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Investigating the effectiveness of vocabulary strategy instruction on content-specific word acquisition

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ABSTRACT
Mathematics is typically one of the subjects with which many students struggle. To improve mathematics achivement, it is helpful for students to gain proficiency in mathematics vocabulary. The importance of developing vocabulary as a means of improving comprehension has long been understood by educators and researchers. Students who are exposed to academic vocabulary are usually more successful in their content area classes; yet, the relative effectiveness of vocabulary strategies to build content area vocabulary comprehension in mathematics at the secondary level has had limited research. In this study, two vocabulary strategies were compared in a six-week long investigation to determine the relative effectiveness of each strategy on students' content area vocabulary development in an Algebra II class - a Modified Cloze/Maze procedure and a Concept of a Definition word map. The research findings conducted from this study are relevant to all content area teachers, in particular math teachers at the secondary level.

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Introduction

In an ever changing technological society, the ability to effectively communicate, reason, and think quantitatively is now a prerequisite skill necessary to succeed in life, as well as in an entry level community college and university course work. The mathematics philosophy of the educational system is focused on achieving such goals. The mastery of mathematical concepts is essential to enable students to develop and utilize reasoning and problem solving skills in real world situations.

Literacy in mathematics is the ability to use formal and informal language through oral and written communication and to justify mathematical applications and processes in a global market. Formal and informal language is used extensively in teaching the content area subjects in school. Knowledge and understanding of content area vocabulary is an important part of improving comprehension in these subject areas. The importance of developing vocabulary as a means of improving comprehension in content area subjects has been long understood by educators and researchers alike (Graves, 2008; Harrison & Jacobson, 1982; Hirsch, 1988; Marzano, Kendall, & Paynter, 2005). Concepts are developed and a deeper understanding is gained through the specific vocabulary used within the subject being taught. Learning academic words is important in helping all students gain fluency in content areas. Most students have developed social vocabularies, but struggle with subjects that contain technical vocabulary. Technical vocabulary is made up of academic vocabulary words that are specific to a content area. Students who are exposed to academic vocabulary are usually more successful in their content-area classes because familiarity with academic vocabulary helps them develop fluency in content-area language. Helping students build a foundation of academic vocabulary is an integral part of ensuring students' success in mastering content-area subjects.

Students often complete their high school Algebra classes without fully comprehending the content-specific terminology, and they struggle with the vocabulary necessary to meaningfully converse about what they have learned. In addition, they often struggle throughout the course due to their insufficient understanding of the vocabulary being used by the teacher in the lessons. This problem is apparent most often in test results. A student's success or failure hinges on gaining understanding of the content area vocabulary (Pierce & Fontaine, 2009). In most high stakes tests and exit level tests the student is expected to have an understanding of not only the concepts, but the vocabulary used in the questioning. The discouragement that accompanies repeated failure can result in the student dropping out of school and/or believing that he or she is just not good at math. Knowledge and application of content area vocabulary strategies can extend students' understanding in content subjects. Building the vocabulary necessary to understand the concepts will improve a student's confidence and ability to be more successful at math and possibly find math enjoyable.

Purpose of the Study

The purpose for this study was to compare the relative effectiveness of two strategies to build content area vocabulary comprehension in a high school Algebra II class. Students struggle with understanding the academic vocabulary necessary to grasp the key concepts in math. What content area vocabulary approaches improve comprehension of math concepts at the secondary level? What are the effects of implementing a Modified Cloze Procedure and using a Concept of a Definition word map on vocabulary development? Two vocabulary methods were compared in a series of Algebra II classes. A six week long investigation in a co-teaching classroom was conducted to determine the relative effectiveness of two strategies on students' comprehension of the content vocabulary in Algebra II.

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Review of Literature

The importance of vocabulary in content area subjects has been viewed for decades as a critical factor in learning the concepts that are integral to mastery of the subject matter. An individual's ability to succeed in a subject matter depends not only on knowing the definitions of content specific vocabulary, but also on the application of this vocabulary within different contexts. Vocabulary learning consists of an integrated network of knowledge that builds throughout one's life. The students experience with vocabulary and the connections made during the development of concepts have been built throughout the individuals' education. One consideration in teaching vocabulary is choosing the level of words appropriate to instruction based on their utility, instructional potential, and conceptual understanding. Beck, McKeown, and Kucan (2002) described how to choose words using a three-tiered approach. Tier 1 consists of words that are highly frequent in everyday talk, commonly known to students (clock, baby, happy) and rarely require instruction. Instruction in tier 2 words are essentially uncommon labels for common ideas (maintain, benevolent, performed), can add to one's language ability and are likely to appear frequently in a variety of text. Tier 3 words are highly specialized, rare words often limited to specific content areas (isotope, lathe, and peninsula) and would best be taught when needed. Beck and her colleagues suggest targeting tier 2 words for their utility. Bravo and Cervetti (2008) suggest selecting more critical tier 3 words because of their importance to content area understanding. Bravo and Cervetti also suggest words that represent the most important concepts or processes. These word tiers are important factors to consider when the goal is content area comprehension. Ryder and Graves (1998) (as cited by Bravo and Cervetti) suggest allowing students (with teacher guidance) to be involved in determining the essential terms. Student involvement would promote an awareness of words and motivation to learn new words as well as concepts. The challenges in teaching and learning vocabulary are numerous. In reviewing the literature several key factors recurred, the complex language of mathematics, the teachers' perspective of vocabulary development and the various methods of vocabulary development.

Mathematical Language

The language of mathematics is an important component to instruction. The difficulty is that the vocabulary is often abstract and complex. "Proficiency in mathematics has increasingly hinged upon a child's ability to understand and use two kinds of math vocabulary words: math-specific words and ambiguous, multiple-meaning words with math denotations" (Pierce & Fontaine, 2009, p. 242). Monroe and Panchyshyn (1995) (as cited by Pearce and Reynolds, 2005) categorize mathematics vocabulary into four categories: technical, subtechnical, general, and symbolic. The technical words must be taught explicitly and have a precise meaning (e.g., parallel, isosceles, integer). Technical words are often defined in textbooks using more technical words, thus making it more difficult for students to actually understand and remember the definition. The subtechnical words have common meanings as well as mathematical denotations (e.g., mean, table, and yard). Discussion of common meanings of subtechnical words is important to clarify their use. General vocabulary is found in everyday language. Terms such as; more than, less than, balance, and gallon are usually in the student's vocabulary outside of the math class. Symbolic vocabulary refers to symbols such as $\leq$, Π, $\approx$, and to the value of numerals. Abbreviations are also included in symbolic vocabulary. Pound (lb.) and ounce (oz.) are just two examples of confusing abbreviations. Blachowicz, Fisher, Ogle, and Watts-Taffe (2006) agreed that the technical words from content areas comprise an important vocabulary set to choose for instruction. Older word lists relevant to content area subjects by Harrison & Jacobson (1982) have been updated by Marzano, Kendall, & Paynter, (2005), and lists representing important content areas by Hirsch, (1988) and word families created by Marzano, (2004) (as cited by Blachowicz et al., 2006) comprise important vocabulary sets to choose for instruction. The goal of using specific vocabulary lists provides for subject relevance and context connection opportunities with the student. Doug Buehl (2009) asserts that authors write to target audiences and academic knowledge parallels the background knowledge a person develops when studying various academic disciplines, and it is narrower and more prescribed than general knowledge. Beck, McKeown, and Kucan (2002) suggest teachers offer "student-friendly explanations" of a word rather than dictionary definitions. The explanations should explain the correct meaning and how the word is typically used. In addition, Verlaan (2010) suggests introducing math terminology through the use of informal proofs as a means of developing mathematics vocabulary. Vocabulary instruction should also be rich and lively so students "develop an interest and awareness in words beyond vocabulary school assignments in order to adequately build their vocabulary repertoires" (Beck, et al., 2002, p. 13). The teacher must consider a hierarchy of student knowledge of words when teaching technical vocabulary. Research agrees that knowledge of a word consists of not only its recognition, but also an understanding of its use in connection with the context. The background knowledge of the students and connections to their existing schemas must be combined with instructional methods that require active processing in context, abundant manipulation of words, and repeated exposures from multiple sources (Pearce & Reynolds, 2005).

Math Teachers Teach Reading Using Content Vocabulary

There is a limited amount of literature that addresses secondary content area vocabulary for mathematics comprehension and academic growth specifically. Most content area vocabulary strategies are targeted towards the elementary level. A majority of the literature focuses on the larger arena of content area learning, teaching across subject matter disciplines and the interplay between vocabulary knowledge and conceptual understanding. There is no single, most effective method of teaching reading or vocabulary. Research findings can be used to provide insight and direction into the complexities of word development. The most effective strategy concerning the area of mathematics is the realization of the content area teacher that literacy is being taught within the context of mathematics. This also implies that teachers consider using explicit forms of vocabulary instruction within the content lesson. Phillips, Bardsley, Bach, and Gibb-Brown (2009) included middle school mathematics teachers and literacy coaches in a study to create min-lessons using math content to teach reading skills. An important aspect for the teachers was that the lessons be "useful and not in addition to" the content (Phillips et al., 2009). The methods used in the study included such things as a think aloud to aid students in understanding how to think through a problem or process, the use of graphic organizers, using roots to determine unknown words, understanding varied formats, understanding directional words, and giving students time to practice the skills in small groups (Phillips et al.). In Adams' (2010) study, patterns of literacy strategy use were related to the teachers' view of pedagogy and of mathematics. The teaching

style of each participant revealed different views and approaches to vocabulary learning, although the same strategies (Frayer Model, word sort, word wall, and the Visual Verbal Word Association) were used by both teachers. The two views of vocabulary development focused on (1) the concept definition view and (2) the concept image view. The concept definition view holds that each term has a precise static verbal definition that must be learned. Meanings are fixed and external to students, who all need to learn the same meaning for each term. Knowledge of a correct definition should provide a student with a correct image. The concept image view is that of developing concept images. Students make sense of each term in their own personal way. Experiences with a concept lead learners to associate various mental images, processes, and characteristics with that concept. These various associations comprise the learners' images of the concept. Concept images become more refined as understanding of the concepts deepen. The results of these projects created teacher confidence in mathematics and literacy knowledge as well as enhancing student comprehension of math vocabulary.

Philosophy and Strategy

Key components to improve math content, vocabulary awareness, understanding, and further growth in mathematics education are varied. The National Reading Panel (National Institute of Child Health and Human Development [NICHD], 2000) (as cited by Scott, Nagy, & Flinspach, 2008) presented the following best practices:

- Vocabulary should be taught both directly and indirectly.
- Multiple exposures to vocabulary items are important.
- Learning in rich contexts is valuable for vocabulary learning.
- Vocabulary tasks should be restructured when necessary.
- Vocabulary learning should entail engagement in learning tasks.
- Computer technology can be used to help vocabulary.
- Vocabulary can be acquired through incidental learning.
- How vocabulary is assessed and evaluated can have differential effects on instruction.
- Dependence on a single vocabulary instruction method will not result in optimal learning.

Scott et al., (2008) state, "Most vocabulary instruction and research have been informed by cognitive linguistic and psychology with little regard for social or cultural aspects of the learning environment (p. 183). Scott and colleagues clarify the differences between cognitivists focus as being on word learning at the level of the individual learner, whereas the sociocultural theorists investigate language learning in a community, looking at social interactions, context, and power relationships that influence learning and use. These philosophies toward vocabulary learning are important because of their influence on the classroom environment and the teachers' perspective of her students. The sociocultural perspective emerges from Vygotskian theory (as cited by Scott et al., 2008), where word learning in an academic setting is part of learning a new discourse with many students. Fisher and Frey (2011) encourage a gradual release of responsibility from the teacher using scaffolding, teacher modeling, and peer interaction to develop vocabulary knowledge, which is a method that allows the student to gradually increase in responsibility of his or her learning. Vacca (2001) suggests word study strategies including learning word parts for students to grow independently. Rubenstein (2000) as cited in Harmon, Wood, & Hedrick (2008), encourages teaching word origins in mathematics classrooms because of the roots and connections with cognates for EAL students. Students can use strategies taught in reading to learn the vocabulary necessary to attain mathematical knowledge. The use of a dictionary to look up the words and definitions still requires the student to integrate the information in the definition within a specific context. Harmon et al. (2008) confirm that the direct teaching of individual words is tied to actual content when words are considered labels for concepts.

There are many empirically grounded techniques for teaching individual content words, including pre-teaching strategies, keyword mnemonics, graphic representations, and other specific vocabulary activities. Visual representations, such as structured overviews, concept mapping, and semantic grids, have gained support as viable instructional techniques for teaching content area vocabulary (Harmon et al., 2008). Graves (2008) reviews several specific strategies for powerful vocabulary instruction such as semantic mapping, semantic feature analysis, robust vocabulary instruction, the Frayer method, glossaries, definitions plus pictures, context-dictionary procedures, and a context-relationship procedure to emphasize that one size does not fit all for instruction of individual words. Schwarz (1999) reviews effective strategies to promote vocabulary learning such as the use of word walls, vocabulary journals, and oral communication. Word walls provide a space in the classroom where student and teacher can post words that students are expected to read, define, and spell automatically in order to develop relationships between words. The visible aspect of a word wall creates a positive atmosphere for word learning and a resource for quick referencing. Vocabulary journals can be used in a variety of ways to increase vocabulary retention. Vocabulary journals can improve syntax, vocabulary definitions, standard spellings, and fluency in handwriting (Schwarz, 1999). Vocabulary journals can be used for students to graphically depict a word through drawing images and symbols. Vocabulary journals are used to create personalized sentences of target words and thoughts about the meanings of words. Vocabulary journals motivate students to acquire more words. Research has found that students attach meaning to words and retain understanding by drawing and writing. Using oral and written communication allows for students to transmit ideas quickly, efficiently, and accurately.

From the vast amount of strategies to the foundational theories underlying them, vocabulary acquisition can be accomplished in meaningful and lasting ways. The difficulties of learning vocabulary in secondary mathematics appear to be related to matching a strategy to the word learning purpose. For vocabulary to be learned conceptually the teacher must have an understanding that word knowledge goes beyond a definitional level, occurs incrementally, and requires different strategies for different words (Harmon et al., 2008). The cloze procedure is a method that relies on prior knowledge and context clues and requires the student to complete a passage with every *nth* word deleted. Pierce (1976) found aspects of the cloze procedure to lend itself as a teaching tool in different content areas.

Richardson, Morgan, and Fleener (2006) demonstrate the use of cloze to build background knowledge and to teach technical or general vocabulary. Guthrie's maze strategy (as cited by Richardson et al., 2006) is similar to cloze but easier for students who lack background knowledge and helps students gain understanding of a subject. The students are given three choices: (1) the correct word, (2) a grammatically similar word but incorrect word, and (3) a distracter, which is a grammatically different and incorrect word. Schwartz and Raphael (1985) designed a word map based on semantic mapping to help students develop an underlying knowledge of the subject matter (as cited by Richardson et al., 2006). Using a graphic organizer,

the key word is in a box and directly under the key word, examples are that remind students of that word are placed. To the right, the properties are written to describe what it is like. Directly above the key word, the concept of the word is represented as a definition or description. In review of the literature, the strategies chosen for the purpose of this research were the modified cloze/maze and the concept/definition map.

Method

Participants

The site of this study was Foy H. Moody High School. The school's student population is composed of 1,855 students in grades 9^{th}-12^{th}. Moody is a South Texas Title I school with a predominately Hispanic population (91%), while there is a minority of African-American (5.2%), and Caucasian (2.9%). Asians and American Indians make up less than 1% of the population. The school is rated recognized by TEA and has met Adequate Yearly Progress requirements as set by the NO Child Left Behind Act.

The participants in this study were from six Algebra II classes. The classes were divided into three groups. Algebra II was a required course for all of the students in the study. Each class contained seniors and juniors working toward a high school diploma and needed to pass the state mandated TAKS test. Each class also contained special education students (22 total) with individual education plans, due to various learning difficulties. The special education students were placed in the mainstream classroom with additional teacher support. There were three ESL students. Two of the classes (n=33) received treatment 1. Two other classes (n=35) received treatment 2. The last 2 classes (n=31) were the control group.

Treatment

Two of the classes (Treatment 1) received the Concept of Definition Map graphic organizer method. A Concept of a Definition Map includes the three elements of a good definition: (1) the overarching category to which the word belongs: What is it? (2) the important features or characteristics of the word or concept: What is it like? and (3) specific examples: What are some examples? I explained that completing a Concept of Definition Map will help them to understand the three elements of a good definition. After introducing the topic information for the unit, I modeled filling in the map on an overhead projector using a transparency of the Concept of Definition Map for each target word. Using the text we identified the general category for each word, defining features, some examples, and their own explanation of the word. Each student followed along and completed a Concept of Definition Map in a vocabulary notebook for reference.

The other two classes (Treatment 2) received the Cloze/Maze Procedure method. After the initial introduction of the concepts and skills for the unit, the students were given a handout of the Modified Cloze passage with the targeted vocabulary words deleted. The Modified Cloze procedure uses a passage with every *nth* word deleted. The Cloze procedure can be used to build background knowledge, and teach technical or general vocabulary. The students are to use context and comprehension strategies to insert the correct word in the blanks. Due to the technical vocabulary used in Algebra II classes, the researcher found it necessary to use the maze method by giving three word choices in parenthesis next to the blank. Students filled in the blanks individually and then discussed their answers with a partner. The teacher/researcher reviewed the correct vocabulary with the whole class using a transparency for clarification of the targeted words. Each lesson is included in the appendix.

The control group did not receive any explicit vocabulary instruction. All of the classes were taught by the same mathematics teacher using the same curricula. All six classes participated in a vocabulary pre-test at the beginning of the study and a post-test at the end of the study. The experiment groups were given a notebook to keep their vocabulary words in during the study. Classroom discussions using the vocabulary and application of the concepts were used daily throughout the study. The study lasted six weeks and was divided into units. Words were selected from each topic. Each unit was taught over a three week period. The strategy was used to directly teach the target vocabulary words after each topic had been introduced. Approximately four words were explicitly taught each week. A total of 23 words were taught.

Measures

The measures used on all students were vocabulary pre and post tests. Validity of the vocabulary measure was determined by having another teacher look at each vocabulary test before administering it to ensure the definitions were accurate. The definitions were derived from the publisher's Algebra II textbook.

Two measures were used to assess the experimental groups. The first of these was a teacher-constructed test over the specific vocabulary words taught in each unit. After each unit, the students took a teacher-constructed test over the vocabulary words. Each student had two vocabulary test scores, one for each unit taught.

The second measure was Algebra II problems taken from the curriculum. These problems were given to the students at the conclusion of each unit. The tests were derived from the curriculum.

The results of each groups pre and post tests were analyzed to determine the mean and the standard deviation. The mean and standard deviation were used in a t-test to gather comparative data between the two groups. The unit tests for the experimental groups were compared using the same process.

Results

This quantitative study was implemented to compare the relative effectiveness of two strategies using direct instruction in an effort to build content area vocabulary comprehension in a high school Algebra II class. The first challenge was to compare two vocabulary approaches: cloze/maze strategy to the concept of a definition/word map for improvement in comprehension of math concepts at the secondary level. In comparison of the Algebra II students at Moody High School, there was no statistically significant difference between the two treatment groups, group 1(M=64, SD= 22) and group 2 (M=72, SD=20), $t(66)$=1.5705, p=0.1211 at the 0.05 level, $CI_{.95}$ -18.17,2.17 on the pre and post tests of the vocabulary words with the definitions (See Table 1). Therefore, we fail to reject the null hypothesis that there is no difference in vocabulary scores between the two strategy groups. The two strategy group unit tests were compared using the same process. By conventional criteria, the difference is considered to be very statistically significant between the two treatment groups, group 1 (M=5, SD=5), and group 2 (M= 9, SD=-7), $t(66)$ =2.70, p=0.0089 at the 0.05 level, $CI_{.95}$ -6.96, -1.04 on the two unit tests (see Table 4). Therefore, we reject the null hypothesis that there is no difference in vocabulary scores between the two treatment groups. The two quiz results for each group did not show progress in mastering the content area words (see Table 5). The second challenge was to measure the effects of implementing a modified cloze/maze procedure and using a concept of a definition/word as opposed to not using any strategy to build

vocabulary comprehension. By the end of the intervention, the participating students had significantly higher achievement in understanding the content area vocabulary when compared with the control group using the pre and post tests only. Among the Algebra II students in the study, there was a statistically significant difference between the control group and treatment group 1, team 1 (M= 64, SD=22) and the control group (M=31, SD=22), $t(62)=6.0168$, p=0.001 at the 0.05 level, $CI._{95}$ 22.04, 43.96 (see Table 2). Therefore, we reject the null hypothesis that there is no difference in vocabulary scores between the control group and treatment group 1. Among the Algebra II students in the study, there was a statistically significant difference between the control group and the treatment group 2, team 2 (M=72, SD=20) and the control group (M=31, SD=22), $t(64)=7.96$, p=0.0001 at the 0.05 level, $CI._{95}$ 30.71, 51.29 (see Table 3). Therefore, we reject the null hypothesis that there is no difference in vocabulary scores between the control group and the treatment group 2.

Discussion

This study focused on the overall importance of implementing and directly teaching vocabulary strategies at the secondary level in content area classrooms, specifically mathematics. Students often complete their high school math classes without comprehending the content or having developed the vocabulary necessary to converse about what they have learned. The overall results of this study show that students improved in their comprehension of content area vocabulary. The vocabulary word test results from the pre-test to the post test show a significant improvement. The second measure of the content area tests of the concepts in each unit also indicated an improvement in understanding of the content. The students gained understanding of the target words in the definition tests and in the unit tests. The progress noted between the quiz results appeared to be lower after the first quiz.

The students were able to discuss the academic language and gain a better understanding of the topics being taught. These results confirm the research of Harmon et al. (2008) in using structured overviews, and that of the National Reading Panel (2000) for the direct instruction of vocabulary. The social interaction while doing the lessons with the students provided for the sociocultural aspect mentioned by Scott et al. (2008), where word learning became part of learning a new discourse among teachers and students. In using the concept of a definition/word map the students benefited by experiencing the words conceptually above the definition level. The maze/cloze procedure lent itself well to teaching academic vocabulary words in an Algebra II class at the secondary level as identified by Pierce (1976).

The researcher observed an increase in student motivation and interaction during the study. At the introduction of the vocabulary words to the students the researcher noted comments from the students concerning the lack of their knowledge of the words. By the end of the study, the general consensus among the students appeared to be a new sense of ownership of the words and math concepts learned. The student's confidence and ability to apply the technical math vocabulary was apparent in the lessons, conversations, and testing.

Further Study

It is this researcher's recommendation that further research be continued in the area of matching vocabulary strategies to teaching technical vocabulary words at the secondary level in math classes. As the current research indicates, the value and benefit of directly teaching vocabulary in the content area can improve students' comprehension of content and enjoyment of the subject. The math teachers' perspective of teaching a strategy commonly used in reading instruction, such as vocabulary, is also an area that needs further research. Future research should include how to teach and support effective use of literacy strategies in a secondary math class.

Limitations

The researcher acknowledges several limitations to this study. The time frame of the study was brief, considering the amount of words studied. The brevity of the study was further complicated by student absences, tardies, SAT, TAKS, benchmark testing and other school functions. Students were often pulled out of the classroom for various reasons during the study and the 5-10 minute vocabulary strategy could not be made up or take up more content area teaching time. The group size and profile (demographics, disabilities, ESL, etc.) could have an effect on the study results. The differences in the levels of academic vocabulary appeared to be limitations observed by the researcher from the two quizzes students were given. The words used in the second quiz were more abstract. The researcher acknowledges that although the concept of a definition/word map had less preparation time, the strategy took more time to teach and presented some difficulty with abstract words. The cloze/maze strategy required more preparation time from the teacher, but was easier to implement with the students. The cloze/maze passages did not follow the traditional passage use as per the technical vocabulary words used in the study. The researcher knowledge of the content vocabulary and experience using the strategies could have affected the student outcomes also. Some of these limitations could have been overcome in a longer study.

Conclusion

The importance of teaching technical vocabulary at the secondary level is a critical factor in learning the associated concepts of mathematics. Implementing vocabulary instruction in mathematics includes using various strategies that do not take a lot of time away from teaching content and enhances the development of the mathematical concepts. The purpose of this study was to compare the relative effectiveness of two strategies to build content area vocabulary comprehension in a high school Algebra II class. This study attempted to answer two questions: What content area vocabulary approaches improve comprehension of math concepts at the secondary level? and What are the effects of implementing a modified cloze/maze procedure and using a concept of a definition/ word map? Both questions have been explored and answered to verify the value of implementing the strategies. These findings are a valuable addition to the current research on vocabulary instruction as it applies to enhancing comprehension in the content area of mathematics. The results of this study should also serve to encourage teachers to incorporate direct teaching of content-specific vocabulary by implementing literacy strategies to help students master content area concepts.

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Table 1. Scores between the two treatment groups pre and post tests.

Instructional Group	*n*	*Mean*	*SD*	*t*	*df*	*p*	*95% Confidence Interval*
Group 1	33	64.00	22.00	-	-	-	-
Group 2	35	72.00	20.00	-	-	-	-
Total	68	68.00	21.00	1.5705	66	0.1211	-18.17-2.17

Table 2. Scores between treatment group1 and control pre and post tests

Instructional Group	*n*	*Mean*	*SD*	*t*	*df*	*p*	*95% Confidence Interval*
Group 1	33	64.00	22.00	-	-	-	-
Control	31	31	21.850713500	-	-	-	-
Total	64	47.5	21.92535675	6.0168	62	0.0001	22.036334110-43.963665890

Table 3. Scores between treatment group 2 and control pre and post tests.

Instructional Group	*n*	*Mean*	*SD*	*t*	*df*	*p*	*95% Confidence Interval*
Group 2	35	72	20	-	-	-	-
Control	31	31	21.850713500	-	-	-	-
Total	66	51.5	20.92535675	7.9585	64	0.0001	30.708-51.29

Table 4. Scores between the two treatment groups unit tests

Instructional Group	*n*	*Mean*	*SD*	*t*	*df*	*p*	*95% Confidence Interval*
Group 1	33	5.00	5.00	-	-	-	-
Group 2	35	9.00	-7.00	-	-	-	-
Total	68	7.00	-1	2.6969	66	0.0089	-6.96to -4.00

Table 5. Mean and standard deviation of the treatment groups quizzes.

	Quiz 1			Quiz 2		
Instructional Group	Mean	SD	N	Mean	SD	N
Group 1	73	31	33	57	31	33
Group 2	81	30	35	69	26	35