6-1-2017

The effectiveness of the mnemonic keyword strategy on math vocabulary learning for students with learning disabilities

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THE EFFECTIVENESS OF THE MNEMONIC KEYWORD STRATEGY ON MATH VOCABULARY LEARNING FOR STUDENTS WITH LEARNING DISABILITIES

by

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A Thesis

Submitted to the
Department of Interdisciplinary and Inclusive Education
College of Education
In partial fulfillment of the requirement
For the degree of
Master of Arts in Special Education
at
Rowan University
May 8, 2017

Thesis Chair: Amy Accardo, Ed.D

Dedications

This thesis is dedicated to my Grandma Esther, who was always proud of me for my accomplishments and would have loved to read my thesis; my loving fiancé, Jared, who supported and encouraged me throughout this process; my parents, Aunt Alice, and Uncle Norm, who are genuinely interested in reading my thesis; and my wonderful sixth grade math students who cooperated in my study, make me smile every day, and make me love my job this year.

Acknowledgment

I would like to express my appreciation to Dr. Amy Accardo for her guidance and encouragement during the research and writing processes.

Abstract

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THE EFFECTIVENESS OF THE MNEMONIC KEYWORD STRATEGY ON MATH VOCABULARY LEARNING FOR STUDENTS WITH LEARNING DISABILITIES
2016-2017
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Master of Arts in Special Education

The purposes of this study were to investigate (a) the impact of the mnemonic keyword strategy on the acquisition of mathematical vocabulary of students with learning disabilities, (b) the impact of the mnemonic keyword strategy on the retention of mathematical vocabulary of students with learning disabilities, and (c) the level of satisfaction that students with learning disabilities have with the mnemonic keyword method. Seven sixth grade students with learning disabilities participated in this study, which utilized a multiple baseline across participants design. During the baseline and mnemonic keyword intervention phases, students completed weekly assessments to measure their acquisition of mathematical vocabulary. At the end of the intervention, students completed an assessment of retention and a student satisfaction survey. Results showed that students benefitted from the mnemonic keyword instruction, as it positively impacted their acquisition and retention of mathematical vocabulary. Also, survey results indicated that the majority of the students were satisfied with the mnemonic keyword method

Table of Contents

Abstract v

List of Figures ix

List of Tables x

Chapter 1: Introduction 1

Statement of Problem 1

Significance of the Study 6

Purpose of the Study 7

Research Questions 7

Chapter 2: Review of Literature 8

Introduction 8

Mnemonic Instruction 8

Using Mnemonic Strategies to Teach Information 10

Using the Mnemonic Keyword Method to Teach Vocabulary 15

Using the Mnemonic Keyword Method to Teach Mathematics Vocabulary 17

Retention of Content Taught by Mnemonic Keyword Method 18

Student Satisfaction with Mnemonic Keyword Method 21

Conclusion 23

Chapter 3: Method 24

Setting 24

School 24

Classroom 24

Participants 25

Table of Contents (Continued)

Students....25

Teacher....28

Materials....28

Binders....28

Handouts....28

Measurement Materials....29

Student Satisfaction Survey....30

Research Design....32

Procedure Design....32

Instructional Design....33

Measurement Procedures....34

Vocabulary Assessments....34

Student Satisfaction Survey....34

Data Analysis....34

Chapter 4: Results....35

Vocabulary Acquisition....35

Student A....36

Student B....37

Student C....38

Student D....39

Student E....40

Student F....42

Table of Contents (Continued)

Student G 43

Multiple Choice Assessments 44

"Create an Example" Assessments 44

Fill in the Blank Assessments 45

Vocabulary Retention and Maintenance 45

Student Satisfaction 46

Chapter 5: Discussion 48

Findings 48

Limitations 53

Implications 54

Conclusion 55

References 56

Appendix A: Mnemonic Keyword Method Handouts for Vocabulary Unit 2 59

Appendix B: Mnemonic Keyword Method Handouts for Vocabulary Unit 3 64

Appendix C: Mnemonic Keyword Method Handouts for Vocabulary Unit 4 69

Appendix D: Vocabulary Assessments for Vocabulary Unit 1 74

Appendix E: Vocabulary Assessments for Vocabulary Unit 2 77

Appendix F: Vocabulary Assessments for Vocabulary Unit 3 80

Appendix G: Vocabulary Assessments for Vocabulary Unit 4 83

Appendix H: Cumulative Vocabulary Assessment 86

List of Figures

Figure Page

Figure 1. Mnemonic Strategy Illustration for the Word *Quadrants.* 29

Figure 2. Student Satisfaction Survey.....31

Figure 3. Student A Vocabulary Acquisition.....37

Figure 4. Student B Vocabulary Acquisition.....38

Figure 5. Student C Vocabulary Acquisition.....39

Figure 6. Student D Vocabulary Acquisition.....40

Figure 7. Student E Vocabulary Acquisition.....41

Figure 8. Student F Vocabulary Acquisition 42

Figure 9. Student G Vocabulary Acquisition.....44

List of Tables

Table Page

Table 1. General Information of Participating Students 26

Table 2. Mean and Standard Deviation (SD) of Student Vocabulary Assessments 36

Table 3. Student Cumulative Vocabulary Assessments 46

Table 4. Student Satisfaction Survey Results in Percentages 47

Chapter 1

Introduction

As students enter secondary school, they are expected to learn and use new content-specific vocabulary (Bryant, Goodwin, Bryant, & Higgins, 2003). Curricular expectations may include specialized vocabulary in English, science, social studies, world language, and mathematics. Many students with learning disabilities have deficits in vocabulary and memory, and they become especially challenged by the increased vocabulary demands in secondary school (Mastropieri, Scruggs, Levin, Gaffney, & McLoone, 1985; Fontana, Scruggs, & Mastropieri, 2007). Although the subject of mathematics has substantial vocabulary terms, mathematical vocabulary instruction is commonly neglected (Brown, 2007). However, students' knowledge of mathematical vocabulary provides a foundation for critical thinking, explanations, problem solving, and understanding of high-level concepts in mathematics (Brown, 2007). The National Council of Teachers of Mathematics (NCTM) suggests that increasing the use of language in mathematics instruction will promote problem solving, reasoning, communication, representations, and connections in mathematics (Bay-Williams & Livers, 2009).

Statement of Problem

According to the Learning Disabilities Association of America (LDA), "learning disabilities are neurologically-based processing problems" (LDA, 2016, p. 1). Processing problems may manifest as issues with learning basic skills as well as higher-order skills. Several specific learning disabilities that affect one's abilities to learn basic academic skills are dyslexia, dysgraphia, and dyscalculia (LDA, 2016). Dyslexia is a specific

learning disability that affects one's abilities to read and process language; dysgraphia is a specific learning disability that impacts one's abilities to write including the physical act of handwriting, spelling, and composing writing; and dyscalculia is a specific learning disability that affects one's abilities to understand math concepts and perform math calculations (LDA, 2016).

Moreover, according to LDA, auditory processing disorder is a specific learning disability that impacts one's abilities to focus on, process, and remember language-based tasks (2016). Individuals with auditory processing disorder may also confuse words that have similar sounds (LDA, 2016). Finally, language processing disorder affects one's abilities to produce and understand language. Individuals with language processing disorder may have difficulty understanding spoken language and readings, and may have difficulty recalling words they already know (LDA, 2016). Thus, learning disabilities can interfere with basic academic skills, as well as memory, attention, and use of language.

Research suggests that deficits in memory, language, reading, and strategy usage negatively impact the vocabulary acquisition of students with learning disabilities (Bryant et al., 2003). It is suggested that students learn substantial amounts of new vocabulary from independent reading (Jitendra, Edwards, Sacks, & Jacobson, 2004). As a result of struggles with reading, students with learning disabilities often fail to engage in the volume of independent reading that would promote their vocabulary development (Jitendra et al., 2004). As a result, it is recommended that vocabulary be taught to students with learning disabilities in a direct and sequential manner (Jitendra et al., 2004). Vocabulary instruction for students with learning disabilities should emphasize word meaning and conceptual connections that enhance retention and application, and

moreover, should feature explicit instruction of definitions and strategies and provide repeated practice (Bryant et al., 2003).

Traditionally, dictionary usage and context clues were popular vocabulary-learning strategies, though research suggests that these strategies are no longer best practice (Bryant et al., 2003). Nagy and Stahl state that the dictionary method yields a "superficial understanding and rapid forgetting of a word" (2000, p. 8). Additional challenges of learning vocabulary from a dictionary are interpreting meanings of words in complex dictionary definitions and selecting the appropriate definitions of words with multiple meanings (Nagy & Stahl, 2000). Although children's dictionaries with simpler definitions are available, often times, the definitions in children's dictionaries are too simplified to convey appropriate word meanings (Nagy & Stahl, 2000). As a result, students may have difficulty internalizing meanings of words in dictionary definitions and using the words in sentences in their own words (Nagy & Stahl, 2000).

Another commonly-used method of learning vocabulary is the context clues strategy. The context clues strategy involves using the surrounding information in texts to generate word meanings. Although it is a useful skill, the context clues strategy has not been found to support students in internalizing meaningful definitions the first time they encounter new words (Nagy & Stahl, 2000). This is because when students apply the context clues strategy they gather partial information about a word each time they are exposed to it, yet it takes repeated exposure to the new word in contexts for students to generate word meanings (Nagy & Stahl, 2000).

Research suggests that the mnemonic keyword strategy can be used to successfully teach vocabulary to students with learning disabilities (Terrill, Scruggs, &

Mastropieri, 2004; Uberti, Scruggs, & Mastropieri, 2003; Scruggs, Mastropieri, Levin, & Gaffney, 1985; Mastropieri et al., 1985). Mnemonic strategies are strategies designed for enhancing memory and they offer new ways to encode information and facilitate retrieval (Mastropieri & Scruggs, 1998). Students who have difficulty learning and retaining verbal information tend to benefit greatly from the mnemonic keyword strategy (Scruggs, Mastropieri, Berkeley, & Marshak, 2010). The mnemonic keyword strategy can be used for teaching both concrete and abstract content, including vocabulary words, people, places, concepts, and cause/effect relationships (Scruggs et al., 2010). In the mnemonic keyword strategy, a concrete, familiar, acoustically-similar word is assigned as a cue to a new term (Fontana et al., 2007). For example, the new vocabulary word *ranid*, which means 'frog,' may be given the keyword *rain* (Mastropieri et al., 1985). Then, an illustration is designed, using the keyword to demonstrate the meaning of the vocabulary word. For example, an illustration of a frog on a rainy day is a cue that *ranid* means *frog* (Mastropieri et al., 1985). Students are instructed to envision the keyword mnemonic illustration in their minds, to facilitate their recall of the word meaning.

Various studies have shown that the mnemonic keyword strategy is an effective strategy for students with disabilities acquiring new vocabulary (Terrill, Scruggs, & Mastropieri, 2004; Uberti et al., 2003; Mastropieri, Sweda, & Scruggs, 2000). Since the 1980s, more than 40 studies have been conducted to investigate the effect of mnemonic keyword strategy instruction on students with mild disabilities, with high success rates reported for over 2,000 participants (Scruggs et al., 2010). For example, Terrill, Scruggs, and Mastropieri (2004) conducted a study during which they taught SAT vocabulary to 10th grade students with learning disabilities, using the mnemonic keyword strategy.

When the students with learning disabilities were taught SAT vocabulary words with the mnemonic strategy, they answered an average of 91.7% words correct. On the other hand, when they were taught with non-mnemonic instruction, they answered an average of 48.8% words correct (Terrill et al., 2004). Thus, the study suggests that the mnemonic keyword method can be effective at teaching complex vocabulary words to high school students with learning disabilities.

In another study, Uberti, Scruggs, and Mastropieri (2003) researched the effects of the mnemonic keyword strategy on the learning of story vocabulary in third grade inclusion reading classes. Three third grade classes participated in the study: The teacher of the first class taught vocabulary words using the mnemonic keyword strategy, the teacher of the second class taught vocabulary words by presenting the definition and a representational (non-mnemonic) picture, and the teacher of the third class simply presented the definitions (Uberti et al., 2003). Study results show that the students with learning disabilities scored an average of 10/10 words correct when taught with the mnemonic keyword strategy, 3/10 words correct when taught with the non-mnemonic picture, and 5.8/10 words correct when taught with only the definition (Uberti et al., 2003). Because the students with learning disabilities answered significantly more words correct when instructed with the mnemonic keyword strategy, the results of the study suggest that the mnemonic keyword strategy may be highly successful for teaching English vocabulary to elementary school students with learning disabilities.

Furthermore, Mastropieri, Sweda, and Scruggs (2000) studied the effect of the mnemonic keyword strategy on the learning of social studies vocabulary for 4th grade students in an inclusion class. Five of the study participants had learning disabilities

(Mastropieri et al., 2000). Sweda taught the class about American colonization, teaching some, but not all, content using the mnemonic keyword strategy. Assessment results showed that the students with learning disabilities scored 36.7% on the non-mnemonic content and 75% on the mnemonically-instructed content (Mastropieri et al., 2000). Hence, the study suggests that students with learning disabilities are able to better grasp content that is taught using the mnemonic keyword strategy, compared to content that is taught non-mnemonically.

Significance of the Study

Although there is a wide array of research regarding the use of the mnemonic keyword strategy for teaching students with learning disabilities, the majority of the research is dated. Much of the existing research is from the 1980s and 1990s (Mastropieri, Scruggs, Whittaker, & Bakken, 1994; Mastropieri, Emerick, & Scruggs, 1988; Mastropieri, Scruggs, & Levin, 1986; Mastropieri, Scruggs, & Levin, 1987; Scruggs et al., 1985; Mastropieri, et al., 1985; Mastropieri et al., 2000; Mastropieri, Scruggs, & Whedon, 1997). There is a need for more current research regarding the impact of the mnemonic keyword strategy on students with learning disabilities. Furthermore, much of the existing research demonstrates the use of the mnemonic keyword strategy for science, social studies, and English content. Study topics include teaching US presidents, state capitals, colonization of America, minerals, dinosaurs, biology, SAT vocabulary, and English vocabulary (Mastropieri et al., 1997; Mastropieri et al., 1994; Mastropieri et al., 2000; Scruggs et al., 1985; Mastropieri et al., 1987; Terrill et al., 2004; Mastropieri et al., 1985). Little research is available about the impact of the mnemonic keyword strategy on math vocabulary for students with learning disabilities.

This study is significant as it will investigate the impact of the mnemonic keyword method on the learning of mathematics vocabulary, for students with learning disabilities. This study is also significant because it will contribute current research to a database of aging research that is mostly from the 1980s and 1990s.

Purpose of the Study

The purpose of this study is to evaluate the impact of the mnemonic keyword strategy on the mathematics vocabulary development of students with learning disabilities. This study investigates: (a) the impact of the mnemonic keyword strategy on the acquisition of mathematical vocabulary of students with learning disabilities, (b) the impact of the mnemonic keyword strategy on the retention of mathematical vocabulary of students with learning disabilities, and (c) the level of satisfaction that students with learning disabilities have with the mnemonic keyword method.

Research Questions

1. Will the use of the mnemonic keyword strategy increase the acquisition of mathematical vocabulary of students with learning disabilities?
2. Will the use of the mnemonic keyword strategy increase the retention of mathematical vocabulary of students with learning disabilities?
3. Are students with learning disabilities satisfied with the mnemonic keyword strategy?

Chapter 2

Review of Literature

Introduction

Throughout their school careers, students are expected to learn new facts and vocabulary across many subject areas, including English, social studies, science, world language, and mathematics. Learning a multitude of new content and vocabulary can be challenging for any student, yet it tends to be particularly challenging for students with learning disabilities (Terrill et al., 2004). Students with learning disabilities often have deficiencies in reading, memory, processing, and language, which affect their abilities to acquire and retain new content and vocabulary (LDA, 2016; Mastropieri & Scruggs, 1998).

Studies suggest that mnemonic instruction aids students with and without disabilities in acquiring and retaining new knowledge and vocabulary (Fontana et al., 2007). A variety of studies have been conducted demonstrating use of mnemonic strategies (Bryant et al., 2003; Mastropieri et al., 1994; Mastropieri et al., 1988; Mastropieri et al., 1986; Mastropieri et al., 1987; Scruggs et al., 1985; Mastropieri, et al., 1985; Mastropieri et al., 2000; Mastropieri et al., 1997). However, there appears to be a need for current studies investigating mnemonic strategies.

Mnemonic Instruction

A mnemonic is “any procedure or operation designed to improve one’s memory” (Scruggs et al., 2010, p. 79). Mnemonic, or memory-enhancing, strategies connect new content to the learner’s pre-existing knowledge, to facilitate retrieval (Scruggs, et al., 2010). In other words, they offer “better ways to take in (encode) information so that it

will be much easier to remember (retrieve)" (Mastropieri & Scruggs, 1998, p. 202). Memory-enhancing strategies are useful for learners with and without disabilities, and have been used to teach facts, ordered information, and vocabulary in English/language arts, social studies, science, world language, and mathematics contexts (Uberti et al., 2003; Mastropieri et al., 1994; Mastropieri et al., 1986; Fritz, Morris, Acton, Voelkel, & Etkind, 2006; Brown, 2007).

Three types of mnemonic strategies are the keyword method, the pegword method, and letter strategies (Scruggs, et al., 2010). The keyword method utilizes acoustically-similar clue words and images to facilitate the recall of new information, such as vocabulary terms, people, and places (Scruggs et al., 2010). When using mnemonic keyword instruction, a teacher may introduce a new term and share an acoustically-similar, easily-pictured clue word (Scruggs, et al., 2010). For example, a teacher teaching the new term *bunnia*, which is a Hindi word for merchant or trader, would use the acoustically-similar, concrete clue word *bunny* (Scruggs et al., 2010). Next, learners would be shown (or asked to imagine) an illustration of the clue word demonstrating the definition (Scruggs et al., 2010). In this case, the leaners would examine an illustration of a merchant/trader selling or trading *bunnies* (Scruggs et al., 2010). Finally, students would be asked to define *bunnia*; they would be able to imagine the illustration of the merchant selling bunnies and recall that *bunnia* means merchant or trader (Scruggs et al., 2010).

Next, the pegword strategy is a mnemonic strategy used to facilitate the recall of numbered or ordered information (Scruggs et al., 2010). The pegword strategy is a "rhyming proxy for a number (e.g., *one* is *bun*, *two* is *shoe*, *three* is *tree*)" (Scruggs et al.,

2010, p. 80). The pegword strategy can be combined with the mnemonic keyword strategy (Scruggs et al., 2010). For example, in science class, students were taught that the mineral *wolframite* is a *4* on the hardness scale. Students were taught that the keyword for *wolframite* is *wolf*, and the pegword for *4* is *floor* (Scruggs et al., 1985). Students utilized an illustration of a *wolf* standing on a *floor*, to recall that wolframite is a 4 on the hardness scale (Scruggs et al., 1985).

Finally, letter strategies are used to remember a group of words. Letter strategies are the most commonly known type of mnemonic device (Scruggs et al., 2010). An acronym is a type of letter strategy that combines the first letter of each new piece of information (Scruggs et al., 2010). For example, the acronym HOMES may be used to remember the five Great Lakes (Huron, Ontario, Michigan, Erie, and Superior) (Scruggs et al., 2010). Additionally, an acrostic is another type of letter strategy, in which the first letters of the new information are combined in a sentence (Scruggs et al., 2010). For example, the acrostic "My very educated mother just served us nine pizzas" can be used to remember the nine planets in order from the sun (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto) (Scruggs et al., 2010, p. 80).

Using Mnemonic Strategies to Teach Information

Research suggests that mnemonic keyword strategies are effective for teaching information to students with and without disabilities, across multiple subject areas. Firstly, Mastropieri, Scruggs, Whittaker, and Bakken (1994) report that the mnemonic keyword strategy was effective for teaching states and state capitals to students with intellectual disabilities. In a study utilizing a pretest-posttest design, eight students diagnosed with mild intellectual disabilities, aged 13-14 years, were taught keywords and

illustrations for both states' names and capitals. For example, students were taught that the keyword for *Florida* is *flower* and the keyword for *Tallahassee* is *television.* Then they were shown an illustration of a television with a flower on it. When asked to provide the capital of Florida, students used the keyword and illustration to aide in the retrieval of the capital: Tallahassee (Mastropieri et al., 1994). Pretest data indicated that the "students answered virtually nothing correct" (Mastropieri et al., 1994, p. 37). Following instruction, posttest results indicated that, on average, the class recalled 94% of the states and capitals correctly. This reveals that the mnemonic keyword strategy can be used to teach facts to students with intellectual disabilities (Mastropieri et al., 1994).

Additionally, Sweda used the mnemonic keyword strategy to teach facts and vocabulary about American history to her inclusion social studies class (Mastropieri, et al., 2000). Participants in the study included 26 fourth grade students, including 5 with learning disabilities, in a Title 1 school inclusion classroom. Sweda taught a social studies unit about American colonization, using mnemonic methods for some, but not all, of the content. For example, she taught that settlers came from Europe to the New World by teaching the keywords *your rope* for *Europe*, with an illustration of people traveling across the ocean on a ship, pulling up a rope. The assessment at the end of the unit indicated that the students who were typically high achievers had success with both the mnemonic and non-mnemonic content, while the students with learning disabilities who were not typically high achievers performed significantly higher on the mnemonic content; the students with learning disabilities scored an average of 36.7% correct on the non-mnemonic content and 75% correct on the mnemonically-instructed content

(Mastropieri et al., 2000). This study suggests that the mnemonic keyword strategy can be effective for teaching factual information to students with learning disabilities.

In another study, Scruggs, Mastropieri, Levin, and Gaffney (1985) used the mnemonic keyword method to teach science content to students with learning disabilities. In the study, 56 seventh, eighth and ninth grade students with learning disabilities were taught minerals' hardness levels, colors, and common uses. In the study, students were randomly assigned to one of four experimental conditions: mnemonic instruction, direct instruction, reduced-list direct instruction, and free-study. In the mnemonic instruction group, students were taught eight minerals using interactive illustrations featuring the mineral name and its keyword, the hardness level and its pegword, its color, and the usage of the mineral. For example, the mineral *wolframite* is a 4 on the hardness scale, is black, and is used for making lightbulbs. The keyword assigned to wolframite was *wolf.* In the illustration, the *wolf* is standing on a *floor* (*floor* is the pegword for *4*), and the floor is lit up by *lightbulbs*. The wolf was colored *black* (Scruggs et al., 1985).

In the direct instruction group, students were taught the same attributes of eight minerals. They were instructed using a drill-and-practice technique. They were shown realistic pictures of the minerals with printed information about the hardness level, color, and usage. The reduced-list direct instruction group was instructed in the same manner, but taught four minerals, instead of eight. Finally, in the free-study condition, students were given a study guide, and were told to study the facts independently, in any way that would help them learn best (Scruggs et al., 1985). Assessment results indicated that students who had exposure to the mnemonic strategy had significantly higher recall of all three mineral attributes: hardness level, color, and use. In addition, the overall recall of

the students who received mnemonic instruction compared to the students in the reduced-list direct instruction condition was descriptively (though not statistically) higher. Thus, Scruggs et al. (1985) argue that the mnemonic keyword strategy has strong potential to teach complex factual information to students with disabilities.

Furthermore, Mastropieri, Scruggs, and Whedon (1997) used the mnemonic keyword and pegword strategies to teach students the chronological order of the presidents. Like Scruggs, Mastropieri, Levin, and Gaffney (1985), Mastropieri et al. (1997) used the same pegword mnemonics for numbers one through ten. However, this time, Mastropieri et al. (1997) developed pegwords for numbers 11- 49. Numbers 1- 19 had their own pegwords (*one* is *bun*… *twelve* is *elf* …) (Mastropieri et al., 1997). After 19, they developed pegwords for decades (*twenty* is *twin-ty*, *thirty* is *thirsty*, *forty* is *party*), followed by the pegword for the one's digit (Mastropieri et al., 1997).

A group of eleven junior high school students with learning disabilities were taught the keyword-pegword strategy to learn the chronological order of the presidents. For example, to learn that Franklin Pierce was the 14th president, students were taught that the keyword for *Pierce* is *purse* and the pegword for *14* is *forking*. Then they were shown an illustration of a hand sticking a *fork* into a *purse* (Mastropieri et al., 1997). In a within-subjects design, students were provided three weeks of mnemonic instruction and three weeks of traditional instruction. Posttest results indicate that students recalled significantly more of the presidents' names and numbers from the mnemonic instruction (Mastropieri et al., 1997). This study suggests that mnemonic keyword strategies can be used to teach ordered information to students with learning disabilities.

Furthermore, Zisimopoulos (2010) used the mnemonic keyword method to teach multiplication facts to students with intellectual disabilities. Two students with moderate intellectual disabilities participated in the study: one was an 11-year-old fourth grader and the other was a 12-year-old fifth grader. Utilizing a multiple baseline design across students and a pictorial prompt fading strategy, they were taught 28 single-digit multiplication facts between 2 and 9. First, students were taught multiplication facts by instructional flashcards with the multiplication facts, answers, mnemonic pictures, and pegword phrases. For example, for the multiplication fact 6 x 7 = 42, students were taught that the pegword for *six* was *sticks*, the pegword for *seven* was *heaven*, and the pegword for *forty-two* was *warty shoe*. Then they were shown an illustration of *sticks in heaven with a warty shoe* (Zisimopoulos, 2010). During the second phase of the pictorial prompt fading, students were shown instructional flashcards with the multiplication facts and pictures (no answers and no word phrases). Third, they were shown instructional flashcards with the multiplication facts and faded picture prompts (no answers and no word phrases). Finally, in the fourth type of instructional flashcards, students were only shown the multiplication facts (no answers, no word phrases, and no picture prompts). Students received this instruction during 20 sessions, which were 10-15 minutes long (Zisimopoulos, 2010).

Both students demonstrated improvement in their multiplication facts after the mnemonic keyword instruction. The first student scored 0% correct on his three baseline assessments, and scored 96.4% correct after the intervention. The second student scored between 0% and 7% correct during his six baseline assessments, and scored 92.8% correct after the intervention (Zisimopoulos, 2010). Thus, the results of Zisimopoulos's

study suggest that the mnemonic keyword strategy can be used to teach numerical content to students with disabilities. The mnemonic keyword strategy can be used to teach various types of information to students with and without disabilities, and can even be used to teach multiple pieces of information at once (Mastropieri et al., 1998; Scruggs et al., 1985).

Using the Mnemonic Keyword Method to Teach Vocabulary

Teaching vocabulary is a popular usage of the mnemonic keyword strategy. Teachers have successfully used the mnemonic keyword strategy to teach science, English, world language, social studies, and math vocabulary (Mastropieri et al., 1988; Terrill et al., 2004; Fritz et al., 2007; Mastropieri, et al., 2000; Brown, 2007). In the area of science, Mastropieri, Emerick, and Scruggs (1988) conducted a study in which students with emotional disabilities were taught vocabulary about the food chain and invertebrates, using the mnemonic keyword method. Eight students in a self-contained class, aged 7-11 years, participated in the study. All students received mnemonic instruction for one chapter of study and traditional instruction for a second chapter of study. Assessment results showed that the students scored an average of 94.5% correct when instructed with the mnemonic keyword strategy, while they scored an average of 58.8% correct when instructed with the traditional strategy (Mastropieri et al., 1988). Thus, it can be suggested that the mnemonic keyword strategy is effective for teaching science vocabulary.

In another study, English SAT vocabulary was taught to 10th grade students with learning disabilities, using the mnemonic keyword strategy (Terrill et al., 2004). Eight students aged 15- 16 years, in a self-contained class, participated in the study. The study

followed an ABABAB sequence, alternating mnemonic and non-mnemonic instruction on a weekly basis. The SAT vocabulary words assessment results indicated that the students recalled more vocabulary when instructed by the mnemonic keyword method. Students answered an average of 91.7% of words correctly when vocabulary words were taught using the mnemonic keyword strategy and 48.8% of words correctly when vocabulary words were taught using a non-mnemonic strategy. (Terrill et al., 2004). This study reveals that the mnemonic keyword strategy may be effective for teaching abstract, high-level vocabulary, such as SAT vocabulary words.

Next, Fritz, Morris, Acton, Voelkel, and Etkind (2007) conducted studies to assess the effectiveness of the mnemonic keyword method and the retrieval practice method for teaching foreign language vocabulary. The retrieval practice method is a technique of "retrieving target information once, or preferably several times, prior to some criterion test" (Fritz et al., 2007, p. 501). In one study, researchers provided foreign language vocabulary instruction to 45 adults without disabilities, ranging in age from 19-35 years. The vocabulary words were of the Russian, Polish, Turkish, Hebrew, Japanese, Welsh, and Italian languages. Participants were assigned one of three learning conditions: mnemonic keyword method, retrieval practice method, or rote rehearsal method. Assessment results of participants who received the mnemonic keyword and retrieval practice method were quite similar (mnemonic keyword average 10.5/12 words correct; retrieval practice average 10.8/12 words correct), and significantly higher than the assessment results of the participants who received rote rehearsal instruction (7.0/12 words correct) (Fritz et al., 2007).

In another study, Fritz et al. (2007) assessed the effectiveness of the mnemonic keyword method, retrieval practice method, and independent study. Study participants were 30 college students without disabilities who were taught German vocabulary. The participants were randomly assigned to one of the instructional conditions: mnemonic keyword method, retrieval practice method, or independent study. Similar to the prior study, results indicated that the mnemonic keyword method and the retrieval practice method were almost equally effective (mnemonic keyword average 15.1/20 words correct; retrieval practice 14.9/20 words correct) and the independent study method was less effective (average 11.0/20 words correct) (Fritz et al., 2007). Fritz et al.'s studies may indicate that the mnemonic keyword method is effective for teaching foreign language vocabulary.

Using the Mnemonic Keyword Method to Teach Mathematics Vocabulary

Proficiency with mathematics vocabulary is critical for students because it is a prerequisite for critical thinking, explanations, and understanding of high-level concepts in mathematics (Brown, 2007). The National Council of Teachers of Mathematics (NCTM) suggests in its Teaching and Learning Principles that increasing the use of language in mathematics instruction improves students' abilities to understand new concepts, problem solve, reason, communicate, and make connections in mathematics (Bay-Williams & Livers, 2009). Mathematical vocabulary can be challenging for students to acquire because many mathematical vocabulary words have alternate meanings in colloquial language (Adams, 2003). For example, in everyday language, the term *base* may refer to a base on a baseball field or the bottom of an object such as a mountain. However, in the mathematical context, *base* may refer to "the perceived horizontal side

on which a plane figure rests or a number equal to the number of units in a given number system required to move one group of values to the next highest place, such as the base 10 number system" (Adams, 2003, p. 789).

Limited research is available regarding the use of the keyword mnemonic strategy for instruction of math vocabulary. Brown (2007) conducted a study to assess the effectiveness of the mnemonic keyword method for teaching math vocabulary. Sixty 8th grade students, 24 with disabilities and 36 without disabilities, who scored at the "basic level" on the Maryland State Assessment participated in the study. The population of the study with disabilities was comprised of students with emotional disabilities, specific learning disabilities, autism, and other health impairments (Brown, 2007). Students were randomly assigned to one of three instructional groups: common method, common method combined with keyword method, or common method combined with keyword/illustration method. The common method involved simply teaching definitions. Assessment results indicated that participants in all three conditions increased their scores as a result of the instruction, yet there was no statistically significant advantage of any one method (Brown, 2007). Despite the disappointing results of Brown's study with respect to the potential advantages of the keyword method, more research was reported as needed to assess the possible advantage of the mnemonic keyword method of instruction for mathematics vocabulary.

Retention of Content Taught by Mnemonic Keyword Method

Research suggests that in addition to teaching new content and vocabulary, instruction by the mnemonic keyword method may impact students' retention of newly taught material (Scruggs & Mastropieri, 1992; Condus, Marshall, & Miller, 1986).

Condus, Marshall, and Miller (1986) conducted a study about the impact of mnemonic keyword instruction on the acquisition and maintenance of English vocabulary of students with learning disabilities. Sixty-four 12-year-old students with learning disabilities participated in the study. Prior to the intervention, students were identified as having high or low receptive vocabularies. Then, students were randomly assigned to one of four groups: keyword-image, picture context, sentence-experience context, or control. In the keyword-image group, students were taught through mnemonic keyword illustrations. In the picture context, students were shown definitions and non-mnemonic pictures that described the words. In the sentence-experience context, students read paragraphs that contained the new vocabulary words, and then were prompted to relate the words to their own experiences. Finally, in the control group, students were told to choose their own method of self-studying. All students studied ten words per week, over five weeks, for a total of 50 words (Condus et al., 1986).

Study results indicated that students assigned to the mnemonic condition outperformed students assigned to all other conditions on immediate assessments, two-week maintenance assessments, and eight-week follow-up assessments. Results of the eight-week follow-up assessment indicate that students exposed to the mnemonic condition made the most gains, on average, from pretest to follow-up test scores. On average, the keyword-image group increased by 28 words correct, the picture-context group increased by 19 words correct, the sentence-experience group increased by 15.5 words correct, and the control group increased by 9 words correct. This data suggests that vocabulary instruction using the mnemonic keyword method may positively impact retention of vocabulary for students with learning disabilities.

Furthermore, Condus, Marshall, and Miller (1986) categorized the data by participants' receptive vocabulary abilities. Results indicate that the students with high and low receptive vocabularies who were taught through mnemonic instruction outperformed students with high and low vocabularies in all other experimental groups. Under the mnemonic condition, the average gain from pretest to follow-up test was an average of 30.3 words for the high ability group and 25.5 words for the low ability group. Data from the remaining experimental conditions follows: Pictorial condition high ability 19.8; pictorial condition low ability 18.1; sentence-experience condition high ability 18.5; sentence-experience low ability 12.5; control condition high ability 11.3; control condition low ability 7.0 (Condus et al., 1986). Thus, even the students taught mnemonically who were considered to have low receptive vocabularies outperformed the students of high ability who were taught by all other methods. The research findings of Condus, Marshall, and Miller (1986) may indicate that the retention of vocabulary of students with learning disabilities is improved when they are instructed though the mnemonic keyword method.

In another study, Scruggs and Mastropieri (1992) investigated the impact of the mnemonic keyword strategy on the acquisition and retention of science vocabulary of students with disabilities. The study participants were 20 students in two sixth/seventh/eighth grade self-contained science classes. Nineteen of the students were classified as having learning disabilities and one student was classified as having a mild intellectual disability. The study utilized a within-subjects crossover design, as all students received instruction in three methods: traditional instruction, mnemonic instruction, and mnemonic transfer. In the traditional instruction, teachers simply taught

the target information to students. In the mnemonic instruction, teachers taught through the use of mnemonic keyword illustrations. For example, to teach the term *radial symmetry*, students were taught the acoustically-similar phrase *radio cemetery* and the definition *body parts extend out from center* (Scruggs & Mastropieri, 1992). They were shown a mnemonic illustration of radios, skeletons, and tombstones in the formation of a star, symbolizing body parts extending from the center (Scruggs & Mastropieri, 1992). Finally, in the mnemonic transfer phase, the class worked together to generate mnemonic keywords and illustrations for the target vocabulary (Scruggs & Mastropieri, 1992).

Posttest data showed that students answered more questions correctly about the information that they learned mnemonically, compared to the information that they learned traditionally. In classroom 1, students scored an average of 44.3% on the content taught traditionally and an average of 77.8% on the content taught mnemonically. In classroom 2, students scored an average of 33.3% correct on the content taught traditionally and an average of 67.9% correct on the content taught mnemonically. On the delayed-recall test, given two weeks after instruction, students scored an average of 59.3% on the content taught mnemonically and an average of 38.0% on the content taught traditionally (Scruggs & Mastropieri, 1992). Thus, Scruggs and Mastropieri's data may suggest that the use of the mnemonic keyword strategy improves the retention of new information for students with disabilities.

Student Satisfaction with Mnemonic Keyword Method

While data demonstrates the effectiveness of mnemonic keyword instruction on the acquisition and retention of vocabulary of students with learning disabilities, additional data suggests that students enjoy mnemonic keyword instruction (Scruggs &

Mastropieri, 1992; Mastropieri et al., 2000). For example, Scruggs and Mastropieri (1992) collected data about student satisfaction with the mnemonic keyword method in their study of acquisition and retention of science vocabulary mentioned above. The participants of the study were 20 students with disabilities in middle school self-contained science classes. Following the mnemonic keyword treatment, participants completed a survey about their satisfaction with the three instructional methods used: traditional instruction, mnemonic instruction, and mnemonic transfer. Survey data indicated that 68.4% of the participants enjoyed mnemonic instruction most. Furthermore, 73.7% of the participants stated that they learned most when they were taught with the mnemonic keyword method, and 63.2% of the participants stated that they would like to use the mnemonic method again (Scruggs & Mastropieri, 1992). This survey data suggests that the majority of the students who tried mnemonic instruction were satisfied with it.

In another study, Mastropieri, Sweda, and Scruggs (2000) collected data about student satisfaction, after providing mnemonic keyword instruction. As mentioned above, in this study, Sweda used mnemonic instruction to teach social studies content in her inclusion class. On the survey, students were asked to rank their satisfaction with the mnemonic keyword method on a scale of 1 to 10, with 10 being the highest. Out of the 22 surveys, 19 students answered "10," two students answered "9," and one student answered "8" (Mastropieri et al., 2000). One student demonstrated his enthusiasm about the mnemonic keyword strategy, writing, "Yes I like using mnemonics in class It is this so good and… so fun to do I lik mnemonics so much [*sic*]" (Mastropieri et al., 1992, p. 71). Because all students answered "8" or higher, with most students answering "10," the

data suggests that the fourth grade students were very satisfied with mnemonic keyword instruction.

Conclusion

Due to weaknesses in reading, memory, processing, and language, many students with learning disabilities have difficulty grasping new vocabulary (LDA, 2016; Mastropieri & Scruggs, 1998). Students' banks of mathematical vocabulary serve as critical background knowledge that they use when formulating explanations and problem solving (Brown, 2007). A breadth of research suggests that the mnemonic keyword strategy positively impacts the acquisition and retention of vocabulary for students with learning disabilities (Scruggs & Mastropieri, 1992; Condus et al., 1986; Mastropieri et al., 2000; Terrill et al., 2004; Uberti et al., 2003). Also, research indicates that students with disabilities are satisfied with mnemonic instruction (Scruggs & Mastropieri, 1992; Mastropieri et al., 2000).

The purpose of this study is to investigate the impact of mnemonic keyword instruction on the learning of mathematics vocabulary of sixth grade students with learning disabilities. Students will receive mnemonic keyword instruction of mathematical vocabulary words over multiple units of study. This study will evaluate: (a) the impact of the mnemonic keyword strategy on the acquisition of mathematical vocabulary of students with learning disabilities, (b) the impact of the mnemonic keyword strategy on the retention of mathematical vocabulary of students with learning disabilities, and (c) the level of satisfaction that students with learning disabilities have with the mnemonic keyword method.

Chapter 3

Method

Setting

School. This study was conducted in an upper-middle class suburban community in northern New Jersey. The school is a public middle school in which all students are in sixth grade. During the 2016-2017 school year, 470 students were enrolled in the school, 69 of whom received special education services. According to the New Jersey performance report in 2015, the school population was 69.4% white, 22.1% Asian, 3.2% black, 2.8% Hispanic, and 2.6% two or more races (NJ School Performance Report, 2015). All participants of the study were enrolled in special education programming, and they all received math instruction in the resource center setting.

Classroom. The study took place within two math resource center classes. The classroom is a small room with no windows located on the first floor of the building. Despite having no windows, the room is well-lit and has colorful decorations. The classroom includes ten student desks, which are arranged into two groups of three desks, and one group of four desks. There are two desktop computers in the back of the room and a table with two chairs for student group work. The teacher's desk is located in the front of the room along with a SMART Board and white board.

The school has nine 43 minute periods each day, and two minutes of passing time between classes. The study was conducted during period 2 math resource center and period 8 math resource center. Period 2 runs from 9:25-10:08, and period 8 runs from

1:55-2:38. Each math resource center class was instructed by the same teacher and no paraprofessionals.

Participants

Students. This study included seven participants, all of whom are classified as having specific learning disabilities, and are receiving math instruction in resource center settings according to their IEPs. Five participants were male and two participants were female. Three of the students were members of the math resource center period 8 class and four of the students were members of the math resource center period 2 class. Table 1 presents the general information of the participants.

Table 1

General Information of Participating Students

Student	Age	Grade	Gender	Classification	Mean Math Vocabulary Score Before Intervention (out of 5 pts)
A	12	6	M	SLD: Reading, Writing	3.33
B	11	6	M	SLD: Reading, Writing, Mathematics	3.67
C	11	6	F	SLD: Mathematics	4.33
D	11	6	F	SLD: Reading, Writing, Mathematics	3.50
E	12	6	M	SLD: Reading, Mathematics	3.83
F	12	6	M	SLD: Language Processing	4.17
G	12	6	M	SLD: Language Processing, Reading	4.17

Students A, B, and C were members of the period 8 math class. The class had six students. The three students with learning disabilities participated in the study. Student A is a twelve-year old, Caucasian male with specific learning disabilities in reading and writing. He is also diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). Student A is easily distracted during class, yet cares about his grades and is motivated to succeed.

Student B is an eleven-year-old, Caucasian male with specific learning disabilities in reading, writing, and mathematics. Student B is consistently attentive and motivated, and actively participates in class. Although retention is an issue for him, he utilizes his class notes and other resources, to help compensate.

Student C is an eleven-year-old, Caucasian female. She has a specific learning disability in mathematics, and a slow rate of processing. She is attentive during lessons and completes her work neatly. She benefits from wait time and utilizes extended time to complete assignments and assessments.

Students D, E, F, and G were members of the period 2 math class. The class had nine students. The four students with learning disabilities participated in the study. Student D is an eleven-year-old, Caucasian female. She has specific learning disabilities in reading, writing, and mathematics. She is respectful and attentive during lessons. She learns from watching the teacher model new math procedures, and she utilizes the strategies that the teacher models.

Student E is a twelve-year-old, Caucasian male. He has specific learning disabilities in reading and mathematics. He is mature, well-behaved, and attentive during lessons. He has made significant progress at solving word problems this year, while application of math vocabulary continues to be an area of need.

Student F is a twelve-year-old, Hispanic male. Although his native language is Portuguese, he is fluent in English. He has a specific learning disability in language processing, is well-behaved, and follows all directions. A factor that continues to impact his learning is attention to detail. When he makes mistakes in his math work, he often mixes up operations or makes basic fact errors.

Student G is a twelve-year-old, Caucasian male. He has specific learning disabilities in language processing and reading. He demonstrates effort and asks for help when needed. His ability to retain concepts and procedures impacts his learning.

Teacher. The math resource center classes were taught by a teacher certified in special education and middle school mathematics. This teacher has three years of experience teaching math resource center classes, based on the Common Core Standards.

Materials

Binders. All students already had math binders with divider tabs. Tab 1 was used for each student's behavior chart, Tab 2 was used for "Calendar Math," Tab 3 was used for class notes, and Tab 4 was used for homework worksheets. Tab 5 was unused, and the teacher instructed the students to make Tab 5 their vocabulary sections at the start of the study.

Handouts. When the teacher introduced a new word using the mnemonic keyword method, she showed a handout with the vocabulary term, definition, an acoustically-similar keyword, and an illustration. She projected the handout onto the SMART Board using a Ladibug document camera, and gave copies to each student, which were put in binder Tab 5.

For example, the teacher instructed the students that the term "quadrants" means "the four sections of the coordinate plane." The teacher told the students that "quadrants" sounds like "quack," so a way to remember the word "quadrants" is to think about this illustration of four ducks in the four sections of the coordinate plane (Figure 1). Copies of all vocabulary handouts can be found in Appendices A- C.

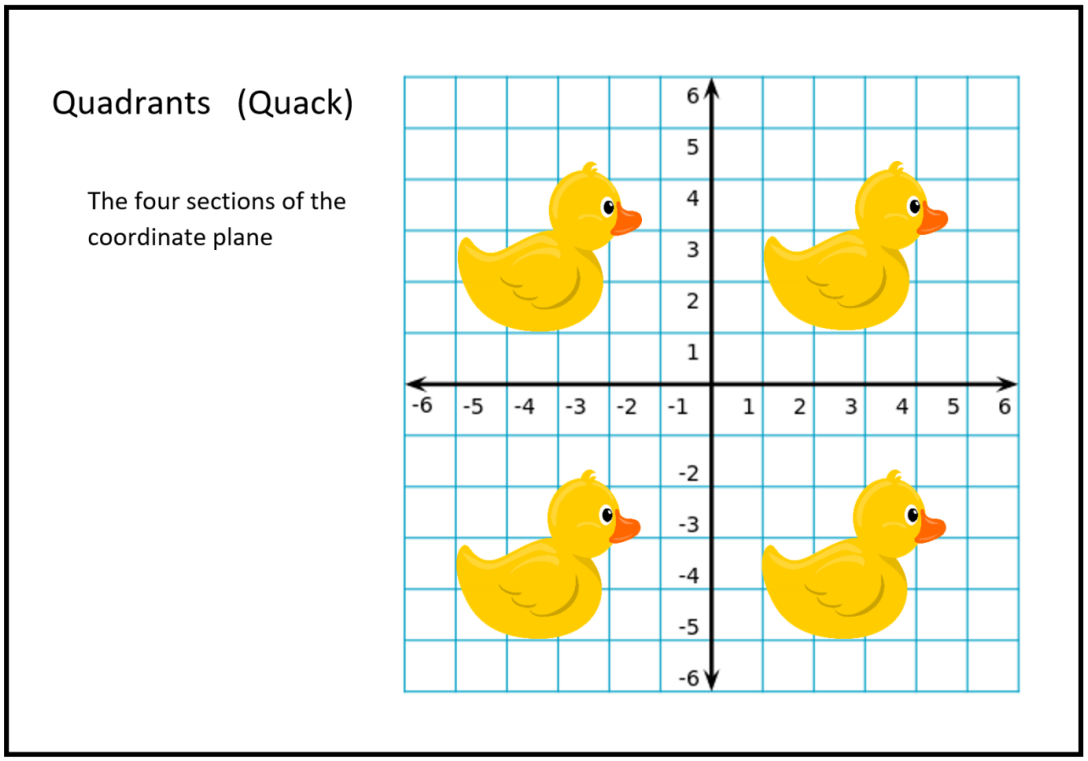


Figure 1. Mnemonic strategy illustration for the word *quadrants.*

When students were taught new vocabulary under the non-mnemonic condition, they were given the terms and definitions in their class notes. They were not given acoustically-similar words or mnemonic illustrations.

Measurement materials. Student acquisition of vocabulary was assessed using three methods: multiple choice, "create an example," and fill in the blank. Each of these assessments was administered as a small five-question warm-up or exit ticket.

The multiple choice assessments displayed the definition, and the students were asked to circle the correct term, given four choices. For the "create an example" assessment, students were to name an example or create a drawing of each term. For

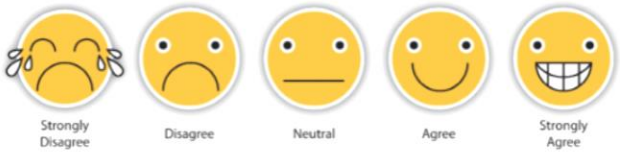
example, given the term “quadrants,” a student may draw a coordinate grid and make arrows pointing to the quadrants Given the term “integer,” a student may give the example “-6.” Lastly, the fill in the blank assessment contained statements with a blank and a definition, and students needed to fill in the blank, without a word bank. Copies of the vocabulary assessments can be found in Appendices D- G.

Student satisfaction survey. At the end of the study, students participated in a survey about their opinions of the mnemonic keyword method. The survey contained five questions, which students answered using a Likert scale. The Likert scale featured a continuum of happy faces to sad faces, as well as words from “strongly agree” to “strongly disagree.” Survey questions asked students to rate their perceptions about the extent to which they found the mnemonic keyword strategy effective and enjoyable. See Figure 2.

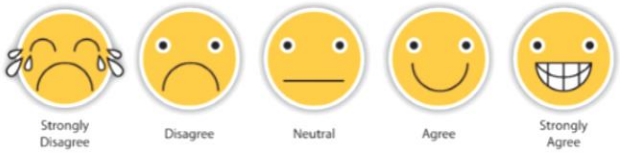
Survey: Mnemonic Keyword Strategy

Choose a response to each of the following statements.

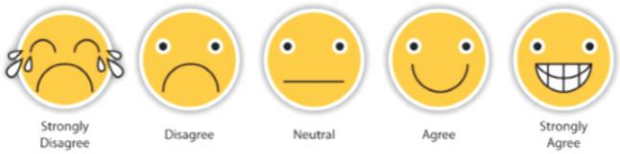
1. This strategy helped me to learn the meaning of new vocabulary words.



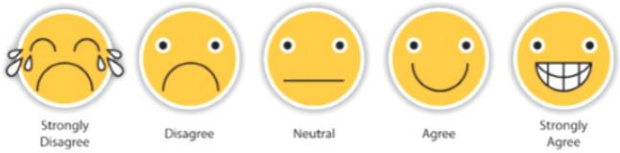
2. This strategy helped me to remember the meaning of new vocabulary words.



3. It was easy to remember the illustrations.



4. I enjoyed this strategy.



5. I want to use this strategy again, to learn new vocabulary.

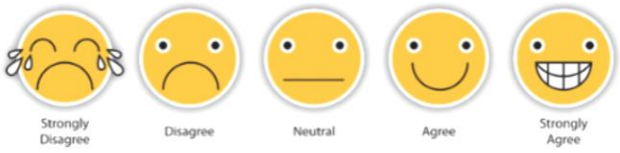


Figure 2. Student satisfaction survey.

Research Design

The design utilized for this study was multiple baseline across participants. It was hypothesized that the mnemonic keyword intervention would be beneficial for all participants. In this study, the independent variable was exposure to the mnemonic keyword instruction. The dependent variables were acquisition of vocabulary and retention of vocabulary.

Procedure Design

This multiple baseline investigation began with a collection of baseline data. During vocabulary unit 1, baseline data was collected while students received the traditional method of vocabulary instruction using three measures: multiple choice, "create an example," and fill in the blank warm-ups. Each assessment consisted of five questions about the same five vocabulary terms.

During vocabulary unit 2, the students in the Period 8 math resource center class began to receive the mnemonic keyword instructional intervention, while the Period 2 students continued to receive the traditional method of vocabulary instruction. At the end of one week, three measures of assessment (multiple choice, "create an example," and fill in the blank) were given to all participants.

Next, students in Period 2 joined the intervention group. During vocabulary units 3 and 4, all students received mnemonic keyword strategy instruction. At the end of the unit 3 and at the end of unit 4, the three measures of assessment were administered to all participants, to assess mastery of the vocabulary words taught that week. Each vocabulary unit lasted one week.

One week later, students were administered a culminating assessment, containing the vocabulary words taught during units 3 and 4 (See Appendix H). Also, participants were administered the student satisfaction survey.

Instructional design. The two methods of instruction utilized in this study were traditional method of vocabulary instruction, and the mnemonic keyword method. For every math lesson, the teacher provided a partially-completed set of typed class notes to her students. These class notes contained definitions, instructions for multi-step procedures, and math problems to be completed during the lesson.

When using the traditional method, the teacher defined new vocabulary words during lessons and in class notes, when vocabulary words were relevant to lessons. She then used the words throughout lessons and discussions during the units of study.

When using the mnemonic keyword method of instruction, the teacher introduced new vocabulary words using a definition, acoustically-similar word, and mnemonic illustration (Figure 1). Students were given photocopies to keep in the vocabulary sections of their binders. For example, when introducing the term "quadrants," during a lesson about the coordinate plane, the teacher instructed the class, "Quadrants are the four sections of the coordinate plane. Quadrant sounds like 'quack.' Look at this illustration. This is an illustration of the coordinate plane, and there are four ducks, one in each of the four quadrants. This illustration reminds you that quadrants are the four sections of the coordinate plane. When you are asked to define the word 'quadrants,' think about 'quack,' and then picture this illustration in your head, so that you can remember that the quadrants are the four sections of the coordinate plane."

Measurement Procedures

Vocabulary assessments. Students participated in three short assessments at the conclusion of each vocabulary unit: Multiple choice, "create an example," and fill in the blank. Although these assessments were untimed, students completed them in fewer than five minutes. Students were administered these three assessments during the last two days of each unit: The multiple choice and "create an example" assessments were taken on the second to last day, and the fill in the blank assessment was taken on the last day. Students were instructed to try their best, and take a guess if they were unsure. Also, they were advised not to stress because these assessments would not count toward their report card grades.

Student satisfaction survey. One week after unit 4, all participants in the study were asked to complete a survey to determine student-reported enjoyment and effectiveness of the mnemonic keyword strategy. The teacher explained how to use the Likert scale, and instructed students that writing their names on their surveys was optional.

Data Analysis

Student performance on vocabulary assessments was recorded in charts and graphs representing each phase. Charts were analyzed for visual patterns. Individual students' mean scores during the mnemonic keyword intervention were compared to their mean scores during baseline instruction. Means and standard deviations were displayed in table format. Student satisfaction survey feedback was also displayed in table format.

Chapter 4

Results

The study was conducted using a multiple baseline across participants design. First, baseline data was collected from all participants during vocabulary unit 1. During vocabulary unit 2, three participants in the Period 8 math class received the mnemonic keyword intervention, while four participants in the Period 2 math class remained in the baseline condition. During vocabulary units 3 and 4, all participants received the mnemonic keyword intervention.

Vocabulary Acquisition

Student acquisition of vocabulary was assessed using three short assessments: multiple choice, "create an example," and fill in the blank. Each assessment was administered as a small five-question warm-up or exit ticket. Students could score a maximum of five points on each assessment. Performance data was collected and means were calculated (See Table 2). Figures 3-9 represent the students' assessment scores in graphic format.

Table 2

Mean and Standard Deviation (SD) of Student Vocabulary Assessments

	Unit 1		Unit 2		Unit 3		Unit 4	
Student	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
	Baseline		*Intervention*					
A	3.33	1.53	4.67	0.58	4.00	1.73	4.67	0.58
B	3.67	1.53	4.33	1.15	5.00	0.00	5.00	0.00
C	4.33	1.15	5.00	0.00	4.00	1.00	5.00	0.00
D	2.00	0.00	5.00	0.00	3.67	1.53	4.00	1.73
E	3.00	1.73	4.67	0.58	4.67	0.58	4.00	1.00
F	3.67	1.15	4.67	0.58	1.00	1.73	4.67	0.58
G	3.33	0.58	5.00	0.00	3.33	1.53	5.00	0.00

The group mean at baseline was 3.33. In unit 2, the mean of the Period 8 participants who received the intervention was 4.67. The mean of the Period 2 participants who did not receive the intervention was 4.83. In unit 3, when all participants received the intervention, the mean was 3.67. In unit 4, the mean was 4.62.

Student A. Student A's baseline scores ranged from 2 – 5. Student A increased vocabulary acquisition per the multiple choice assessment from a baseline of 2 to a consistent score of 5 across three subsequent vocabulary units. Student A increased vocabulary acquisition per the fill in the blank assessment from a baseline of 3 to an intervention mean of 4.67. In contrast, Student A decreased vocabulary acquisition per the "create your own example" assessment from a baseline of 5 to an intervention mean

of 3.67. Student A demonstrated the highest levels of vocabulary acquisition during units 2 and 4, and the lowest level of vocabulary acquisition during unit 1. He received the mnemonic keyword intervention during units 2, 3, and 4, and the traditional method of instruction during unit 1. See Figure 3 below.

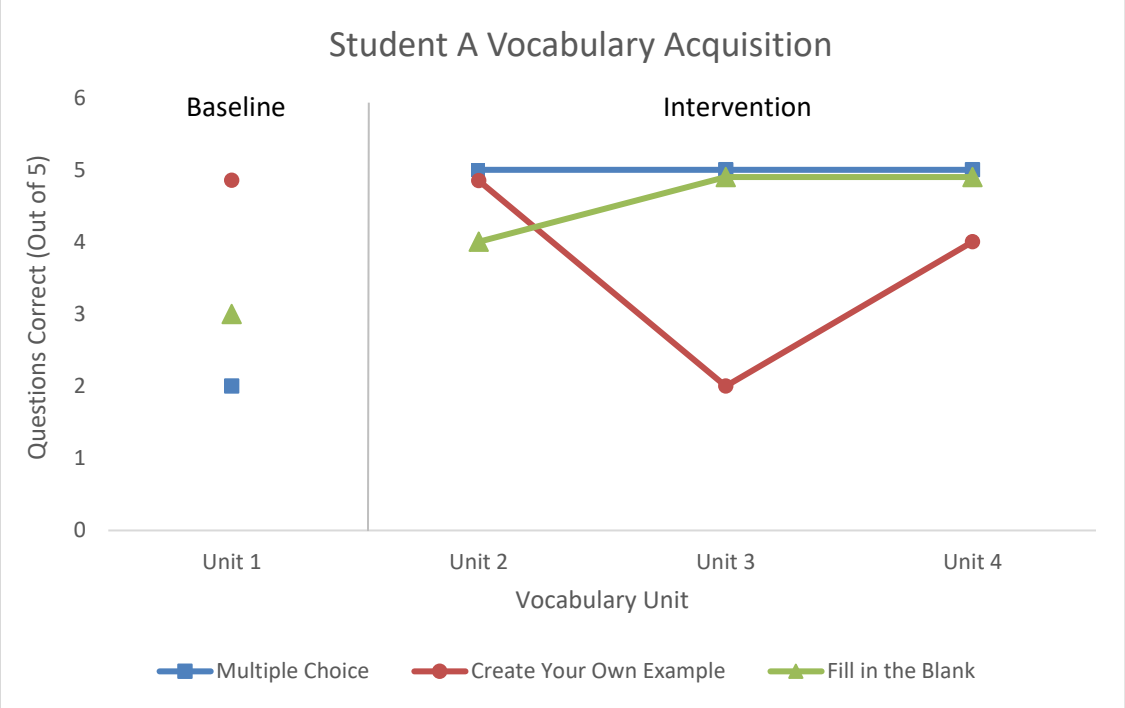


Figure 3. Student A Vocabulary Acquisition

Student B. Student B's baseline scores ranged from 2 – 5. Student B increased vocabulary acquisition per the multiple choice assessment from a baseline of 2 to a consistent score of 5 across the three subsequent vocabulary units of the intervention. Student B increased vocabulary acquisition per the fill in the blank assessment from a baseline of 4 to an intervention mean of 4.33. On the "create your own example"

assessments, Student B earned a baseline score of 5, and continued to earn scores of 5 throughout the three vocabulary units of the intervention. Student B demonstrated the highest levels of vocabulary acquisition during units 3 and 4, and the lowest level of vocabulary acquisition during unit 1. He received mnemonic keyword instruction during units 2, 3 and 4, and traditional instruction during unit 1. See Figure 4.

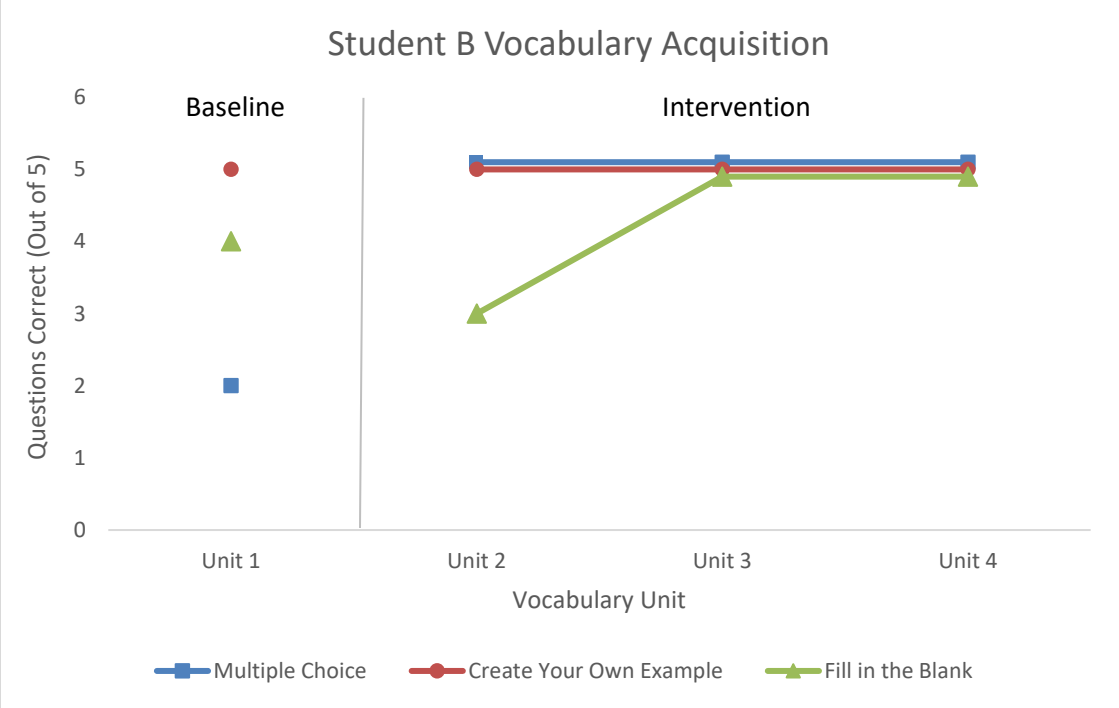


Figure 4. Student B Vocabulary Acquisition

Student C. Student C's baseline scores ranged from 3 – 5. Student C increased vocabulary acquisition per the multiple choice assessment from a baseline of 3 to an intervention mean of 4.67. Student C slightly decreased vocabulary acquisition per the fill in the blank assessment from a baseline of 5 to an intervention mean of 4.33. On the

"create your own example" assessments, Student C earned a baseline score of 5, and continued to earn scores of 5 throughout the three vocabulary units of the intervention. Student C demonstrated the highest levels of vocabulary acquisition in units 2 and 4, and the lowest level of vocabulary acquisition during unit 1. During units 2, 3, and 4 she received mnemonic keyword instruction, and during unit 1 she received traditional instruction. See Figure 5.

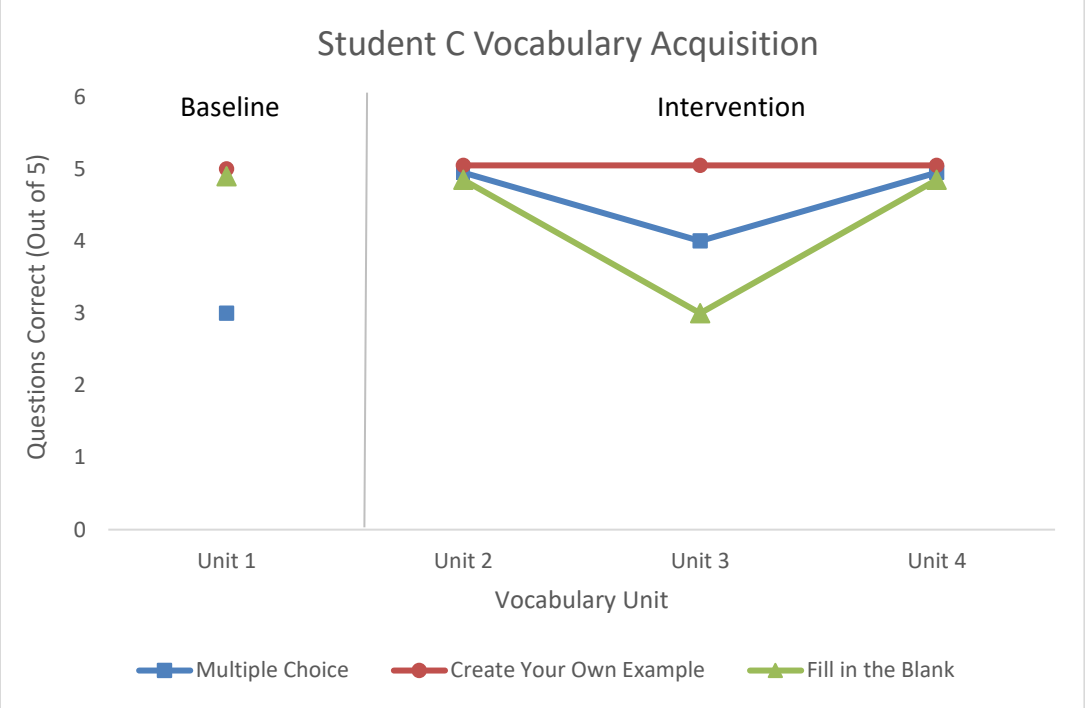


Figure 5. Student C Vocabulary Acquisition

Student D. Student D's baseline scores ranged from 2 – 5. Student D increased vocabulary acquisition per the multiple choice assessment from a baseline mean of 3.5 to a consistent score of 5 across the vocabulary units of the intervention. Student D's

vocabulary acquisition per the fill in the blank assessment remained constant from a baseline mean of 3.5 to an intervention mean of 3.5. In contrast, Student D slightly decreased vocabulary acquisition per the "create your own example" assessment from a baseline mean of 3.5 to an intervention mean of 3. Student D performed the lowest during unit 1, when she earned 2s on all assessments, and she performed highest during unit 2, when she earned 5s on all assessments. She received the traditional method of instruction during both units 1 and 2. See Figure 6.

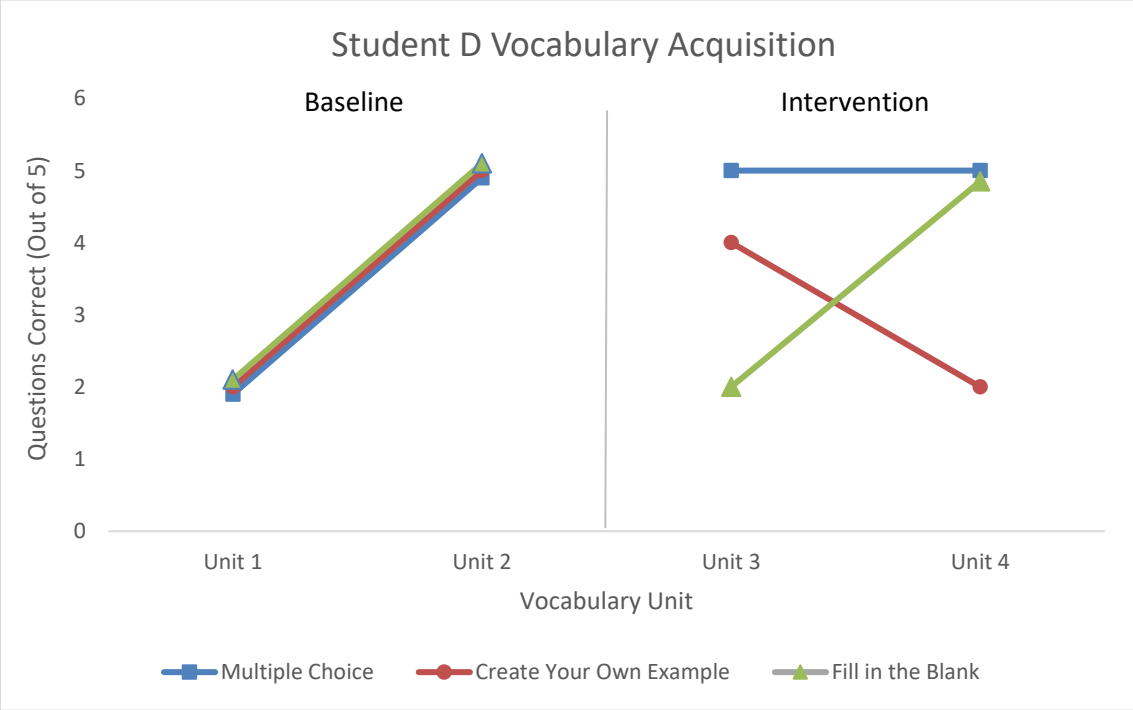


Figure 6. Student D Vocabulary Acquisition

Student E. Student E's baseline scores ranged from 2 – 5. Student E increased vocabulary acquisition per the multiple choice assessment from a baseline mean of 3.5 to

a consistent score of 5 across the two vocabulary units of the intervention. Student E slightly increased vocabulary acquisition per the fill in the blank assessment from a baseline mean of 3 to an intervention mean of 3.5. In contrast, Student E slightly decreased vocabulary acquisition per the "create your own example" assessment from a baseline mean of 5 to an intervention mean of 4.5. Student E demonstrated the highest levels of vocabulary acquisitions during units 2 and 3. During unit 2 he received traditional instruction and during unit 3 he received mnemonic keyword instruction. He demonstrated the lowest level of vocabulary acquisition during unit 1, when he received traditional instruction. See Figure 7.

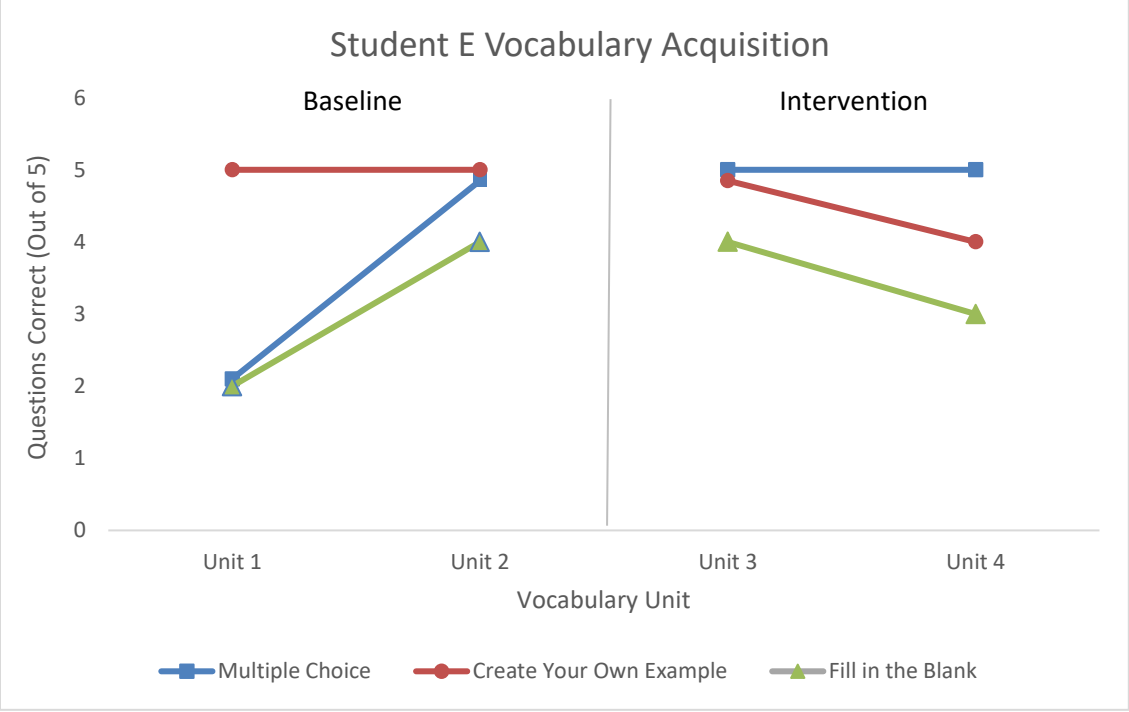


Figure 7. Student E Vocabulary Acquisition

Student F. Student F's baseline scores ranged from 3 – 5. Student F's vocabulary acquisition remained constant per the multiple choice assessment from a baseline mean of 4 to an intervention mean of 4. Student F decreased vocabulary acquisition per the fill in the blank assessment from a baseline mean of 3.5 to an intervention mean of 2. Student F also decreased vocabulary acquisition per the "create your own example" assessment from a baseline mean of 5 to an intervention mean of 2.5. He demonstrated the highest level of vocabulary acquisition during unit 2 and the lowest level of vocabulary acquisition during unit 3. He received traditional instruction during unit 2 and mnemonic keyword instruction during unit 3. See Figure 8.

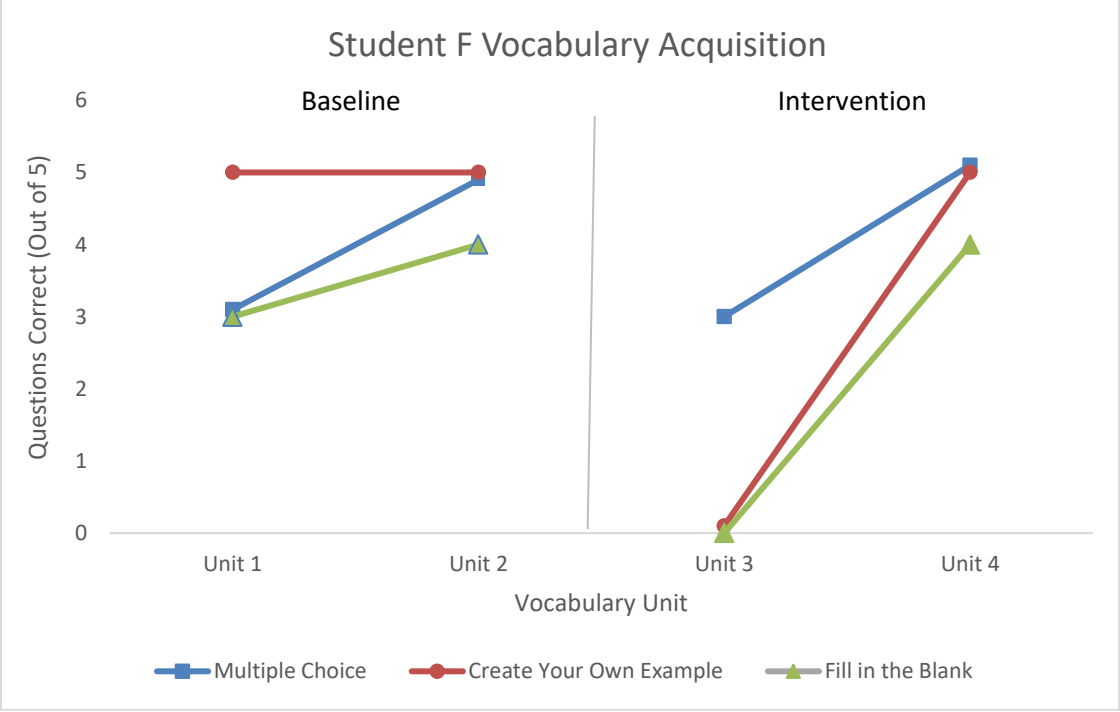


Figure 8. Student F Vocabulary Acquisition

Student G. Student G's baseline scores ranged from 3 – 5. Student G's vocabulary acquisition remained consistent per the multiple choice assessment from a baseline mean of 4 to an intervention mean of 4. Student G increased vocabulary acquisition per the fill in the blank assessment from a baseline mean of 4 to consistent scores of 5 during the two units of the intervention. In contrast, Student G decreased vocabulary acquisition per the "create your own example" assessment from a baseline mean of 4.5 to an intervention mean of 3.5. Student G demonstrated the highest levels of vocabulary acquisition during units 2 and 4, when he earned scores of 5 across all three assessments. He received traditional instruction during unit 2 and mnemonic keyword instruction during unit 4. He demonstrated the lowest level of vocabulary acquisition during unit 3, when he received mnemonic keyword instruction. See Figure 9.

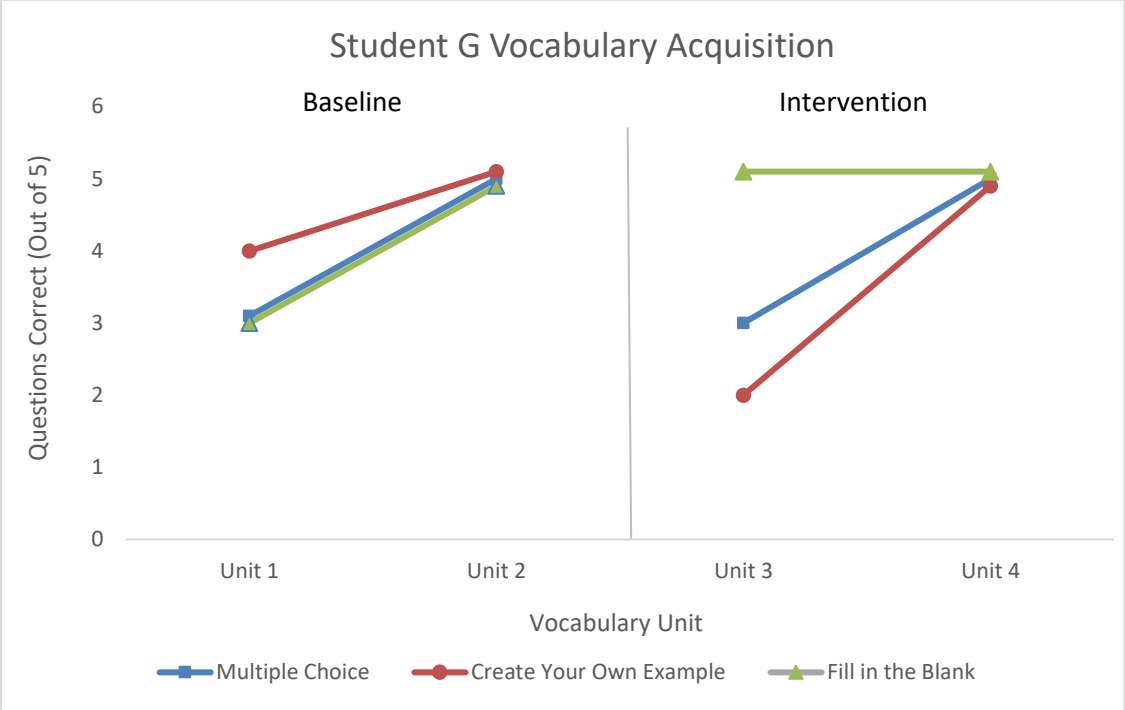


Figure 9. Student G Vocabulary Acquisition

Multiple choice assessments. A visual review of individual student multiple choice assessments suggests a trend in which students had higher scores on vocabulary units 2 and 4, and lower scores on vocabulary units 1 and 3. This trend is noted, regardless of whether or not students received the intervention during unit 2. Another trend reveals that students often performed the highest on their multiple choice assessments, compared to assessments taken in the other two formats.

"Create an example" assessments. A visual review of individual "create an example" assessments suggests a trend in which students had the overall highest scores on vocabulary unit 2. This trend is noted regardless of whether or not they received the intervention during unit 2.

Fill in the blank assessments. A visual review of individual fill in the blank assessments suggests a trend in which students had higher scores on vocabulary units 2 and 4, and lower scores on vocabulary units 1 and 3. This trend is noted, regardless of whether or not students received the intervention during unit 2.

Vocabulary Retention and Maintenance

Vocabulary retention was measured by a cumulative vocabulary assessment, given one week after vocabulary unit 4. The cumulative vocabulary assessment contained multiple choice, "create your own example," and fill in the blank questions. Students could earn a maximum of 10 points on each assessment section. Scores of students' cumulative vocabulary assessments are presented in Table 3. All students increased scores from baseline vocabulary acquisition assessments, and maintained intervention gains.

Table 3

Student Cumulative Vocabulary Assessments

Student	Multiple Choice	Create Your Own Example	Fill in the Blank	Total (Out of 30)
A	10	10	10	30
B	10	10	10	30
C	10	10	10	30
D	10	6	4	20
E	10	9	10	29
F	10	10	10	30
G	10	10	9	29

The group mean on the cumulative multiple choice section was 10.00. The group mean on the "create your own example" section was 9.29. The group mean on the fill in the blank section was 9.00. The mean total score was 28.29. The mean total score of the group that entered the intervention during unit 2 was 30. The mean total score of the group that entered the intervention during unit 3 was 27.25.

Student Satisfaction

Student satisfaction with the mnemonic keyword method was assessed using a survey (see Figure 2) after the students learned four units of vocabulary. Students were told that it was optional to write their names on their surveys. Percentages of student responses are presented in Table 4.

Table 4

Student Satisfaction Survey Results in Percentages

	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1. This strategy helped me to learn the meaning of new vocabulary words.	**0**	**14**	**14**	**57**	**14**
2. This strategy helped me to remember the meaning of new vocabulary words.	**0**	**0**	**43**	**43**	**14**
3. It was easy to remember the illustrations.	**0**	**14**	**43**	**14**	**29**
4. I enjoyed this strategy.	**0**	**14**	**14**	**14**	**57**
5. I want to use this strategy again, to learn new vocabulary.	**0**	**29**	**0**	**29**	**43**

According to the results of the student survey, 71% of the participants agreed or strongly agreed that the mnemonic keyword strategy helped them learn new vocabulary words. However, only 43% of the participants agreed or strongly agreed that it was easy to remember the illustrations. Seventy-one percent of the participants agreed or strongly agreed that they enjoyed the strategy, and 72% of the participants agreed or strongly agreed that they would like to use the mnemonic keyword strategy again. Also of note, none of the participants strongly disagreed with any of the statements on the survey.

Chapter 5

Discussion

The purpose of this study was to evaluate the impact of the mnemonic keyword strategy on the mathematics vocabulary development of students with learning disabilities. This study utilized a multiple baseline across participants design, and took place in a sixth grade resource center mathematics classroom. The following research questions were examined:

1. Will the use of the mnemonic keyword strategy increase the acquisition of mathematical vocabulary of students with learning disabilities?
2. Will the use of the mnemonic keyword strategy increase the retention of mathematical vocabulary of students with learning disabilities?
3. Are students with learning disabilities satisfied with the mnemonic keyword strategy?

Findings

In the area of acquisition of mathematical vocabulary, five out of seven students increased their vocabulary acquisition during the intervention. The results suggest that the mnemonic keyword method increases the mathematical vocabulary acquisition of students with learning disabilities. Students A, B, and C received the traditional method of instruction during unit 1 and the mnemonic keyword method of instruction during units 2, 3, and 4. All three students in this group demonstrated increases in vocabulary acquisition. This data suggests that Students A, B, and C more successfully acquired vocabulary when receiving the mnemonic keyword intervention.

Students D, E, F, and G received the traditional method of instruction during units 1 and 2, and the mnemonic keyword method of instruction during units 3 and 4. Based on mean baseline and intervention scores, Students D and E also demonstrated increases in vocabulary acquisition during the intervention. The results of Students F and G, however, were not as conclusive. Student F demonstrated a decrease, and Student G remained constant from baseline to intervention. Thus, the data shows that five out of seven participants increased their vocabulary acquisition during the intervention.

Of note, however, Students D, E, F, and G all achieved their highest scores on vocabulary assessments during unit 2, and they received the traditional method of instruction during this unit. The mean assessment scores of each student in unit 2 are as follows: Student D, M=5; Student E, M=4.67; Student F, M=4.67; and Student G, M=5. This suggests that the participants were highly successful while receiving the traditional method of instruction during unit 2.

Students A and C also demonstrated their highest levels of vocabulary acquisition during unit 2, and they received mnemonic keyword instruction during that time; Student A earned a mean of 4.67 and Student C earned a mean of 5. Because so many participants performed best in unit 2, it appears that the nature of the vocabulary terms may be a stronger predictor of vocabulary acquisition than the method of vocabulary instruction. Unit 2 vocabulary consisted of vocabulary words related to the coordinate plane (x-axis, y-axis, integer, quadrants, origin). These terms were concrete and easily visualized on the coordinate plane. Meanwhile, many students performed lower in unit 3, which consisted of more advanced, abstract algebra vocabulary words (variable, expression, equation, evaluate, substitute).

The results of the present study, specifically the positive outcomes of Students A, B, C, D and E, were consistent with the findings of many studies of the mnemonic keyword method. Terrill and colleagues (2004), Uberti and colleagues (2003), Scruggs and colleagues (1985), and Mastropieri and colleagues (1985) indicated that the mnemonic keyword strategy positively impacts the vocabulary learning of students with disabilities.

In contrast, the results of Students F and G appear more consistent with the findings of Brown (2007). Brown (2007) researched the effectiveness of the mnemonic keyword method on the math vocabulary development of 8th grade students with and without disabilities. Some participants in the study were randomly assigned to an instructional group that used the mnemonic keyword method, while others did not receive mnemonic keyword instruction. Assessment results indicated that participants in all instructional conditions increased their vocabulary scores as a result of the instruction, yet there was no statistically significant advantage of any one method (Brown, 2007). These results are similar to the present study's results of Students F and G because in both situations, the mnemonic keyword method did not appear to be significantly more advantageous than the traditional method of instruction for teaching mathematical vocabulary.

In the area of retention, students' retention of mathematical vocabulary was assessed by a cumulative assessment, featuring all of the vocabulary words from units 3 and 4. All study participants received mnemonic keyword instruction during these two units. Data showed that all students made gains from baseline to cumulative assessment, indicating that all students maintained the mathematical vocabulary that they acquired

during mnemonic keyword instruction. On the cumulative assessment, four students earned 30/30, two students earned 29/30, and one student earned 20/30. Thus, the present study suggests that the mnemonic keyword method may be effective for retention of vocabulary in students with learning disabilities.

Like the present study, the findings of Scruggs and Mastropieri (1992) and Condus and colleagues (1986) suggest that the mnemonic keyword strategy is effective for the retention of vocabulary in students with learning disabilities. Scruggs and Mastropieri (1992) studied the acquisition and retention of science vocabulary of 20 students with disabilities in a middle school self-contained class. Nineteen of the participants were classified as having learning disabilities and one participant was classified as having a mild intellectual disability. During the study, all students participated in phases of mnemonic keyword instruction and traditional instruction. Two weeks after instruction, study participants took a delayed-recall test, to assess the retention of their vocabulary learning. The assessment results showed that the students scored significantly higher on the content taught mnemonically compared to the content taught traditionally (Scruggs & Mastropieri, 1992). Thus, the findings of the present study are consistent with the findings of Scruggs and Mastropieri (1992) because both suggest that the mnemonic keyword method positively impacts the retention of vocabulary of students with learning disabilities.

The research of Condus, Marshall, and Miller (1986) also suggest that the mnemonic keyword method of instruction positively impacts the retention of vocabulary in students with learning disabilities. Condus et al. (1986) investigated the impact of the mnemonic keyword method on the development of English vocabulary of 12-year-old

students with learning disabilities. The study participants were assigned to groups that received various methods of vocabulary instruction, including the mnemonic keyword method. Results of an eight-week follow-up assessment indicated that the students who received mnemonic keyword instruction demonstrated the highest levels of vocabulary retention, compared to students who received other instructional methods (Condus et al., 1986). Thus, the findings of the present study support the findings of Condus et al., as both studies demonstrated improvement in vocabulary retention.

Finally, the present study investigated the participants' satisfaction with the mnemonic keyword method. The results of the student satisfaction survey indicated that the majority of the participants were satisfied with the mnemonic keyword method. The majority of the participants believed that the mnemonic keyword strategy helped them learn new vocabulary and was enjoyable. Also, the majority of the participants indicated that they would like to use the mnemonic keyword method again. In fact, one student circled and drew stars around his "strongly agree" response, indicating his enthusiasm with the strategy.

Like the present study, the studies of Scruggs and Mastropieri (1992) and Mastropieri et al., (2000) suggest that students are satisfied with the mnemonic keyword method of vocabulary instruction. In Scruggs and Mastropieri's (1992) study of middle school students with disabilities, the majority of the students indicated that the mnemonic keyword method helped them learn and was enjoyable, and that they would like to use the method again. Students of a fourth grade inclusion class in Mastropieri et al.'s (2000) study also completed a student satisfaction survey to indicate their satisfaction with the mnemonic keyword method. All study participants ranked their satisfaction as an 8/10 or

higher, suggesting strong satisfaction with the mnemonic keyword method (Mastropieri et al., 2000). Thus, the present study and the studies of Scruggs and Mastropieri (1992) and Mastropieri et al. (2000) consistently report student satisfaction with the mnemonic keyword method.

Limitations

There were several limitations to this study. First, the study had a small sample size of seven students. The study originally had nine participants, but two students had many absences from school, and missed too many instructional days to be counted in the study. The study's findings would have been strengthened by additional participant data.

Second, time was a limitation to this study. This study was a master's thesis conducted during a spring semester, and there was a limited number of weeks between the IRB approval and the end of the semester. Because of the time constraints, each phase of the study was limited to one week, and the assessment of retention was administered one week after the conclusion of the intervention. If more time was available, the study could have been improved by lengthening the phases of the study and the number of weeks between the intervention and assessment of retention.

Furthermore, the variance of vocabulary units was a limitation to the study. Although new vocabulary was introduced during each vocabulary unit, some mathematical vocabulary words were naturally more concrete or abstract than others. For example, unit 2 featured terms related to the coordinate grid, which could be easily visualized, while unit 3 featured more abstract algebra vocabulary. The variance in academic content may have impacted results as there was a pattern of students increasing scores in unit 2, decreasing in unit 3, and increasing in unit 4 regardless of intervention

phase. All vocabulary units were selected based on their relevance to the sixth grade math curriculum, which the teacher was required to follow.

Finally, the variance in assessments may have been a limitation to the study. Three different forms of assessments were administered: multiple choice, "create your own example," and fill in the blank. Although 15 points of data per participant were collected, they were of three different formats, which had higher variability than expected. The study contained one or two phases of baseline data for each participant, and two or three phases of intervention data for each participant. However, baseline data of three to five vocabulary units and intervention data of three to five vocabulary units would have greatly strengthened conclusions drawn from findings.

Implications

Although this study had its limitations, it presents the usefulness of the mnemonic keyword method for the acquisition and retention of vocabulary of students with learning disabilities. Teachers should be aware of the mnemonic keyword method, so that they may use it in conjunction with their existing practices, to aid in the learning of new vocabulary. Furthermore, according to the present study and the findings of Scruggs and Mastropieri (1992) and Mastropieri et al. (2000), students are likely to enjoy the strategy.

Further studies are needed in order to determine the effectiveness of the mnemonic keyword strategy on the acquisition of mathematical vocabulary of students with learning disabilities. Although there are many available studies on the impact of the mnemonic keyword strategy, few are recent and related to mathematics. Future studies should contain larger participant populations to yield stronger results. Also, the variance of the academic content was a limitation in this study. Future studies should feature

vocabulary units that are more similar to one another (i.e. all units of algebra vocabulary). Additionally, researchers may consider conducting future studies over longer time periods, to gather more data and strengthen the findings.

Conclusion

As a result of this study, it can be concluded that the mnemonic keyword strategy positively impacted the acquisition and retention of mathematical vocabulary of students with learning disabilities and that students with learning disabilities enjoyed learning through the mnemonic keyword strategy. The majority of the students demonstrated growth on their weekly unit assessments, all students demonstrated growth on the cumulative assessment, and the majority of the students indicated satisfaction on the student survey. However, the study had limitations. Further research is needed to evaluate the effectiveness of the mnemonic keyword strategy on the acquisition of mathematical vocabulary of students with learning disabilities. Nevertheless, the study suggests the mnemonic keyword strategy is an instructional strategy that may improve vocabulary acquisition and retention and may be enjoyed by sixth grade students with learning disabilities.

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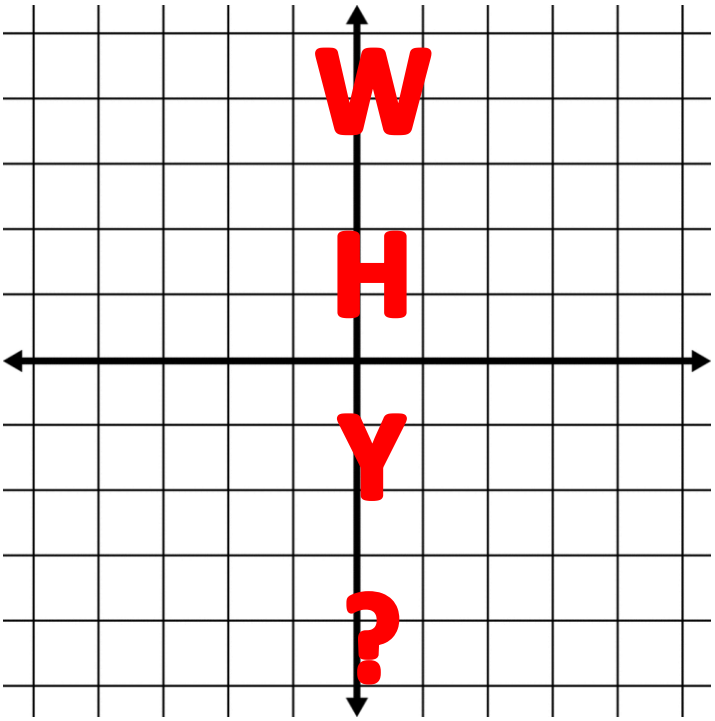
Appendix A

Mnemonic Keyword Method Handouts for Vocabulary Unit 2

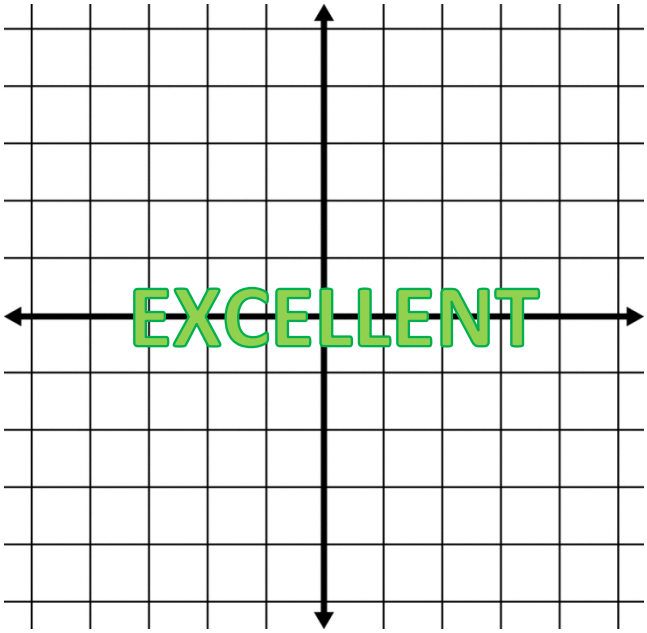
Y-Axis (Why?)

The vertical (up-down) axis on the coordinate plane



X-Axis (Excellent)

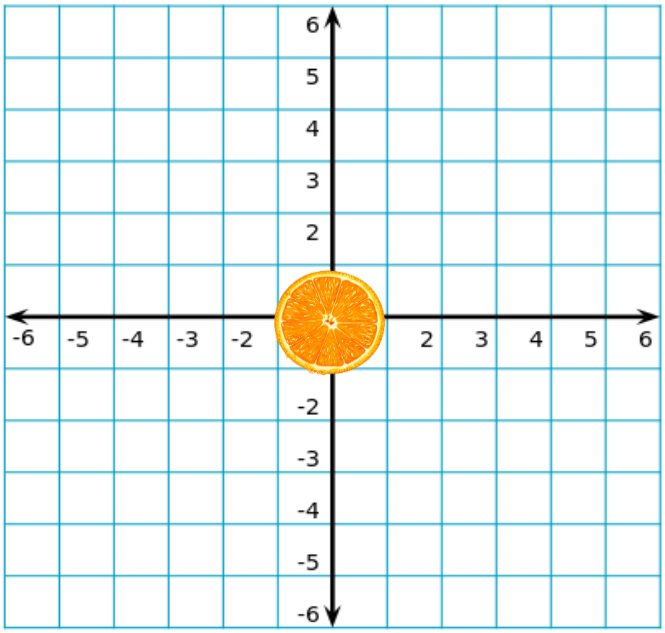
The horizontal (across) axis on the coordinate plane



Origin (Orange)

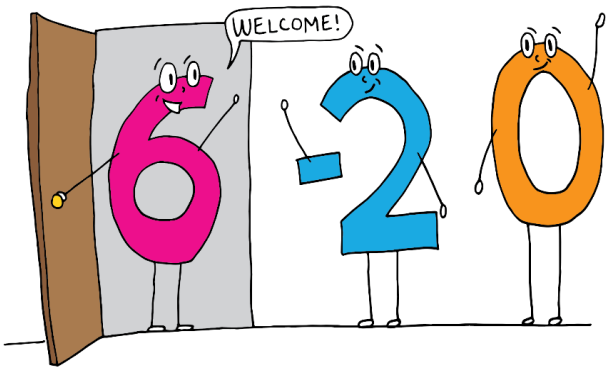
The center of the coordinate plane

Point (0,0)



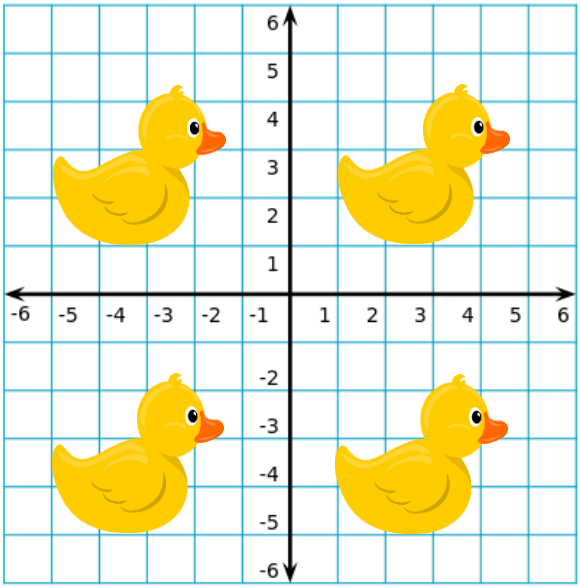
Integer (Visitor)

Positive numbers, negative numbers, and zero



Quadrants (Quack)

The four sections of the coordinate plane



Appendix B

Mnemonic Keyword Method Handouts for Vocabulary Unit 3

Evaluate (Evil)

To determine the value

A.K.A. to solve and get the answer

Expression (Explosion)

Numbers, symbols, and/or operations put together. An expression does NOT have an equal sign.

*There was an **explosion**, and so now there is no equal sign.*

Equation (Equal)

A statement with an EQUAL SIGN.

It shows that the amounts on each side of sign are equal.

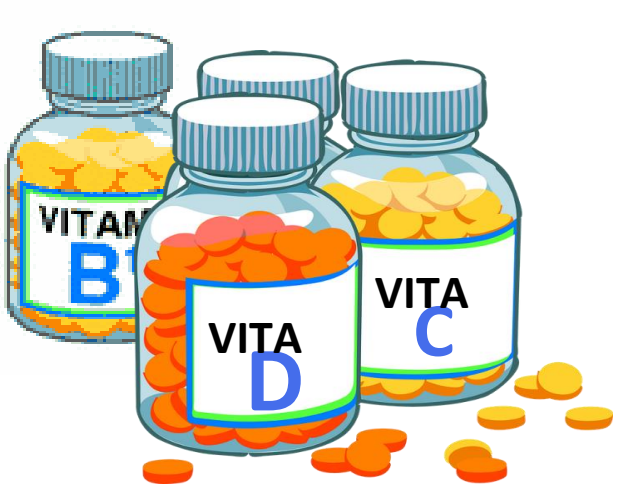
.

$$2 + 3 = 5$$

Variable (Vitamin)

A letter that represents a number

For example: x, y, a, b, etc



Substitute (Substitute Teacher)

To replace

Your teacher is absent today, so I will **replace** her.

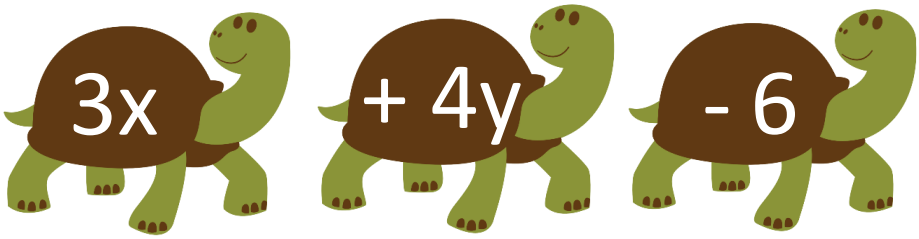
Appendix C

Mnemonic Keyword Method Handouts for Vocabulary Unit 4

Term (Turtle)

A single number, a variable, or numbers and variables grouped together

In the expression 3x +4y -6, the terms are: 3x, 4y, and -6



Like Terms (Like)

Terms that have the same variable

Example: *3a* and *17a* are like terms because they both have *a*

*"We **<u>like the same thing</u>**. We both like ice cream."*

Coefficient (Coffee)

the number that comes **before** variable

For example: 4x

The coefficient is 4.

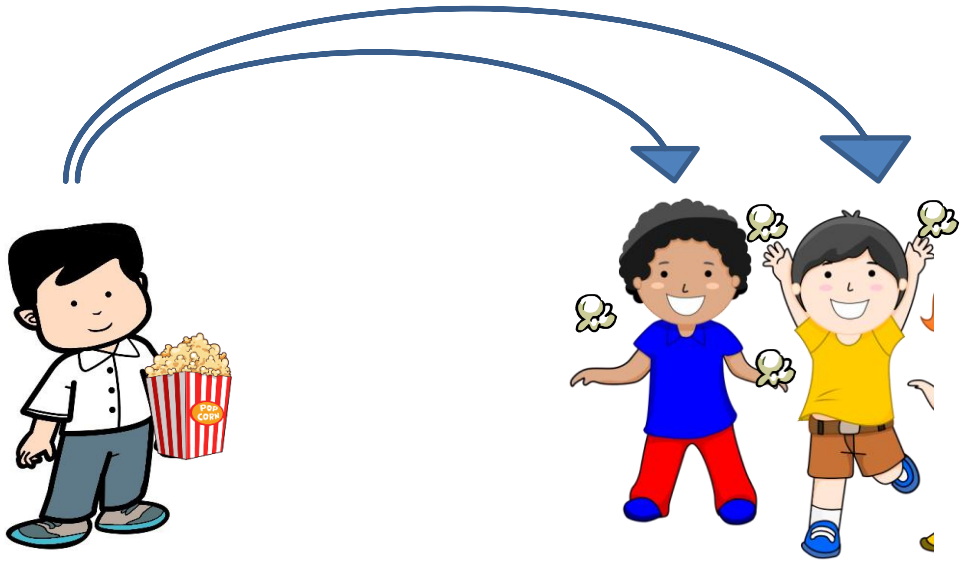
*"I drink coffee **before** I start my day!"*

Constant (Stand)

A number that stands by itself. It is not connected to a variable.

Distributive Property (Distant Popcorn)

Multiply the number outside the parentheses by each number inside the parentheses



Appendix D

Vocabulary Assessments for Vocabulary Unit 1

Name _____

Vocabulary Warm-Up

1. A number that **only has two factors** is …
   A. an exponent
   B. a square number
   C. a prime number
   D. a composite number

2. A number with **more than two factors** is…
   A. an exponent
   B. a base
   C. a prime number
   D. a composite number

3. Any number that **divides into a given number with no remainder** is…
   A. a factor
   B. a base
   C. a product
   D. a divisor

4. In a division problem, the _____ is the **number of equal groups**.
   A. factor
   B. dividend
   C. divisor
   D. quotient

5. In a division problem, the _____ is the total you **begin with before fair sharing** or making equal groups.
   A. quotient
   B. product
   C. dividend
   D. divisor

Name _____

Make an example of each vocabulary word.

1. Factor

2. Prime Number

3. Composite Number

4. Dividend

5. Divisor

Name _____

Fill-in-the-Blank Vocabulary

1. In a division problem, the _____ is the total you begin with before fair sharing or making equal groups.

2. A _____ is any number that divides into a given number with no remainder.

3. A _____ is a number that has more than two factors.

4. In a division problem, the _____ is the number of equal groups.

5. A _____ is a number that only has two factors: 1 and itself.

Appendix E

Vocabulary Assessments for Vocabulary Unit 2

Name _____

Vocabulary Warm-Up

1. The **vertical (up-down)** axis on the coordinate plane is…
    A. The origin
    B. The x-axis
    C. The y-axis
    D. Quadrant

2. The **horizontal (across)** axis on the coordinate plane is…
    A. The origin
    B. Coordinate pair
    C. The x-axis
    D. The y-axis

3. Point **(0,0)** at the **center** of the coordinate plane is called…
    A. Negative zero
    B. Absolute zero
    C. The origin
    D. Quadrant

4. The set of **positive numbers, negative numbers, and zero** are called…
    A. Factors
    B. Exponents
    C. Integers
    D. Quadrants

5. The **four sections** of the coordinate plane are called…
    A. Quadrants
    B. X-axis
    C. Y-axis
    D. Absolute values

Name _____

Draw or make an example of each vocabulary word.

1. Integer

2. Origin

3. X-axis

4. Y-axis

5. Quadrants

Name _____

Fill-in-the-Blank Vocabulary

1. On the coordinate plane, the _____ is the vertical (up-down) axis.

2. On the coordinate plane, the _____ is the horizontal (across) axis.

3. The _____ is the center of the coordinate plane, located at (0,0).

4. The four sections of the coordinate plane are called _____.

5. Positive numbers, negative numbers, and zero are _____.

Appendix F

Vocabulary Assessments for Vocabulary Unit 3

Name _____

Vocabulary Warm-Up

1. This word means **"to determine the value"** or **"to get the answer."**
   A. equation
   B. evaluate
   C. fraction
   D. substitute

2. A **letter** that represents a number is…
   A. substitution
   B. a base
   C. a variable
   D. an equation

3. When you are asked to _____, you would **replace** a number for a variable.
   A. evaluate
   B. substitute
   C. expression
   D. equation

4. A statement **with an equal sign** is _____.
   A. An expression
   B. An equation
   C. A variable
   D. Algebra

5. A _____ is numbers, symbols, and/or operations put together. It **does NOT contain an equal sign.**
   A. equation
   B. expression
   C. product
   D. substitution

Name _____

Make an example of each vocabulary word. You may use arrows to point to your answers.

1. Expression

2. Equation

3. Variable

4. Substitute

5. Evaluate

Name _____

Fill-in-the-Blank Vocabulary

1. A _____ is a **letter** that represents a number.

2. A _____ is numbers, symbols, and/or operations put together**.** It **does NOT contain an equal sign.**

3. A _____ is a statement **with an equal sign.**

4. _____ means **"to replace."**

5. _____ means "to determine the value" or "to get the answer."

Appendix G

Vocabulary Assessments for Vocabulary Unit 4

Name _____

Vocabulary Warm-Up

1. A single number, variable, or numbers and variables **grouped** together is…
   A. a term
   B. a coefficient
   C. a constant
   D. a variable

2. **Terms that have the same variable** are called…
   A. a constant
   B. like terms
   C. equation
   D. exponents

3. A **number attached to a variable** is called…
   A. a variable
   B. a coefficient
   C. an expression
   D. a composite number

4. A **number that stands by itself** is called a _____. It is not attached to a variable.
   A. term
   B. coefficient
   C. integer
   D. constant

5. When you multiply a number **outside the parentheses by each number inside the parentheses**, you use the _____.
   A. Distributive Property
   B. Associative Property
   C. Like terms
   D. Coordinate grid

Name _____

Make an example of each vocabulary word. You may use arrows to point to your answers.

1. Distributive Property

2. Term

3. Like Terms

4. Coefficient

5. Constant

Name _____

Fill-in-the-Blank Vocabulary

1. When you multiply a number **outside the parentheses by each number inside the parentheses**, you use the _____.

2. A single number, variable, or numbers and variables **grouped** together is _____.

3. **Terms that have the same variable** are called _____.

4. A **number attached to a variable** is called _____.

5. A **number that stands by itself** is called a _____. It is not attached to a variable.

Appendix H

Cumulative Vocabulary Assessment

1. When you multiply a number **outside the parentheses by each number inside the parentheses**, you use the…

   A. Distributive Property
   B. Associative Property
   C. Like terms
   D. Coordinate grid

2. This word means **"to determine the value"** or **"to get the answer."**
   A. equation
   B. evaluate
   C. fraction
   D. substitute

3. A **letter** that represents a number is…

   A. substitution
   B. a base
   C. a variable
   D. an equation

4. A single number, variable, or numbers and variables **grouped** together is…

   A. a term
   B. a coefficient
   C. a constant
   D. a variable

5. **Terms that have the same variable** are called…

   A. a constant
   B. like terms
   C. equation
   D. exponents

6. A **number attached to a variable** is called…

   A. a variable
   B. a coefficient
   C. an expression
   D. a composite number

7. A **number that stands by itself** is called a _______________. It is not attached to a variable.

   A. term
   B. coefficient
   C. integer
   D. constant

8. When you are asked to __________________, you would **replace** a number for a variable.

   A. Evaluate
   B. Substitute
   C. Expression
   D. equation

9. A statement **with an equal sign** is ____________________.

   A. An expression
   B. An equation
   C. A variable
   D. Algebra

10. A ________________ is numbers, symbols, and/or operations put together. It **does NOT contain an equal sign.**

    A. equation
    B. expression
    C. product
    D. substitution

Name _____

Create an example for each algebra vocabulary term.

Distributive Property	**Constant**
Expression	**Variable**
Equation	**Coefficient**
Term	**Substitute**
Like Terms	**Evaluate**

Name _____

We have learned a lot of new algebra vocabulary. Let's see how much you know. This warm-up is not graded for the gradebook. However, I will check it over, and show you your score.

1. A **number attached to a variable** is called _____.

2. A **number that stands by itself** is called a _____. It is not attached to a variable.

3. A _____ is a **letter** that represents a number.

4. A single number, variable, or numbers and variables **grouped** together is _____.

5. **Terms that have the same variable** are called _____.

6. A _____ is numbers, symbols, and/or operations put together**.** It **does NOT contain an equal sign.**

7. A _____ is a statement **with an equal sign.**

8. _____ means **"to replace."**

9. _____ means "to determine the value" or **"to get the answer."**

10. When you multiply a number **outside the parentheses by each number inside the parentheses**, you use the _____.