first survey) they would do.

Long-Term Effects

This study spanned three academic years. It began (2004–05) with no focus on vocabulary instruction, and in its second year (2005–06), vocabulary instruction was an integral part. In the third year (2006–07), 13 students remained from the original group, and vocabulary instruction was not used in their math class. These 13 cases were used to compute a dependent variable mean (see Figure 2), along with the means for the previous two years.

Figure 2. Dependent Variable Mean

Year 1 (2004–05)	Year 2 (2005–06)	Year 3 (2006–07)
34.846	40.308	45.846

The mean score was found for each year of the study. In 2004–05, the mean was 34.846 for the students before the vocabulary treatment. The second year of the study (2005–06) was the beginning of the vocabulary treatment. The mean score for that year was 40.308. In the third year (2006–07), the 13 students remaining in the study entered 7th grade. The question remained, “Would there be any carryover effect of the intensive vocabulary program?”

The mean score increased to 45.846 in 2006–07. How likely is it that these results occurred by chance? By using a repeated measure of analysis of variance (see Figure 3), a ratio mean test score change (variance) over time compared to sampling error produced a *p-value* of 0.000. This result indicates that it is highly unlikely (i.e., chances are less than 1 in 1000) that the results were due to chance, leading to the conclusion that the difference in means was most likely due to the vocabulary treatment.

Figure 3. Repeated Measures of Analysis

Source	SS	df	MS	F	p
Time	786.513	2	393.256	11.621	0.000
Error	812.154	24	33.840		

SS = sum of squares

df = degrees of freedom

MS = mean square; a variance estimate obtained by dividing a sum of squares by its degrees of freedom

F = the ratio of the observed differences between all sample means to the expected/chance differences; for 3 or more samples, the null hypothesis is tested with the F ratio.

p = the degree of rarity of a test result; p equals the probability of a difference among means this large occurring due to sampling/chance.

Conclusion

Overall, the academic vocabulary program gave the students the tools they needed to successfully show their math knowledge on the TCAP tests. They were excited each day after completing the math portions of the tests; their self-confidence showed in their eyes as they talked about things that were on the tests. In the past, where students might have said, “There were questions about lines and angles,” they were now saying, “They asked about perpendicular lines and acute angles all the stuff we know!” The math students at this level had never been able to do that before and left 6th grade feeling like they finally understood math.

The study also had some unexpected results. It was easier to teach new concepts when all of the students understood, in their own way, what was being discussed. And because they did understand, it took fewer days to review each chapter before testing. For example, in the previous year, without academic

vocabulary focus, it would take three to four days of review before students were ready to be tested; with the academic vocabulary program, it never took more than two days of review and, many times, it took as little as one. The students would readily discuss math concepts, and they felt comfortable discussing math. Now that they knew the terminology, they could express their thoughts clearly and concisely.

Because of this “common language,” it took a fraction of the time it used to take to understand and clear up students’ misconceptions; students could quickly explain what they were struggling with and could more quickly understand explanations. Another result of the common language was that, although the same lesson plans and learning activities from the previous year’s class were used, the 2005–06 year’s students mastered material much faster. For example, students were ready for the topic of prime factorization, previously not introduced until after Thanksgiving, at Halloween time. This enabled them to learn more new math concepts than any class at this level had before.

This study looked at only one class and one year of focused academic vocabulary instruction. There are no illusions about the statistical results with such a small population. What is known is that a difference was made in these students’ lives for at least one year. Will these students continue to be successful in 7th grade? Future tracking of this same group will answer that question. This study has discovered, however, an avenue for students, teachers, and tests that allows for better communication with one another in a way that comes close to reaching everyone.

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