THE FRAYER METHOD: TEACHING VOCABULARY IN THE SCIENCE CONTENT AREA FOR MIDDLE SCHOOL LIFE SCIENCE

by

Sue Tracy

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2018

©COPYRIGHT

by

Sue A Tracy

2018

ALL RIGHTS RESERVED

ACKNOWLEDGMENT

I would like to thank my superintendent, Kimberly Belcastro, for her support in my efforts to finish my action research project and allowing me to conduct this project in my classroom at Wrenshall schools. I also want to thank my students at Wrenshall Public Schools who hung in there with me while I taught a technique I have never used before; your patience was greatly appreciated. Many thanks to Diana Paterson for patiently answering all my pestering questions and my capstone advisor Eric Brunsell for suffering through all my writing, some of which was sketchy, revisions and questions.

I especially want to thank my husband and boys who sat alone many a night while I toiled away on this project; thanks for your support and love.

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND 1

2. CONCEPTUAL FRAMEWORK 4

3. METHODOLOGY 16

4. DATA AND ANALYSIS 23

5. INTREPRETATION AND CONCLUSION 37

6. VALUE 42

REFERENCES CITED.....46

APPENDICES 50

APPENDIX A MSU-IRB Form.....51
APPENDIX B Pre-and Post-Treatment Student Survey 53
APPENDIX C Vocabulary Lists.....56
APPENDIX D Example Pre- and Post-Test 58
APPENDIX E Muddiest Point Sheets 60
APPENDIX F New Term Checkpoint Sheets 63
APPENDIX G Post Checkpoint Interview Questions 65
APPENDIX H Frayer Model 69
APPENDIX I Frayer Model Grading Rubric.....68
APPENDIX J Post Intervention Interview Questions 71
APPENDIX K Graphic Representation of Pre- and Post-Survey.....73

LIST OF TABLES

1. Data Triangulation Matrix 17

2. Classroom Demographics 18

3. Primary Focus Question..... 23

4. Normalized Gains and t-Test for Pre- and Post-Test Data 24

5. Analysis of First VKS Self-Assessment 26

6. Treatment Phase VKS Analysis Questions One of Three 27

7. Treatment Phase VKS Analysis Questions Two of Three.....28

8. Treatment Phase VKS Analysis Questions Three to Three 28

9. Secondary Focus Question One 29

10. Student Intervention Analysis, (Questions 1-3).....34

11. Secondary Focus Question Two 35

12. Student Intervention Analysis, (Questions 4-6).....35

LIST OF FIGURES

1. Student's Change for the Desire to Read 30

3. Student's Preference for Vocabulary Acquisition 31

4. Student's Pre vs. Post-Intervention Survey, (Question 8) 32

5. Post Intervention Survey Data, (Question 3) 68

6. Post Intervention Survey Data, (Question 4) 69

7. Post Intervention Survey Data, (Question 5) 70

8. Post Intervention Survey Data, (Question 6) 71

9. Post Intervention Survey Data, (Question 7) 72

ABSTRACT

Teaching techniques that allow students to define new vocabulary words and then use them in science context is difficult and a challenge for many science teachers today. Ensuring their students get a good foundational background and can understand the information they read and to fully participate in class discussion is a key motivator. This action research project set out to design, implement and utilize the Frayer Model for vocabulary instruction and compare it to traditional means of vocabulary acquisition. Instead of having my students define vocabulary words from the text, I had students use the Frayer Model – Graphic Organizer in vocabulary groups for the new terms they were required to learn. Students then had to demonstrate they could define and use the new terms contextually. Qualitative and quantitative data modes were utilized to collect data to analyze if the testing method made a difference to my students' understanding of vocabulary. Students were given a pre-test before new words were assigned and an identical post-test when the terms were learned. The pre- and post-tests data were compared using normalized gains to record growth in students' ability with definition and contextual use of terms. A paired t-test was then conducted with the normalized gains data to discover whether the changes were significant or chance. The comparison and post-implementation survey were administered to students. This qualitative, nonparametric data tool will be evaluated using a frequency method to determine the connections of student perceptions to students' desires to read. A vocabulary knowledge scale tool and a student-teacher post implementation survey were conducted to determine teaching efficiencies and inefficiencies. Analyzed data revealed no significant educational gains using the Frayer Method. Data also revealed students did not perceive a gain in their learning either, however, students did report they still wanted to use the graphic organizer. As the instructor, I gained an incredible amount of information about my teaching techniques and the importance of using multiple methods of vocabulary instruction in my classroom.

INTRODUCTION AND BACKGROUND

I work at Wrenshall Public Schools, located in Wrenshall, Minnesota that services Pre-K to 12 all in one facility and is called the "small school with the big heart." The school prides itself on having small class sizes with an average maximum of 25 students, if there is staff enough to meet those goals.

The town has a population of 399 people, and we are located approximately 17 miles southwest of Duluth, Minnesota which has a population approximately 85,000. The current student enrollment is approximately 390 students. The City of Wrenshall is surrounded by farming community, and while not many farms are operational anymore, there is still the "farming" philosophy among residents, parents and students.

Because of the school's philosophy for small class sizes, we draw a large population of students from surrounding communities and the much larger county north. The student population consists mainly of Caucasian students, a very small percentage of African American students, and about four percent of our students are Native American. We recently enrolled three students from a family who adopted three children from Sierra Leone, Africa; one of these children is a seventh grader in my life science class. We have a high special education population with approximately 28% of the student body needing some sort of special education services, increasing the need for small class sizes to meet the variety of learning. The free and reduced lunch population exceeds 40% and many years approaches 50%. We have several children who qualify for the weekend backpack program which provides them with some food for the weekend. This program is

provided to the school through a joint, county effort through the Second Harvest Food Bank.

I teach seventh grade Life Science, seventh and eighth grade Food Science, 11th - 12th grade college-in-the-schools (CITS) Cell Biology/Anatomy-Physiology and 9-12th HS Food Science. Because of our small school and our desire to offer as many choices as possible to students, my schedule can change from year-to-year, and I can teach different electives. For example, I also teach other electives such as Forensics, eighth grade Earth Science, 9-12th grade Conceptual Physics and Landscape-Horticulture. I am certified to teach all science disciplines in grades five through 12 in the state of Minnesota.

Our administration and union adopted a program four years ago named Quality Compensation, which we refer to as Q-Comp. In this program, teaching staff are required to work collaboratively in professional learning communities (PLC); develop, implement and conduct mini-action research projects; and other requirements set by the State of Minnesota. The Quality Oversight Team sets the goal for our teams to follow, and we individually design plans that help to meet the school's goals. All goals for the past four years have been set around the State of Minnesota Comprehensive Assessments (MCA-III) for math and reading; with math and reading alternating every year. The PLC's focus their action plans on meeting and/or exceeding the MCA-III scores or on increasing student growth scores from the previous year.

In the past four years, I have focused solely on my eighth grade Earth Science students in math and reading because they are not only tested for math and reading in eighth grade, they are also tested in science. My mini action research plans are designed

to help with growth in all three subjects. In the school year 2014-15, I focused on increasing reading scores by having my students do more reading activities in my classroom. In the school year 2016-17, I focused on increasing students' vocabulary. Some of the tactics I instituted were creating a word wall, students reading more current events, and practicing with prefixes, suffixes and root words through an IXL computer practice program offered to students primarily for math but was extended to reading literacy. Even though this has been something different than what I do normally, I still do not feel I have asked my students to really do anything different than looking up words in their text, define them and expect them to learn and use them correctly. I also feel strongly that I have not done a thorough job of teaching vocabulary acquisition. The implementations that I have been doing have all been teacher driven, and I would like to shift to student-inquiry based. I have not seen a long-lasting memory of the scientific vocabulary content that I have been teaching despite the methods I have tried to implement. With the small school environment, I get to teach many of these kids again when they are upper classmen, and I have noticed they do not remember much of what I taught them.

Having done more concrete research on what others have done to address this same issue in their classrooms, I have decided to change the way I ask my students to define scientific words. Instead of copying definitions out of the text on a sheet of paper, I would like to see how using a method that incorporates art, synonyms, writing and antonyms may affect my students' ability to learn word meanings and use the words contextually. My primary and secondary questions are as follows:

a) Primary Question: What is the impact of using the Frayer Model on student understanding of vocabulary and their ability to use it contextually?
b) Secondary Question: What are the students' perception about the usefulness of the Frayer Model for helping them understand vocabulary?
c) Secondary Question: What impact will the Frayer Model have on my own motivation and instructional pacing guide?

CONCEPTUAL FRAMEWORK

The unique vocabulary that is found in science provides a pathway to reading, writing, and other communication (Anderson, 2016) and "students learning science in school brings about citizens with an inclination toward continued learning about issues, scientific and otherwise, that affect their lives and communities" (States, Ngss, & Ngss Consortium of Lead States, 2014, p. 286). The importance of building a strong scientific vocabulary is crucial to science; however, it is not just students defining a list of terms (Aune, 2012). It has been hypothesized that the poor performance on standardized science tests may be due to a failure on the part of educators to instruct students properly on what is required to understand science reading (Cromley, Snyder-Hogan & Luciw-Dubas, 2010); however, this failure, in part, is due to lack of attention to building scientific vocabulary (Fisher, Frey & Grant, 2009). A student's knowledge base is tied into the fundamental role vocabulary plays. Campbell goes on to further state some research supports teaching vocabulary to access prior knowledge (Campbell, 2009).

If educators expect students to be engaged, informed science communicators, then a solid vocabulary that can be remembered must be taught. Capturing student's prior

knowledge using various techniques that enhance encoding is going to be the key to helping students learn scientific vocabulary and increasing their prior knowledge base. In addition, varying instruction so teachers do not get caught in a "rut" is also going to engage and encourage students to take responsibility for their own vocabulary learning.

"Even the single most distinctive talent of human cognition, the ability to write and speak in a language, exists because of active remembering" (Medina, 2008, p. 129). Thus, educators need to find a way to make vocabulary accessible to their students and have them consistently use it in authentic contexts (Anderson, 2016). This may seem easier said than done, especially when one considers how the brain recalls information and the student's background. Campbell (2009) believes students bring their own experiences into the classroom which can include their beliefs, life and academic experiences.

Understanding human memory is one key to teaching students to learn and retain vocabulary. Long-term and short-term are types of memories of the human brain. Long-term memory can be broken down into categories such as explicit (declarative) and implicit memories. Explicit memory also referred to as autobiographical and/or declarative can be broken down into two categories: semantic memory (a student's knowledge of his/her own world) and episodic memory (a list of episodes of a person's memories in his/her lifetime). Declarative memory, the ability to recall pieces of information, is one type of memory science has studied the most. Declarative memory is also referred to as prior knowledge; "[background knowledge] is the raw material that conditions learning. It acts as mental hooks for the lodging of new information and is the

basic building block of content and skill knowledge" (Campbell, 2009, p. 9). Prior knowledge consists of networks in the brain that have been placed in permanent memory (Sprenger, 2013).

Implicit memories, or procedural memories, are those that help us to perform operations that do not require us to have an active role in remembering. There are two types of procedural memories, motor and nonmotor. Motor memories help us to walk up steps or ride a bike. Nonmotor memories help students to decode words. Scientists have identified four steps to declarative memory: encoding, storing, retrieving and forgetting (Medina, 2008). Medina states that whether something will be remembered after being initially perceived is crucial in the first few moments of the first steps of declarative memory (Medina, 2008). According to Sprenger (2013) encoding and storing are vital to a long-term memory and will create vocabulary schemata. Sprenger also believes the more experiences surrounding vocabulary work will also create more webbing in the brain through a representation of concepts, ideas and actions that are related (Sprenger, 2013).

Medina shares that when information gets into the brain, it gets broken down into pieces that can be turned into electrical stimuli the brain can recognize. These pieces of information are not stored in one central location, but rather all along the cortex of the brain and at this stage they are very malleable and subject to change. Medina writes in his book that people routinely forget 90 percent of what they've learned in a month from their first exposure. More surprisingly, much of this forgetting can happen within a few hours after class (Medina, 2008). Sprenger's suggestions of repeated exposure to

vocabulary can help to engage the brain in longer memory through linking to prior knowledge and creating more schemata in the brain.

Remembering or recalling information is as complicated as the encoding and storing process. There are two basic modes to remembering information in the brain: recognition and recall (Mastin, 2010). Recalling memories is a two-step process where the brain pulls the memories from the several locations it has stored them and then must process what it is recalling; where recognition seems to happen more quickly. Mastin (2010) and Medina (2008) both agree through their writings the more stimuli involved in the encoding process the better the recall and recognition will be. Medina further states there are certain senses and conditions that help to make the recall process more reliable. All of one's senses are involved in encoding and retrieving information, but some appear to be more effective than others. In chapter nine of "Brain Rules," summarizes that vision is the most dominant sense that takes up approximately half of the brain's resources (Medina, 2009). He goes on to state teachers should restructure all their PowerPoint presentations by removing most of the words and adding visually appealing graphics. Automatic processing of the brain uses the visual aspects of what one takes in. Memories that are automatically processed seem to be bound together and are easily retrieved later. Sense of smell is reported to be the next most powerful sense for triggering memories. Studies have shown a greater ability to recall information if fragrances were released upon the time of encoding the information and then released again later when students are expected to retrieve the information. Recreating the initial setting or circumstances when the information was first encountered or learned creates a

better pathway for remembering or recalling the information that was stored (Mastin, 2010).

Campbell stated to avoid the negative effects of prior knowledge, dedicated time and effort need to be given by teachers to students through visible and malleable efforts (Campbell, 2009).

Using techniques that enhance the encoding and memory process will be more useful when using other vocabulary techniques of just defining a list of terms (McDermott & Roediger, 2017). Using repetition in orderly spaced intervals to give students time to acquire and instill information in the memory are important tactics to use (Medina, 2009). To solidify new knowledge, vocabulary should be utilized frequently and in multiple applications, as understanding is achieved through regular opportunities to reinforce meaning (Davis, 2015; Misulis, 2011).

There is lack of "robust" vocabulary instruction in American schools today even though research supports a strong vocabulary instruction (Anderson & Gallagher, 2016). Fisher warns that this does not include a list of words for students to define from a dictionary or their books as the only approach (Fisher et al., 2009).

The use of prefixes, suffixes and root words is one tactic to lasting vocabulary instruction and the building of prior knowledge. "Word recognition" is a criterion for reading and has been so established for some time and especially for the average reader (Breen, 1960). To read and effectively communicate, children must have a foundational set of words they have acquired. Having a foundational set of words allows children to make connections and "psychologists concede that a certain amount of transfer takes

place in learning when the learner has the ability to perceive identical elements in the activities which are related" (Breen, 1960, p. 93). Breen (1960) has compiled a list of 15 prefixes, 19 Greek-derivative, 35 Latin derivatives and 11 suffixes that every student should know. In "Effective Strategies for Teaching Science Vocabulary" (Carrier, 2011) also supports teaching word derivatives in activities such as word list and word banks where students are given cards with words that describe procedural words, opposites or movement cards. She also describes a technique where students are given vocabulary cards with multiple meanings; she states, multiple meaning words can be hard for English speaking students let alone for those where English is their second language. Multiple meaning cards are tools that help to ease some of that confusion (Carrier, 2011). Carrier believes all students can develop a good context-based knowledge of language through hands-on learning that is focused through inquiry. "Teachers, through purposeful instruction, can help students absorb vocabulary knowledge by building and activating background knowledge" (Fisher et al., 2009, p. 183). Strategies must be diverse, and teachers need to pull themselves away from traditional vocabulary definitions through glossaries and dictionaries. Approaches can include "time to talk", where students are given the opportunity to speak with one another and use their new science vocabulary. Instead of teaching prefixes, suffixes and root words, Sprenger (2013), states there are 55 words students should know to help them pass the state standardized testing under the common core standards.

A repeating theme in journal literature is the use of a word walls. "Word walls have become a more common element in today's classrooms to support visual

scaffolding, reading and language arts instruction" (Cox, Jackson &Tripp, 2010, p. 45) Jackson et al. states that many middle school classrooms have traditional word walls that are haphazard and uncoordinated lists of new words students have come across in their time in class. Science classrooms can also use word walls; Husty and Jackson (2008) suggest a creation they developed for an interactive wall with semantic mapping. The wall resembles a graphic organizer that assembles words into interlinking relationships and concepts. This technique helps to support the idea that more connections equates to better retrieval of information. The most effective word walls are ones that have photographs, pictures or the actual item being defined and are also student-driven (Jackson et al., 2010). Students also like word walls and stated they liked the organized walls much better than the traditional walls, in interviews with sixth and eighth grade students they reported:

> '[the wall] helped me because whenever I forgot I could just look back and it gave me good information"
> "it helps remind us of what we have learned"
> "since it is always up there I always remember"
> "The word wall helps me by giving me a visual understanding."
> "I like the word wall because it helps me remember which order [the words} go in and the definition."
> "They helped me with picture definitions and the order that they go in helped me a lot." (Jackson et al, 2010, p. 46)

Gallagher and Anderson (2016) interviewed several teachers regarding their [teachers] "graffiti walls" for strategies that had been developed, tested and effectively used by students. The most liked method incorporated was the Frayer Model, using graphic organizers. Students, while listening to rich vocabulary text; would try to recognize, record, and share new words with the class. A running list of words was kept by student

groups. Finally, students were asked to write new words on the center of their papers in graffiti style and then in the four corners they followed the Frayer model by placing a definition in one corner, antonyms in another, an illustration in yet another and finally in the last corner a sentence using the word. In time, students became more independent and would be able to work individually with this method of learning vocabulary.

The Frayer Method was first described in a working paper for the University of Wisconsin, Madison. Frayer, Frederick & Kalusmeier (1969) wished to devise an appropriate test to discover the level of concept mastery of a person. In this study, Frayer et al, developed a set of questions to test a person set of schemata regarding a concept. Frayer et al stated:

> the item writer must have the following information concerning a concept to be tested: (a) the names of the attributes which comprise the concept examples, and which are relevant an which and irrelevant to the concept; (b) examples and non-examples of the attribute values; (c) the name of the concept; (d) concept examples and non-examples; (e) a definition of the concept; (f) the name of superordinate, coordinate and subordinate concepts, (g) principles entailing the concept, and (h) problems which may be solved by relating principles involving the concept (Frayer, 1969, p. 9).

The Frayer Method has morphed into a technique the can be used to define concepts as well as vocabulary in graphic organizer format. The graphic organizer has a four-square format where the creator can select from the schema above to design a model which asks the user to define, list examples and non-examples and draw a picture, if so desired.

"Having much reading time and many different periodicals for reading still seems to be one of the easiest, most effective ways to build background" (Fisher et al, 2009, p.184).

> We propose a focus on science learning with strong theoretical and practical supports from reading and the purposeful combination of informational texts, textbooks, and hands-on science activities in a manner that is adaptable to the needs of all students in learning science through strategically designed student encounters that take place in real time over an extended time period (Rupley & Slough, 2010, p. 106).

Carrier (2009) suggests using "reading science text cards". There are several strategies for this format with a theme being based upon what students have read and how they have comprehended and learned what they read. In her journal article, "Fun with Vocabulary", Towell (1998) shares several reading/vocabulary techniques such as "clusters", "ABC books" and "color-shock" (p. 356). Color shock is a method for learning disabled children and has the student write each letter in a different coloring starting with green for "go". Clusters is a technique where students combine words that are synonymous or have conceptual connections around the key term. ABC books are highly visual tools where students draw concept of the term; they can include antonyms and synonyms. The beauty of this technique is students can individualize their book and call forth background knowledge they already have and create their own new schemata.

Another interesting approach to teaching scientific vocabulary is the use of familiar objects as a tool of inquiry to elicit prior knowledge. "By trying to relate to familiar objects to scientific terms, students begin to construct learning pathways to the new word and to inquire into the concepts that will be covered in the unit" (Hughes & Pries, 2012, p. 67). The University of Florida and the National Science Foundation funded the program called SPICE (Science Partners in Inquiry-Based Collaborative

Education) where teachers could collaborate and come up with strategies for teaching vocabulary (Pries et al., 2012). SPICE collaborators set up rotation stations which had familiar, instantly recognizable objects such as toys, food, household items, and iconic images. Each station had several new terms that were specifically picked for the one or two objects at the station. Stations also had specific, vocabulary-term, driven questions and students were given a recording sheet. Students were encouraged to play (or explore) with the objects then record their answers on their sheets. The "play-time" at each station was a strategy to get them thinking. Once all stations were completed, students were gathered together to pair and share their responses. Teachers finally worked with students and guided them to towards the vocabulary knowledge they wished for them to know. Pries and Hughes feel that students become more motivated to learn word meanings and this helps them to further learn their actual meaning later (Pries et al., 2012). Because of small space required for this method, large lab areas do not need to be used and this method can be used in other subject areas in science and students involved in this process were reported to have higher scores.

Vocabulary games are also a common approach to student learning. "Disguising instruction as play by using word games is one way of increasing student motivation to actively participate in their learning" (Charlton et al., 2005; Narkon & Wells, 2011, p. 46). Students with special educational needs can have issues due to past performance and may lack motivation to learn. This can happen with non-special education children as well simply by being tired of the same instruction time after time. Games help to influence personal interest in student-based learning. One such game that is used widely

in schools with 1:1 devices or students' phones is Kahootz. Students get to make up names and be playful while they practice their knowledge. Teachers can use previously entered games or they can create their own. The website allows instructors to record student answers, so teachers can keep track of growth, can complete pre-and post-testing or just for quizzes when a unit is finished. Charlton et al. (2011) lists several games that include: "mystery word", "word-o", and "word sorts" (p. 46-48). Word walls are incorporated into "Mystery Word" which is a teacher-led activity where 20 words are the topic. At the start of the game the teacher writes a word down, that is on the wall, on a secret sheet and then gives the student-groups clues. After each clue, student groups can guess which vocabulary word they think is being asked. Each successive clue should get the student groups closer to identifying the word. "Word-O" is an adaptation of Bingo. Students place their vocabulary words from a list onto their word-o card. As the teacher gives clues, students cover the term until someone wins by having "Word-O" covered on the card. Word-O cards can be modified to have nine, 16 or 25 blanks for terms. "Word Sorts" is a more complicated game for older students where teachers give students several words and students are required to make connections among the words. Teachers can make the word lists open or closed. In an open list, students come up with their own rationale for their sorts and in closed lists, the rationale is already included in the list.

One final approach is techniques that aid in memory acquisition is tried and true rote learning. Miller (2016) asked, "How do we help students learn in courses where there's a lot of memorization?" Miller has found in her years of teaching that memorization deserves more "airtime" because it is an important route to building

content knowledge and expertise. "Effortful processing takes energy and effort on part of the learner, especially if it is information that is not used commonly or often" (Miller, 2016, p. 2). Medina (2009) states researchers have found that this information does not get bound together well in the memory and requires repetition to be easily retrieved.

Mnemonics is a technique that is helpful for combinations of words that are sequential or connected. Students come up with a term or word where each letter in the word represents the first letter of each word in the sequence. Students should be informed of the difficulty in memorizing because the mind isn't setup to take in all sorts of disjointed information. Following Medina's suggestions, memorization should be frequent, but spaced for best memory acquisition (Medina, 2012). The mental machinery in the brain that holds onto sounds called the phonological loop is a useful technique to use (Miller, 2016). To take advantage of this tool, words that need to be learned and memorized can be said out loud several times. This should be a teacher driven tool at the start to ensure students are getting the word phonics correct; after some practice, students can become more independent. These two techniques could be useful for upper level high school instruction with vocabulary terms that may be difficult to spell, say and an enormous amount of new terms such as in an Anatomy and Physiology classroom setting. Miller (2016) states that ensuring that students understand why they are being required to learn the facts, in the first place, is also a good tool to get student buy-in. If they understand why, Miller believes "they will be better primed to remember it" (p. 2).

Nemati (2009, p. 14) states that "in spite of teacher efforts, vocabulary is the most sizeable, difficult and unmanageable component of learning." Nemati goes on to say that

vocabulary learning should be intentional and incidental (Nemati, 2009). Teachers can give students ample ways to experience vocabulary in many different types of reading material and purposefully exposing students to vocabulary strategies that work with the brain's memory and the complexity of learning and remembering vocabulary.

METHODOLOGY

The purpose of this action research project was to investigate whether the Frayer Model was more effective than the traditional "write out the definitions" model in helping my students define scientific vocabulary and use new terms in scientific context. I had not been satisfied with my students' scientific vocabulary acquisition for several years and had tried many different approaches. Even though this method has been used for many years, I had not been familiar with the technique and therefore had never tried to implement the model, thus this classroom action research plan.

One primary and two secondary focus questions were established to develop, implement and collect data to determine the effectiveness of this action research plan, please see Table I below. All classroom, survey and interview methodologies were designed to answer the focus questions of my project and were approved by the Montana State University's Institutional Review Board.

Table 1
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
Primary Question: What is the impact of using the Frayer Model on student understanding of vocabulary and their ability to use it in science context?	Pre- and post-vocabulary assessment for comparison and intervention periods	Student Self-Assessed Vocabulary Knowledge Scale (VKS-new term checkpoint warm - up)	Student interviews following scores of 1-3 on the VKS, new term checkpoint sheets.
Secondary Question: What are the students' perception about the usefulness of the Frayer Model for helping them understand vocabulary?	Post-Intervention Interview with selected students	Comparison of Pre- and Post-Intervention Surveys	Muddiest point on the weekly planner
Secondary Question: What impact will the Frayer Model have on my own motivation and instructional pacing?	Post-Intervention Interview with selected students	Instructional pacing guide and personal curricular map	Teacher Observation and Reflection

I implemented my action research plan in two, nine-week increments starting November 6, 2017 and continuing until March 23, 2018. I received approval from the Montana State IRB committee on October 30, 2017 to move ahead on exemption status (Appendix A). This action research plan was administered over an 18-week period and while this seemed like a long time, I felt it is necessary to achieve reliable data and complete my primary goal of teaching and preparing my students for their Minnesota science standardized test. In reading several action research plans that used this method, I noted their treatment time was short. I felt if I gave my students more time to learn and then fully use the method, I would get more reliable data. In addition, these students are required to participate in the school's science fair which fell within the project timeframe,

tends to be a time-intensive endeavor and can take some time away from vocabulary acquisition.

In the beginning, my comparison (control) and intervention groups were the same class of 25-seventh graders in my 2017-2018 Life Science class. As time went on, two students dropped and went to another school, one student opted to not participate in pre-tests and surveys and one student had repeated absences which interfered with test taking. At the end of the intervention period, 21 students' data were used for this action research plan.

In my school, seventh grade is the first-time students switch classes and have a great deal of independence. It takes them a long time to adjust to the freedom and to acquire a schedule that is beneficial to learning. However, they still have the desire and curiosity to learn scientific concepts. The demographics of these students can be seen in Table 2 below.

Table 2
Seventh Grade Life Science Classroom Demographics

Demographic Category	Demographic Ratios
Female to Male Ratio	14:11
Special Education (SPED) to Non-SPED	6:19
English Language- Native English Speaking	1:24
Free/Reduced Lunch to Paying Students	18:7
Caucasian to African American	23:2

Prior to start of my project, students who chose to participate were administered the student survey that can be viewed in Appendix B and asked to complete questions one through seven. This survey is a Likert scale to be used to determine students' prior conceptions of vocabulary importance and acquisition, the impact of learning vocabulary for reading and learning and then finally their desire to read.

In the first portion of my project, I covered my cell unit and a portion of genetics. This included, but was not limited to: the cell theory, cell structure and function, and mitosis. There were several challenging vocabulary words to learn in this unit. Words I asked my students to learn can be found in Appendix C. During the second portion of my project, students learned about Mendelian genetics, meiosis, modern genetics and heredity (see also Appendix C for vocabulary terms).

To collect data for my primary focus question of this action project, please see Table 1: students were administered a pre-test of terms prior to any exposure of new vocabulary. A copy of a sample test is provided in Appendix D. The pre-and post-tests were written in two sections to separate data; definition mastery and use of words in scientific context.

After administration of the pre-test, participants were asked to use their text to define the assigned words as a portion of their reading assignments. After students had turned in their reading (vocabulary) assignments, I taught and used the terms during daily warm ups, lecture, lab, class discussion and added them to the word wall. Students were given the opportunity to express concerns and ask questions when confusion arouse. One of these opportunities was on the weekly planner and warm up sheet I require of my seventh-grade students, see Appendix E. On this form, I placed a muddiest point portion listing current words being learned. Students were asked to express concerns they may have had so I could view and address. I also asked students to self-assess their word knowledge by using the new term checkpoint sheet (a vocabular knowledge scale, VKS style) as seen in Appendix F. Students who selected responses one through three, and

who had also completed their reading (vocabulary) assignments, were interviewed to determine why they felt they were having difficulty with the new terms and how I could help. The interview questions can be found in Appendix G. I only used the new term checkpoint sheet once in the comparison phase with the last grouping of words. My reasoning for this was to acquaint students with this form for the testing phase. This and the muddiest points were intended to be tools for me to assess and reteach were necessary.

When students came to the end of the unit section, they were administered a post-test that was identical to the pre-test they had taken earlier. All data collected were entered to an Excel spreadsheet designed to analyze and compare pre- to post-test scores. Depending upon the unit of study, most scientific terms were learned over a seven to 14 school-day period from the administration of the pre- to post-tests.

At the end of the first nine-week period, students entered the intervention phase of this study. Students were instructed on how to use the Frayer Method Graphic Organizer, as seen in Appendix H, by using words they were already familiar and had just learned in the previous unit. This was done to ensure students understood how to complete the sheets. As with the comparison protocols, prior to a set of new words, students took a pre-test.

Students were assigned vocabulary groups which I selected. The groups were arranged so several students with good grades and reading skills were matched with students who struggled with reading and behavior. Groups were no larger than five students to prevent inefficient work time but to keep workloads low. During the initial

group meeting, students were required to select a group leader who would assign a word to each member and collect sheets upon completion. Since the Frayer Method was time intensive, and completed during classroom time, I decided students would complete a sheet for at least one word within the section set. During this initial group meeting, students completed their first solo Frayer sheet and turned it in to the group leader. I then collected the sheets and corrected them using the rubric guide as seen in Appendix I. This was to ensure students fully understood the use of the method. Sheets were returned to students for corrections.

When students demonstrated their understanding of how to use the Frayer Graphic Organizer and finished their words, I collected the originals and made copies, so each member of the group would have a sheet for each word they were responsible for knowing. When students received a complete set, groups were assembled to go over words and study for the post-test. Students could take their Frayer sheets home the night before the post-test to study.

In this portion of the action research plan, vocabulary work was done at the end of the unit section. My rationale lies in the complexity of the Frayer Method and students being required to know antonyms, synonyms and enough information about the new word to draw a picture. Students would be completing their vocabulary work several days prior to the post-test administration to implement the new term self-assessment sheet as a warm up ensure students were comprehending the material. If students scored one through three and did their homework, an interview with these students were conducted to find out where students were having difficulties and give them/me an opportunity to

provide aid where necessary. At the end of this process, the post-test was administered. To introduce material that would be studied, and instead of doing a reading assignment where they defined new vocabulary, students would complete a directed reading assignment that encompassed the vocabulary in scientific context. Once the directed reading was completed, I taught my science class in the same way I had in the control phase with warm ups, labs, word walls, and classroom discussion. Students again had the opportunity to list concerns on their weekly warm up sheets as they had during the pre-treatment phase.

To investigate my first secondary focus question on student perception of the Frayer Method and my instruction, volunteers were asked to participate in my post-intervention interview. Questions for these interviews can be viewed in Appendix J. Eight students volunteered to be interviewed and interviews were conducted privately during my instructional planning time and one-at-a-time. Students perceptions of the Frayer model were also assessed in the student pre- and post-survey. At the end of the testing phase, students were once again given the student survey with the addition of question eight.

To investigate my final secondary focus question on instructional pacing, at the end of the second nine-week intervention, I went through my curriculum map and the previous year's lessons plans to assess the time difference of using the Frayer Method opposed to simple vocabulary assignments as used in the comparison phase. I also used questions from the new term checkpoint warm up sheets and the post intervention

interviews to assess students' perceptions of my effectiveness during this action research project.

DATA AND ANALYSIS

For my action plan I asked one primary and two secondary focus questions. My data collection methods were selected based upon quantitative and qualitative methods that I felt would effectively demonstrate the success of the Frayer Method with my students.

For my primary focus question, see Table 3 below, I selected three data sources: pre- and post-tests, a new term checkpoint warm up sheets and student interviews of those sheets if students selected options one through three and had finished their assignments.

Table 3
Primary Focus Question from Triangular Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
Primary Question: What is the impact of using the Frayer Model on student understanding of vocabulary and their ability to use it in science context?	Pre- and post-vocabulary assessment for comparison and intervention periods	Student Self-Assessed Vocabulary Knowledge Scale (VKS-new term checkpoint warm - up)	Student interviews following scores of 1-3 on the VKS, new term checkpoint sheets.

The impact of using the Frayer Model on student understanding of vocabulary and their ability to use it in science context was not shown to make a statistically significant difference between the pre and post-test results. My primary data source was the pre and post-test normalized gains scores. Data were collected for every student and an individual normalized gain for each test was calculated. When all individual gains were

calculated, an average of the class was taken. In the comparison phase of my project, the average percent normalized gain, based upon 21 students, was 58.517% for students' definition growth and 51.865% in contextual use growth. For my treatment phase the definition growth percentage calculated 49.926% and the contextual use growth a 50.565%. This gave a pre-post difference of -6.652 and 0.636% for definitions and context respectively, see Table 4 below.

Table 4
Normalized Gains and t-Test Scores for Pre and Post-Tests

Total Pre vs. Post			Total Pre vs. Post
Average % (g) Definitions	58.517 %	51.865 %	Average % (g) Definitions
Average % (g) Context	46.929 %	50.565 %	Average % (g) Context
Growth Through Frayer Method	-6.652%	0.636%	
Paired t-Test Definitions			
Comparison vs. Testing	t=1.00	df=20	p= 0.3293
Paired t-Test Context			
Comparison vs. Testing	t=0.0627	df=20	p=0.9506

Note. Definitions means students were able to match vocabulary words with their definitions. Context means students were able to use the vocabulary words in a contextual reading.

With growth numbers so close, a paired t-Test was calculated to support or refute the significance of the data. Since the probability for the t-test for definition growth was 0.3293 and being so much higher than 0.05, the data could not be considered significant and cannot be attributed to instructional differences between the two groups. In addition, the contextual growth was also extremely close, and a paired t-test was also calculated and presented a probability of 0.9506. Again, this number was above 0.05 which

indicates the data could not be interpreted as significant and cannot be attributed to instructional differences.

My second and third data source for determining the impact of the Frayer Method was the use of the new term checkpoint warm-up sheets and interviews. This was a Vocabulary Knowledge Scale (V.K.S.) self-monitoring sheet where students self-assessed their knowledge prior to taking a post test. Students who did not do their assignments or who did not want to think about their knowledge would mark one and twos consistently, they would not have to write the definition or a sentence. Students who had done their assignments and participated in class marked threes, fours and fives. What I noticed often was students who knew their information logged a lower score, but when interviewed showed they were able to demonstrate their knowledge. The outcome of this tool suggested a lower percentage of students not completing their assignments, but a high percentage of students who did their assignment did not demonstrate a sense of confidence in their knowledge of the terms.

Several days prior to the post test and after student groups completed their graphic organizers, students would be administered one of these warm up sheets with a random word out of the list of new terms to evaluate. Tables 5-8 are an analysis of student responses for each new term checkpoint warm up sheets. Table 5 was a warm up given prior to the last post-test of the comparison phase. Tables 6, 7 and 8 were all administered prior to post-tests in the treatment phase.

Table 5

Analysis of First V.K.S. Self-assessment Administered During Comparison Phase

New Term Checkpoint Warm Up Responses Number of Student Responses: *21*		New Term: *Eukaryote* Conducted During Comparison Phase
Response Selection	Percentage of Students Selected	Response Rationale
1. I don't remember having seen this word.	4.8%	One out one student did not do assignment
2. I have seen this word, before, but I don't know what it means.	47.6%	Eight out of 10 students did not do their assignment Two of 10 did their assignments but did not remember definition, one of which is an ELL/ESL student.
3. I have seen this word and I think it means:	9.5%	Two of two students gave the incorrect definition. One student had completed their assignment.
4. I know this word, it means:	38.1%	Students remembered and wrote definition correctly
5. I can use this word in a sentence.	-----	Students who selected response "4" were to proceed to "5" after righting definition and write a sentence using the vocabulary word. Five of the eight students from "4" wrote correct sentences. One person did not write a sentence and one wrote an incorrect sentence.

Note. Forty seven percent of students did not complete their assignments. Since this was the first time completing this warm up sheet, students may have shown a lack of confidence that should not be measured.

In the comparison phase, students were still required to complete a reading assignment that included new term definitions. There was a high percentage of students who did not complete their assignments and therefore selected options 1, 2 and 3. During the treatment phase, students were defining new teams in their vocabulary groups and were required to define, at a minimum, at least one term. This may account for the percentage decrease of 23.8% to 10% of students who did not complete their assignments. There was a trend for students to lack confidence from the start of the Frayer Method to the end of the treatment phase. With the first warm up of the treatment phase, 14.3% of students reported not being sure, see Table 5. The second warm up, (see Table 6) yielded 30% of students who were unsure of their answer and finally the third warm up, which would have been administered prior to the last post-test, for the entire project, yielded a 36.8% lack of student confidence, see Table 7.

Table 6

Analysis of One of Three V.K.S. Self-Assessment Administered During Treatment Phase

New Term Checkpoint Warm Up Responses New Term: *Mitosis*
Number of Student Responses: *21* Conducted During Treatment Phase

Response Selection	Percentage of Students Selected	Response Rationale
1. I don't remember having seen this word.	4.8%	One out one student never does their Frayer Graphic Organizer, does not work and does not study
2. I have seen this word, before, but I don't know what it means.	28.6%	Three of six did not do their Frayer Graphic Organizer with their group. Three of six did not remember and did not want to get the answer wrong.
3. I have seen this word and I think it means:	28.6%	One of the six did not finish their graphic organizer, but still got the definition correct. Five of six were able to get the definitions right. Students were able to draw a picture but could not describe likes and non-likes. Students stated they needed to study more.
4. I know this word, it means:	38.1%	Students remembered and wrote definition correctly
5. I can use this word in a sentence.	-----	Only four of the eight students from "4" wrote correct sentences. Students reported they were not sure with the definition enough to write a sentence but reported they could draw a picture.

Note. Twenty three percent of students did not complete their assignment and 14.3% of students did not show confidence in answer.

This lack of confidence could be attributed to some group members not finishing their assigned word(s). Also, students were only required to complete at least one organizer for each set of terms. Students may have been complacent and only payed attention to their own graphic organizer and not the others, even though there was group discussion and a copy made available to each organizer. These contributing factors could also lead to the poor scores for the pre and post-test data.

Table 7

Analysis of Two of Three V.K.S. Self-assessment Administered During Treatment Phase

New Term Checkpoint Warm Up Responses Number of Student Responses: *20*		New Term: *Aerobic* Conducted During Treatment Phase
Response Selection	Percentage of Students Selected	Response Rationale
1. I don't remember having seen this word.	0.0%	
2. I have seen this word, before, but I don't know what it means.	10.0%	One of two students did not finish graphic organizer and does not pay attention in class. This response is considered a cop-out. One of two students always select this response even though they know the word and can use it in a sentence. Student is very unsure of their knowledge.
3. I have seen this word and I think it means:	30.0%	One of six students typically do not finish graphic organizer but know the terms and can use it in a sentence. Five of six students did do their assignments and did know the correct answer. When asked why they did not select "4", students stated they were not sure of themselves.
4. I know this word, it means:	60.0%	12 of 12 students were properly able to define word.
5. I can use this word in a sentence.	-----	11 of 12 students attempted sentence and while they were close to the correct usage contextually, they did not write a proper sentence. Upon closer view, students had used the word exactly the way I had taught it and I needed to go back and reteach term.

Note. Ten percent of students did not complete their graphic organizer. 30% of students did not show confidence in answering warm up or interview.

Table 8

Analysis of Three of Three V.K.S. Self-assessment Administered During Treatment Phase

New Term Checkpoint Warm Up Responses **Number of Student Responses: *19***		**New Term: *Allele*** **Completed during the treatment phase**
Response Selection	Percentage of Students Selected	Response Rationale
1. I don't remember having seen this word.	5.3%	One of one student does not like to participate in this warm up activity. Student did not complete graphic organizer. Student did not pay attention during class time and did not take notes.
2. I have seen this word, before, but I don't know what it means.	26.3%	One of the five did not do their graphic organizer. Four of five were not confident enough to select anything other than "2". Three of five could draw picture.
3. I have seen this word and I think it means:	15.8%	Students gave proper definitions. Students are unsure of their knowledge.
4. I know this word, it means:	52.6%	Students remembered and wrote definition correctly.
5. I can use this word in a sentence.	-----	One of ten drew a picture instead of writing a sentence. Nine of ten used the new term correctly in a sentence.

Note. Ten percent of students did not do their graphic organizer and 36.8% of students did not show confidence in answering warm up or interview.

For my first of two secondary focus questions, see Table 9 below, I wanted to know what the students' perception about the usefulness of the Frayer Model was for helping them understand vocabulary. My data sources were the post-intervention student interviews, the comparison of the post to pre-student survey questions and the muddiest point opportunities on the weekly planner.

Table 9
Secondary Focus Question One from Triangular Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
Secondary Question: What are the students' perception about the usefulness of the Frayer Model for helping them understand vocabulary?	Post-Intervention Interview with selected students	Comparison of Pre- and Post-Intervention Surveys	Muddiest point on the weekly planner

Data source three, the muddiest point, produced zero participation throughout the entire action research project and therefore produced zero useful information. The tool was discussed and demonstrated several times, but students still did not use the tool. I am not sure if students felt confident and they did not need to ask for help or simply did not understand the significance of having another opportunity to ask questions. There is no identifiable data that can be drawn from this tool.

The data source two for this focus question were the comparison results between the pre and post-intervention surveys, analysis results to each question can be seen in Appendix B. I was trying to make a correlation between students' desire to read and the specific question being asked. From the surveys, I also compiled more specific data in Figures 1-3 to reflect the change in desire to read, the preference between methods in comparison versus testing phase and what students overall feelings were on the Frayer Method. My focus question centered around student's perception of the Frayer Method

compared to the method used during the comparison phase. Looking closely at the pre and post-intervention surveys, the percentage of students who thought the method made a difference in the way they learned vocabulary was 54.7%, 31.8% thought it helped a little and 13.5% felt it didn't help them at all (Figure 3). Data source one, the student interviews, supported Figure 3's data. A majority of the 8 students who were interviewed did report liking the Frayer Method and wishing for its continuance for the remainder of the school year.

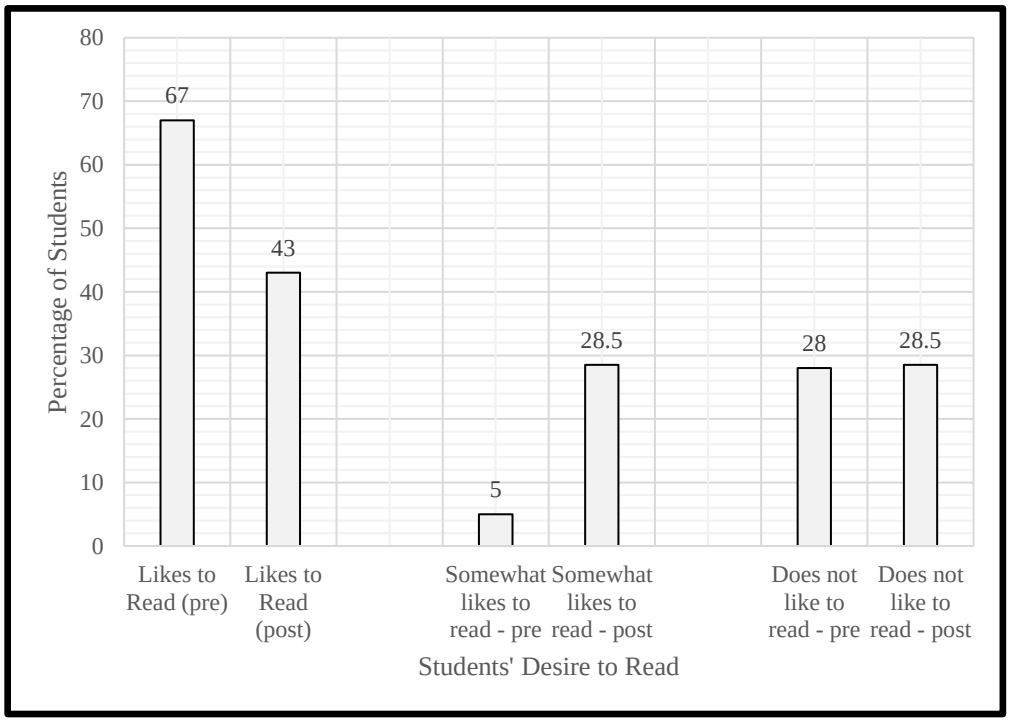


Figure 1. Change in students' desire to read: post vs. pre-intervention, (*N*=21).

What seemed to contradict the students' positive perceptions was the data comparing liking to use the method during the comparison phase to the Frayer Method. There was an 18.4% approval drop from the comparison method to the Frayer Method for students who liked to read from the start of the project to its conclusion. There was a slight increase in the percentage of students who somewhat liked to read by 8.2% and a

10.2% increase in students who did not like to read between both methods. When added together, a total decrease of 20.4% of students reported favoring the method used in the comparison phase over the Frayer Method.

There was also a 24% drop in students who reported liking to read at the beginning of the project compared to the project's end. However, there was an increase of 23.5% of students who reported to somewhat like to read from the beginning of the project to the end. The percentage of students who reported not liking to

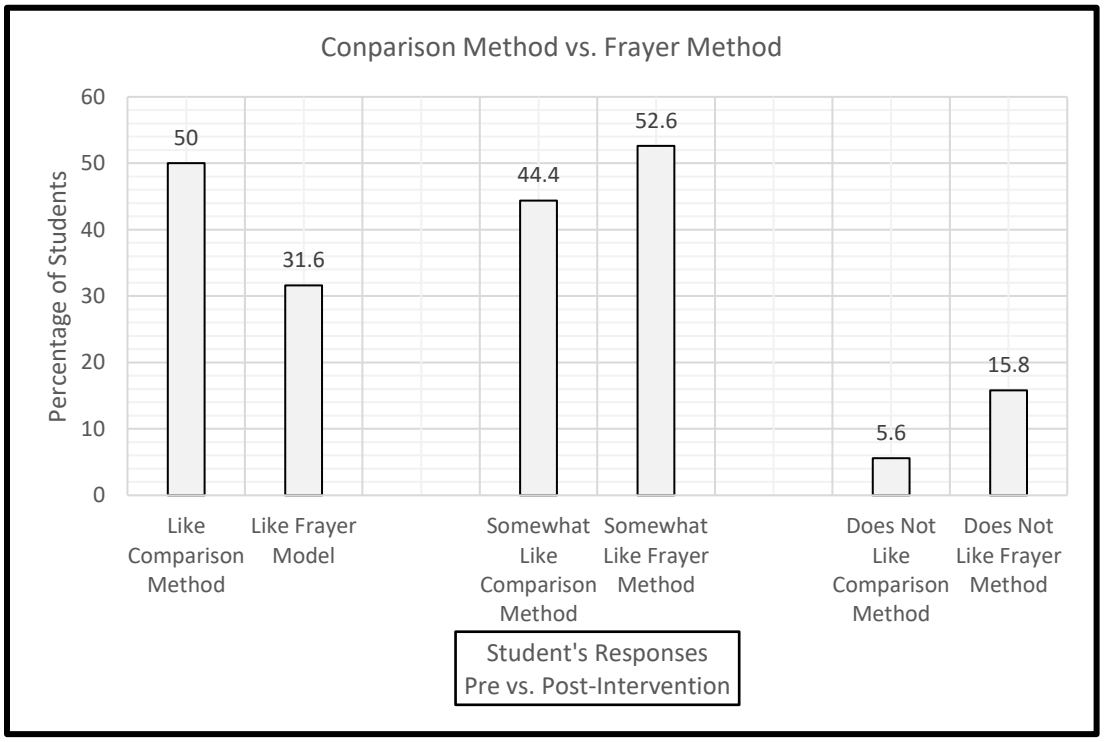


Figure 2. Student's Preferred Method of Vocabulary Acquisition, (*N*=21).

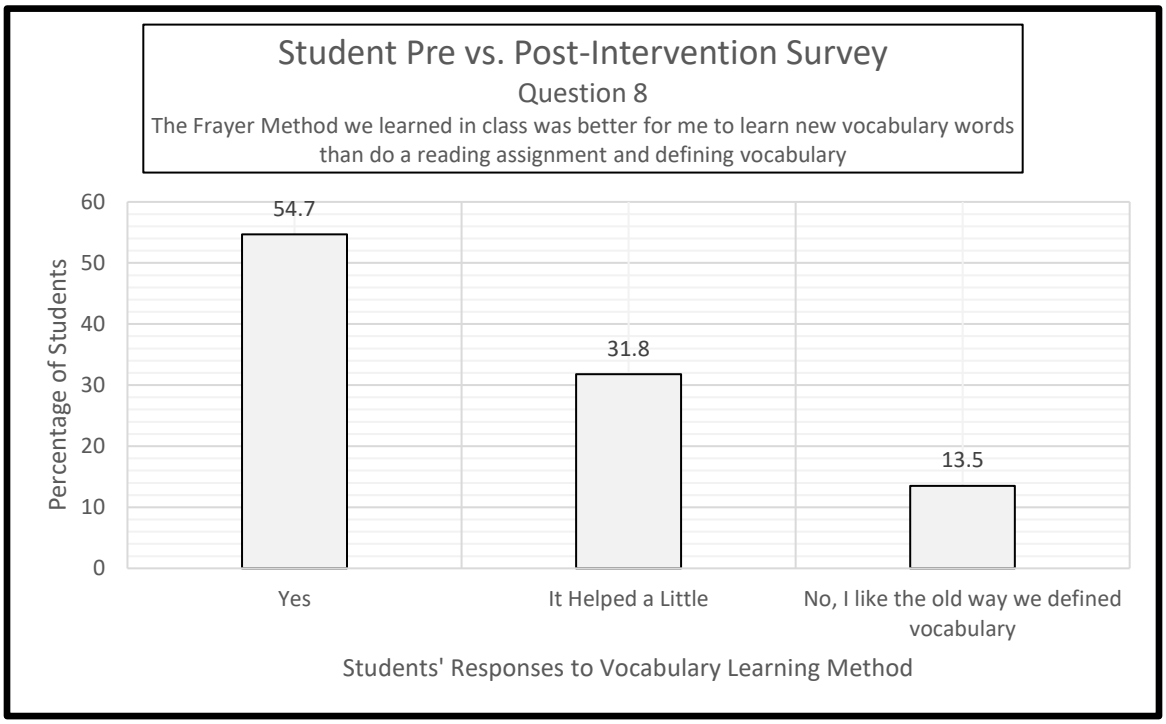


Figure 3. Students' Preference for a Vocabulary Acquisition Method, (*N*=21).

read remained relatively constant. While there are many reasons students could lose the desire to read from one quarter to the next and the decrease in students who like to read is close to the increase in students who somewhat like to read, this still may be an inconsistency with students' positive perceptions of the Frayer Method. Since the survey was anonymous, it would be impossible to determine if students who hated to read at the end of the project were students who loved to read at the beginning and vice versa.

While the students' perceptions of the Frayer Method were favorable, the insignificant normalized gains scores, drop in reading desire and the data associated with question seven did not seem to support this perception. Students did make comments on why they liked or disliked the Frayer Method.

These included the following positive comments:

> "[it] helps me learn new words"
> "they are available in my folder so that I do not have to use a dictionary or my book"
> "it works"
> "it gets more stuck in my brain"
> "it's easier"
> "it's fun"
> "it's easier to understand"
> "working on one word at a time – but we could go on to the next"

The following are unfavorable comments from students regarding the Frayer Method:

> "[it] is okay, I wish it was a little easier"
> "I don't like doing book assignments" (referring to directed readings)
> "there is nothing I like about this"
> "it's work"

The primary data source for this focus questions was the post-intervention student interviews. Nine of the 21 students in this action research project volunteered to be interviewed during my planning period. There was a high percentage (89%) of the nine students who liked using the Frayer Method, 78% who considered the method easy to use and 78% who would use it for the rest of the year if certain conditions could be met.

Table 10

Student Interview Analysis of Questions 1-5; N=9

Interview Questions	Number of Students Who Responded	Pro Statements	Con Statements
Question 1: Which method did you prefer?	Frayer 7 of 9 (78%) Old 1 of 9 (11%) Don't care which one 1 of 9 (11%)	"It's easy" "I like the pictures, they make it easy" 'It's hard for me to do all the words at once, I like doing just a few.'	"I didn't like it, I couldn't figure it out"
Question 2: Did you find the Frayer Method easy to use?	"Yes" 8 of 9 (89%) "No" 1 of 9 (11%)	"The paper was easy to read and look at to study" "I didn't have to do all of the work" "I liked it because it helped my learning" "Simple because of the sections and it was easy to remember the rules" "I liked working with people and sharing ideas" "I liked the pictures" "It was organized, and all the information was there so I didn't have to go looking for it" "It was easier to understand, and I liked the picture"	"It was hard to find likes and non-likes" "Confusing with picture, likes/non-likes and I missed the training." "I was lost the whole time" "It was too much work" "Some of the group members goofed off too much"
Question 3: If you consistently did not do your work, why?	1 out of 9	"I mean to do my work, I just forget"	
Question 4: Did you feel like this [Frayer Method] made learning easier or harder for you?	"Easier" 7 of 9 (78%) "Mixed" 1 of 9 (11%) "Harder" 1 of 9 (11%)	"Drawing out Pictures was helpful" "Simple to look at and study" "It explains better with the pictures, likes and non-likes" "No stress because of groups" "I liked being able to use my phone" "All the information is there" "It's mostly easy"	"I just didn't know how to use it" "I would rather do stuff on my own"
Question 5: Would you like to continue using the method for the rest of the school year?	"Yes-7 of 9 (78%) "Mixed-1 of 9 (11%) "No" 1 of 9 (11%)	Yes if: "if everyone would do their own work" "we can have different groups" "change groups" "we can be with less people to get rid of goofing off" "if we could just draw a picture and forget the likes and non-likes" "I don't care what we use for the rest of the year"	

These numbers appear to reinforce the students' positive perception of the Frayer Method.

My final focus question (Table 11) asked what impact using the Frayer Method had on me as a teacher, my motivation and instructional pacing. My first data source were questions six through eight of the post-intervention student interviews, see Table 12 below.

Table 11
Secondary Focus Question One from Triangular Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
Secondary Question: What impact will the Frayer Model have on my own motivation and instructional pacing?	Post-Intervention Interview with selected students	Instructional pacing guide and personal curricular map	Teacher Observation and Reflection

Table 12
Student Interview Analysis of Questions 6-8, N=9

Interview Questions	Student Comments
Question 6: How do you think I helped you learn this new technique?	"you showed us how in the beginning and answered questions we had" "the description and help with pictures was useful" "you helped describe how to use the different categories, so we were ready to use the sheets" "I thought you explained in detail" "I thought it was simple anyhow and didn't need much help"
Question 7: Do you feel like I gave you enough time to work on each work in the unit?	"Nobody finished and some of my group didn't even do their work, so I needed more help with those issues" "yes, because there was too much goof off time" "No because some organizers didn't get finished. Two students were never present, and this was hard for our group" "yes"
Question 8: What are some things you think I could have done to make all this easier to learn?	"if you gave me different group members, it would have been better" "I needed smaller groups and I would have liked to pick my own group members that I trust" "I needed you to explain the method better and give me a different group who would not let me down" "It would have been nice if you would have let us group by seating, friends or people we trust" "I need more hands-on activities like labs" "I hate the directed reading worksheets" "I don't like learning so many words at once" "Nothing"

On a whole, students liked the Frayer Method and would continue to use it with conditions. Most students did not like their groups because some members let the team down and the leaders were stressed. This dislike of group structure and members who did not hold up their end of the bargain may have contributed to the pre- verses post-test scores being insignificant. Most students wished they could pick their own groups, but this can also cause problems with student downtime and unfinished work.

Most students felt that I had explained the method well and was available to answer questions they had. Half of the students interviewed felt I gave enough time and the other half did not. This reflects typical group work for young students who still do not know how to work efficiently together yet. I feel several students may have wished I become more involved with the groups and hold students accountable. The graphic organizer sheets were not graded, so some students may have seen this as a reason to not finish their work.

My second data source was my curriculum map and pacing guide. This is a difficult item to dissect because of many variables that could affect pacing guides. This year's students required more time and aid for our annual science fair. This class of students is also incredibly social and not as much content gets covered as a class with less sociability. When I compared my previous years' lesson plans, my pacing was not much farther off with the Frayer Method use.

My final data source were my observations and reflections. I feel there were many things I could have done to make this project more productive and give better quantitative data. The group design was not a good plan even though in theory, it should

have been effective. Perhaps an older group of students would be able to work in groups where all members worked equally. After conducting this research plan, I feel my students could have completed a graphic organizer for each term assigned. This would give students reliability on themselves and if they did not complete the assignments, the only person who was affected would have been themselves.

My data sources could have been more effective through better precision and experience. The way I wrote my focus questions, and then my data sources were too broad to effectively collect data to support my claims.

Finally, the graphic organizer I developed would have been successful for mathematics because the form I used was too difficult for the material I was teaching to 7th grade students. I would keep the book definition and the drawing but would add a section for students to predict what they thought the term's meaning was prior to discovering the true meaning. I also feel it would have been more productive to remove the likes and non-likes and add a section where students were required to write a sentence using the term correctly. The quantitative data from the pre and post test scores were so unreliable and all over the place, had I used a more precise form, I may have seen better data scores had I designed the make-up of the graphic organizer more fully.

INTERPRETATION AND CONCLUSION

Despite teacher efforts, vocabulary is the most sizeable, difficult and unmanageable component of learning (Nemati, 2009). I have found this to be the case and even more so in this action research project. It was difficult for me to utilize just one method of vocabulary acquisition for per quarter for two quarters of student learning

during this project. I have tried several methods throughout my teaching career and have concluded that no one method is adequate and fair to students' science education. Misulis (2011) and Davis (2015) state to solidify new knowledge, vocabulary should be utilized frequently and in multiple applications, as understanding is achieved through regular opportunities to reinforce meaning. To limit the number of variables as possible, it was necessary to employee the two methods separately. I would not normally teach in this manner, but the value this project has gained was worth the methodology used.

Using the Frayer Method during my implementation phase of my project was not entirely successful in achieving positive scores as to its increase ability to improve student understanding of term definition and contextual use, however, the use of the method and seeing what worked and what did not, had significant implications to my teaching. I think in order to show true benefits of this method, a much longer time with an increased number of opportunities may have had a different outcome.

Some of the important aspects of this project that I discovered during the project were the importance of student engagement in the method you select; allowing students to assess their own knowledge of what they have learned; having students demonstrate their vocabulary knowledge at the end of a unit; the importance of creating authentic assessment tools to test students' ability to define vocabulary but also use it in scientific context.

Pre and post-test normalized gains scores did not produce reliable data to support the gains and losses comparing my control to my test were purposeful and not random. There are many factors that could have contributed to the unreliable scores. There are

many students in my class who don't study for quizzes and this seems to be a standard now. Students will study with class time, but very few will spend time outside of class. I have several special education kids who have significant difficulty with reading and several students with behavioral problems wo don't care about grades. I think the group format for conducting the Frayer Method made it difficult for students to do well while they were completing the graph and while studying independently. I was afraid of giving my students too much work with this graphic organizer but may have inadvertently caused a lackadaisical attitude.

Even though test scores were unreliable, student interviews did indicate my seventh-grade students enjoyed several aspects of using the Frayer Method. Those interviewed overwhelmingly stated they liked the picture drawing portion of the graphic organizer. When asked why they related most with this portion they stated it helped to "stick" the vocabulary term in their brain better. "Finding vocabulary techniques that work with and enhance the encoding and memory processes of the brain are going to be more useful than defining a list of terms" (McDermott & Roediger, 2017). By allowing students this type of activity as part of learning vocabulary, I feel I allowed them to reinforce encoding and memory process.

The new term checkpoint warm-up sheets (Appendix F) I used during this action research project was an amazing tool to survey students' knowledge, difficulties and confidence while learning vocabulary. Asking students to have an active role in assessing their own learning was incredibly helpful to me as a teacher. This tool kept me from making assumptions about student knowledge and it showed me insights into my

practice which would be less effective. In the past, if a student did poorly on a quiz I may have made assumptions such as but not limited to, they didn't study, they have test anxiety, they don't care and more. With this tool, I could separate out students who didn't do their work and motivate them to move forward from students who had. More importantly it helped identify students who did their work and knew their material but were too afraid to risk a wrong answer. These students could be encouraged to trust their knowledge and hard work. On won of the new term checkpoint sheets I had asked students to assess their knowledge of the word "aerobic". There was a larger number of students who marked higher scores on this word and wrote sentences to show their understanding. Students wrote sentences that reflected what I had taught. Students wrote sentences such as, "Humans are aerobic" and "I am using aerobic as I soar through the half pipe". Students were defining as using the word aerobic the way I had taught them; aerobic means "with oxygen". What I witnessed in my teaching was me making assumptions of what my students were able to interpret to understand. For most of my kids, this was the first time they were introduced to this word, so I know needed to be more specific and give them the true meaning. When I say aerobic means "with oxygen" I know I mean a process that uses oxygen. But I cannot make such a leap with such young learners and I need to be more purposeful in my teaching. It has been hypothesized that the poor performance on standardized science tests may be due to a failure on the part of educators to instruct students properly on what is required to understand science reading (Cromley, Luciw-Dubas & Snyder-Hogan, 2010).

Prior to this action research project, I never considered having students perform vocabulary work at the end of a unit when they have had repeated exposure to new terms and in different ways. I have always had students define their words at the beginning of or throughout a unit. I know I have routinely reverted to the way I was taught vocabulary as a student myself. This action research project allowed to me step outside of my comfort zone and try some new techniques. I am not sure students realized they were doing vocabulary practice at the end of the unit, they were excited about not having to do reading assignments that included vocabulary definition. Again, I think a combination of techniques is going to provide the best instruction to students. If the goal is to create strong vocabulary knowledge, giving students the ability to do well and feel good about their knowledge will increase their desire to learn.

The best takeaway from this project for me has been the way I will format my quizzes and tests in the future. Because my action research plan focused on not only learning new term definitions but the ability to use the term in context, I had to devise a method to measure both. In the past, I would simply give students a matching assessment where students would match the term to its definition. This did not take into consideration the students might be cramming before and not necessarily comprehend the vocabulary. Formatting an assessment for students to do prove their knowledge in both was an interesting experience. When I created assessments, I would first use the traditional matching method and then require students to read a passage and put the terms in the correct space to complete the reading. I will have to refine my skills to make my assessments better as to measure student success more precisely.

The students reported they enjoyed using most of the Frayer graphic organizer. Students did state they had a difficult time finding synonyms and antonyms for vocabulary terms assigned. I found this to be difficult as well and would not include this section in future use. In its original use, the Frayer Method, was used in mathematics. (Frayer et al., 1969) In this subject area, there are definite applications of the likes and non-likes. For instance, a circle is not a square. If I were looking for non-likes to a square, I could like ovals, ellipticals and circles. In science, some of the terms students were using were not so cut and dried. In genetics, a genotype is not necessarily an opposite of a phenotype because they are both ways to describe the genetic makeup of an individual. I think there are more useful measures that can be added to a Frayer graphic organizer to encourage student learning.

I found it interesting in a scientific student of vocabulary acquisition the qualitative data were more useful than the quantitative data I collected. I think the qualitative data measurement tools were adequate for this project, but perhaps, with more skill, they could have been planned better to refine the questions asked and allow for a more authentic measuring tool. I feel my questions may have been leading and not detailed enough. If I think student test scores were a consequence of group work, I should have asked questions trying to measure whether this was true or false.

VALUE

This action research project was an excellent exercise for me to personally conduct a project to get an appreciation for its complexity. I found immense value in its outcomes and its possibilities.

I run my school's science fair project and I help many kids set up and work through their projects. Figuring the best method to calculate and present data was enlightening. There are many students who conduct social science type projects and learning how to work with qualitative data in this project was an amazing opportunity which I will be able to pass on. I have always relied on quantitative data and felt it was more valuable, but in this project, the qualitative data revealed more useful information.

As for my data collection methods, I was not satisfied with their quality or assessment potency. I felt my quantitative tools were adequate and were able to provide some information. The questionnaires and surveys however were akin to an amateur and a lack of confidence, I am sure this confidence must come with practice. I felt my questions were too superficial and were leading. I feel it would have been better to come up with questions where students may not have felt as though they had to be nice. If I were to do an experiment such as this again, I would do more research on surveys and questionnaires to formulate a more effective tool.

I wasn't entirely happy with the way I arranged the graphic organizer for this project, however, there were many aspects of the organizer I found useful and several changes I would make in the future. With the younger students, I would eliminate the section on likes and non-likes. This was too difficult and ambiguous for the seventh graders. For older students, this may be appropriate depending upon the science topic. If I eliminated this section, I would add a pre-graphic organizer section where students could guess what they think the new term means. My hope is they would be able to call on some prior knowledge to accomplish this. There might be a prefix, root word or suffix

they recognize that would start to give them a clue. Even if students were not able to decipher the entire word, a guess would set them up for hopefully some excitement to want to know more. I would add a section where students are required to use their term in a sentence that is not the definition. I noticed when I asked students to write a sentence, they defaulted to its definition. I would like to see some creativity and some higher order thinking.

I liked the idea of having students completing the graphic organizer at the end of a unit. Instead of trying to complete this organizer at one time, I would have students work on the paper in increments, so it is not so intense and time consuming. I am hoping this would allow students the opportunity to have repeated exposure to their new terms. According to Sprenger (2013) encoding and storing are vital to a long-term memory and will create vocabulary schemata. Sprenger also believes the more experiences surrounding vocabulary work will also create more webbing in the brain through a representation of concepts, ideas and actions that are related (Sprenger, 2013).

I did not like the group structure for this project, it may have been a major contributing factor for the reason my pre- and post-test scores were unreliable. There was too much confusion during work time, too many students did not complete their work, and this left too many students waiting for information to study. Small group work with older students may work, but it was not effective with my group of seventh graders.

I dislike administering too many quizzes and tests in my classes, but through this project I found value in having small vocabulary quizzes to assess students' knowledge. I also found it gave students a motivator to be more invested and a bit more responsible

to learning. I liked the format I came up with during this project where I assessed definition and contextual knowledge. Since the completion of this project, I have given several quizzes to students where I have incorporated the definitions with context or with pictures. I haven't gathered enough data to support its effectiveness at this point, but I feel better about the quality of my assessments.

For future vocabulary lessons I will be incorporating several models because I believe one model is not enough to successfully teach new terms, especially where contextual learning is concerned. Even though several studies suggested not using the "look up definitions" method, there is much value in this method to introduce students to new terms. By itself, it is not enough. I will continue to use and improve upon the word wall I have in my room. The kids seem to like participating in the preparation of the wall and they like to have the image and word on the wall to jog their memory. I will continue to use the Frayer Method, with the changes I proposed. I think this method will take some time to perfect its implementation and use, but I believe the effort will be worth the input of time.

Seventh grade students come to class at the beginning of the year wanting to learn and be engaged, it is my responsibility to create an environment and activities that enhance that desire. This action research project gave me a renewed desire to keep those seventh graders interested in science.

REFERENCES CITED

Anderson, K. (2016). Learning Vocabulary in Science. Retrieved February 12, 2017, from Wisconsin Department of Public Instruction, https://dpi.wi.gov/science/disciplinary-literacy/vocabulary

Aune, K. P. (2012). *Improving Vocabulary Instruction to Increase Student Comprehension and Science Literacy* (Capstone thesis)

Bell, T., Urhahne, D., Schanze, S., & Ploetzner, R. (2010). Collaborative inquiry learning: Models, tools, and challenges. *International Journal of Science Education*, *32*(3), 349–377. doi:10.1080/09500690802582241

Breen, L. C. "Vocabulary Development By Teaching Prefixes, Suffixes And Root Derivatives". *The Reading Teacher* 14.2 (1960): 93-97. Print.

Brown, D. (2008, December 12). Using a modified version of the Vocabulary Knowledge Scale to aid vocabulary development. Retrieved October 25, 2017, from https://www.jalt-publications.org/tlt/departments/myshare/articles/628-using-modified-version-vocabulary-knowledge-scale-aid-vocabular

Campbell, L. M. (2009). *Mindful learning: 101 proven strategies for student and teacher success* (Second ed.). Thousand Oaks, CA: Corwin Press.

Carrier, Sarah J. "Effective Strategies For Teaching Science Vocabulary". *Learnnc.org*. N.p., 2011. Web. 11 Mar. 2017.

Charlton, B., R. L. Williams, and T. F. McLaughlin. "Educational Games: A Technique To Accelerate The Acquisition Of Reading Skills Of Children With Learning Disabilities". *International Journal of Special Education* 20 (2011): 66-72. Print.

Cromley, J. G., Snyder-Hogan, L. E., & Luciw-Dubas, U. A. (2010). Reading comprehension of scientific text: A domain-specific test of the direct and inferential mediation model of reading comprehension. *Journal of Educational Psychology*, *102*(3), 687–700. doi:10.1037/a0019452

Davis, Michelle. "The Effect Of Implementing Strategic Vocabulary Activities And Writing Activities With Reasoning Strategies On Student Understanding Of Eighth Grade Earth Science Concepts". *Scholarworks.montana.edu*. N.p., 2015. Web. 9 Feb. 2017.

Dougherty Stahl, K.A., & Bravo, M.A. (2010, April). Contemporary Classroom Vocabulary Assessment for Content Areas. *The Reading Teacher, 63* (7), 566–578. doi: 10.1598/RT.63.7.4

Fisher, D., Grant, M., & Frey, N. (2009). Science Literacy Is > Strategies. *The Clearing House*, *82*(4), 183–186.

Frayer, D. A., Fredrick, W.C. & Kalusmeier, H.J. (1969, April). Working Paper No. 16: A Schema for Testing the Level of Content Mastery [Scholarly project]. In *Wisconsin Research and Development Center for Cognitive Learning.* October 10, 2017, http://dx.doi.org/10.4135/9781452275413

Gallagher, Melissa A. and Blythe E. Anderson. "Get All "Jazzed Up" For Vocabulary Instruction: Strategies That Engage". *The Reading Teacher* 70.3 (2016): 273-282. Web.

Jackson, J. K. (2013). Interactive, conceptual word walls: Transforming content vocabulary instruction one word at a time. *International Research in Education*, *2*(1), 22. doi:10.5296/ire.v2i1.4232

Kamil, M. L., Mosenthal, P., Pearson, P. D., & Barr, R. (2009). *Chapter 18, Vocabulary Processes, Handbook of Reading Research, Volume 3*. New York and London: Routledge.

Marshall, J. C. (2014). In Step With The New Science Standards. *Educational Leadership*, *72*(4), p16–22. 7p.

Mastin, Luke. "Memory Recall/Retrieval - Memory Processes - The Human Memory". *Human-memory.net*. N.p., 2010. Web. 3 Apr. 2017.

McDermott, K. B. & Roediger, H. L. (2017). Memory (encoding, storage, retrieval). In R. Biswas-Diener & E. Diener (Eds), *Noba textbook series: Psychology*. Champaign, IL: DEF publishers. DOI:nobaproject.com

Medina, J. (2008). *Brain rules: 12 principles for surviving and thriving at work, home, and school* (Second (2014) ed.). Seattle, WA: Pear Press.

Miller, M. (2014). Helping Students Memorize: Tips from Cognitive Science. *The Teaching Professor*, *28*(9), 3.

Misulis, K. (2011). A place for content literacy. The Science Teacher, 78 (1), 47-50.

Murphy, Elizabeth. "Constructivism: From Philosophy To Practice". *ERIC*. N.p., 1997. Web. 11 Mar. 2017.

Nemati, A. "Memory Vocabulary Learning Strategies and Long-Term Retention". *International Journal of Vocational and Technical Education* 1.2 (2009): 14-24. Web. 1 Apr. 2017.

Pries, C.H., & Hughes, J. (2012). Inquiring into familiar objects: An inquiry-based approach to introduce scientific vocabulary. *Science Activities: Classroom Projects and Curriculum Ideas*, *49*(2), 64–69. doi:10.1080/00368121.2011.627574

Rupley, W. H., & Slough, S. (2010). Building prior knowledge and vocabulary in science in the intermediate grades: Creating hooks for learning. *Literacy Research and Instruction*, *49*(2), 99–112. doi:10.1080/19388070902780472

Sprenger, M. (2013). *Teaching the critical vocabulary of the common core: 55 words that make or break student understanding*. ALEXANDRIA: Association for Supervision & Curriculum Development.

States, N. L., Ngss, & Ngss Consortium of Lead States (2014). *Next generation science standards: For states, by states*. Washington, DC, United States: National Academies Press.

The essentials of science, grades 7-12: Effective curriculum, instruction, and assessment (2008). *Choice Reviews Online*, *45*(11), 45–6309–45–6309. doi:10.5860/choice.45-6309

Towell, Janet. "Fun With Vocabulary". *The Reading Teacher* 51.4 (1998): 356-358. Print.

Wells, Jenny C. and Drue E. Narkon. "Motivate Students To Engage In Word Study Using Vocabulary Games". *Intervention in School and Clinic* 47.1 (2011): 45-49. Web. 12 Mar. 2017.

What should content-area teachers know about vocabulary instruction? (2018, April 01). Retrieved April 29, 2018, from https://iris.peabody.vanderbilt.edu/module/sec-rdng/cresource/q2/p07/

White, H. (2013). Examining scientific vocabulary: Mapping controlled vocabularies with free text Keywords. *Cataloging & Classification Quarterly*, *51*(6), 655–674. doi:10.1080/01639374.2013.777004

APPENDICES

APPENDIX A

MSU INSTITUTIONAL REVIEW BOARD – EXEMPTION

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

960 Technology Blvd. Room 127
c/o Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4303
E-mail: cherylj@montana.edu

Chair: Mark Quinn
406-994-4707
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-4706
cherylj@montana.edu

MEMORANDUM

TO: Sue Tracy and Eric Brunsell

FROM: Mark Quinn Mark Quinn cxj'
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: October 30, 2017

RE: *"Authentic Techniques to Teach Lasting Vocabulary Knowledge in the Middle School Science Class"* [ST103017-EX]

The above research, described in your submission of October 30, 2017, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

_____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

PRE- AND POST-TREATMENT STUDENT SURVEY

NOTE: This survey is completely **VOLUNTARY**, and you are **NOT** required to participate if you so wish. If you choose not to volunteer, your grade will **NOT** be affected in any way.

Please do not place your name on this survey form, thank you!

Vocabulary Survey

Please answer each question truthfully and honestly to the best of your ability by circling the response that best answers each statement.

1. I am a:	
a. Male	b. Female

2. I like to read.	
a. True	b. False

3. I like learning new words.		
a. Always	b. Sometimes	c. Never

4. It is easy for me to learn new words.		
a. Always	b. Sometimes, depends on words and/or the subject	c. No, it is hard.

5. Learning new words makes it easy to read new material.		
a. Always	b. Sometimes, depends on words and/or the subject.	c. Not at all

6. Learning new words helps me do better in my class.		
a. Always	b. Sometimes, depends on words and/or the subject	c. Not at all

7. I like the way we are learning to define new words right now in science class.		
a. Yes	b. It's is okay.	c. Not at all

Please describe what it is you like about learning vocabulary this way.

Post Intervention Survey Question

8. The new method we learned in class was better for me to learn new vocabulary words than do a reading assignment and defining vocabulary.		
a. Yes	b. It helped a little	c. No, I like the old way we defined vocabulary

APPENDIX C

VOCABULARY WORDS ASSIGNED DURING ACTION PLAN

Vocabulary Words – Control Phase (comparison)

Chapter 3-Section 1 "The Diversity of Cells"

Cell Cell Membrane Organelles Nucleus Prokaryotes Eukaryote

Chapter 3 – Section 2 "Eukaryotic Cells"

Cell Wall	Cellulose	Chitin	Nucleus
Ribosomes	Vesicle	Lysosomes	Vacuoles
Golgi Complex	Cytoskeleton	Mitochondria	Cell Membrane
Chloroplast			

Chapter 4 – Section 1 "The Cell in Action"

Diffusion	Osmosis	Endocytosis	Exocytosis
Active Transport	Passive Transport		

Vocabulary Words – Testing Phase (implementation)

Chapter 4 – Section 2 "Photosynthesis and Cellular Respiration"

Photosynthesis	Fermentation	Cellular Respiration	ATP
Glucose	Anaerobic	Aerobic	

Chapter 4 – Section 3 "Mitosis"

Cell Cycle	Chromosome	Homologous Chromosome
Mitosis	Cytokinesis	

Chapter 5 – Section 1 & 2 "Heredity"

Heredity	Dominant Trait	Recessive Trait	Probability	Genes
Allele	Phenotype	Genotype		

APPENDIX D

EXAMPLE OF PRE- AND POST-TEST

Name: _____ Chapter 3 – Section 1

Vocabulary Pre-test

Please match the correct definition with the correct vocabulary term:

a. Cell	**b. Cell Membrane**	**c. Organelle**
d. Nucleus	**e. Prokaryotes**	**f. Eukaryotes**

_____1. An organism that consists of a single cell that does not have a nucleus.

_____2. A phospholipid layer that covers a cell's surface; acts as a barrier between the inside of a cell and the cell's environment.

_____3. In biology, the smallest unit that can all life processes; covered by a membrane and have cytoplasm and DNA.

_____4. An organism made up of cells that have a nucleus enclosed by a membrane; included are animals, plants and fungi but not bacteria.

_____5. One of the small bodies in a cell's cytoplasm that are specialized to perform a specific function.

_____6. In a eukaryotic cell, this membrane bound organelle that contains the cell's DMA and that has a role in processes such as growth, metabolism and reproduction.

Using the vocabulary words above and write the word in the correct space in the paragraph below.

Jennifer said, "All living things are composed of one or two _____." She wanted to help Bobby learn about this structure. All cells are surrounded by a protective covering, protecting them from the outer environment. This is called the _____. Bobby asked Jennifer, "Do all cells contain a control center containing DNA called a _____?" Jennifer replied, "No some cells have one and they are called _____, but the cells do not contain that structure are called _____." "Is there a name for structures that are in the cytoplasm and have a specific function?" Bobby asked. "Yes", Jennifer said. "We call these structures _____."

APPENDIX E

STUDENT WEEKLY PLANNER WITH MUDDIEST POINT PORTION

Name:_____ **Grade:** _____/_10_

Daily Warm-Up Seat Work

Monday:
Tuesday
Wednesday
Thursday
Friday

Muddiest Point:

Please list vocabulary words or concepts you still feel do not understand or feel you cannot describe. Please describe how I can help you to better understand.

Week of Monday, _____ to Friday _____

Monday	
Tuesday	
Wednesday	
Thursday	
Friday	

Name of Article:_____ Author:

_____

Name of
Magazine:_____ Volume:_____ Issue: _____
Date of Magazine:_____ Pages of Article: _____
Summarize the article you read (who, what, why, where and when):

WHO:

WHAT:

WHY:

WHERE:

WHEN:

APPENDIX F

VOCABULARY KNOWLEDGE SCALES (VKS)

NEW TERM CHECKPOINT WARM UP SHEETS

Name:_____

New Term Checkpoint Warm Up

Use your warm up sheet to answer the questions about _____(new term)

1. I don't remember having seen this word before.
2. I have seen this word before, but I don't know what it means.
3. I have seen this word before and I think it means (you may use the synonym or definition):
4. I know this word. It means (you may use the synonym or definition):

   (If you know #4, then proceed to #5)
5. I can use this word in a sentence. Please write your sentence here:

(Created with the aid of Brown, 2008; Daugherty et al, 2010)

APPENDIX G

FOLLOW UP QUESTIONS: NEW TERM CHECKPOINT WARM UP SHEET

You are being interviewed because you selected 1, 2 or 3 as your knowledge of new terms on the most recent warm up activity.

You are **NOT** required to participate in this interview. If you choose not to participate, your grade will **NOT** be affected.

1. Why did you select _____?
2. Did you complete the definition section of your graphic organizer on time?
   If no, stop interview and encourage student to complete assignment.
   If yes, proceed to question #3.

3. Can you describe the difficulty you are having?

4. Can you draw a sketch or diagram of the term

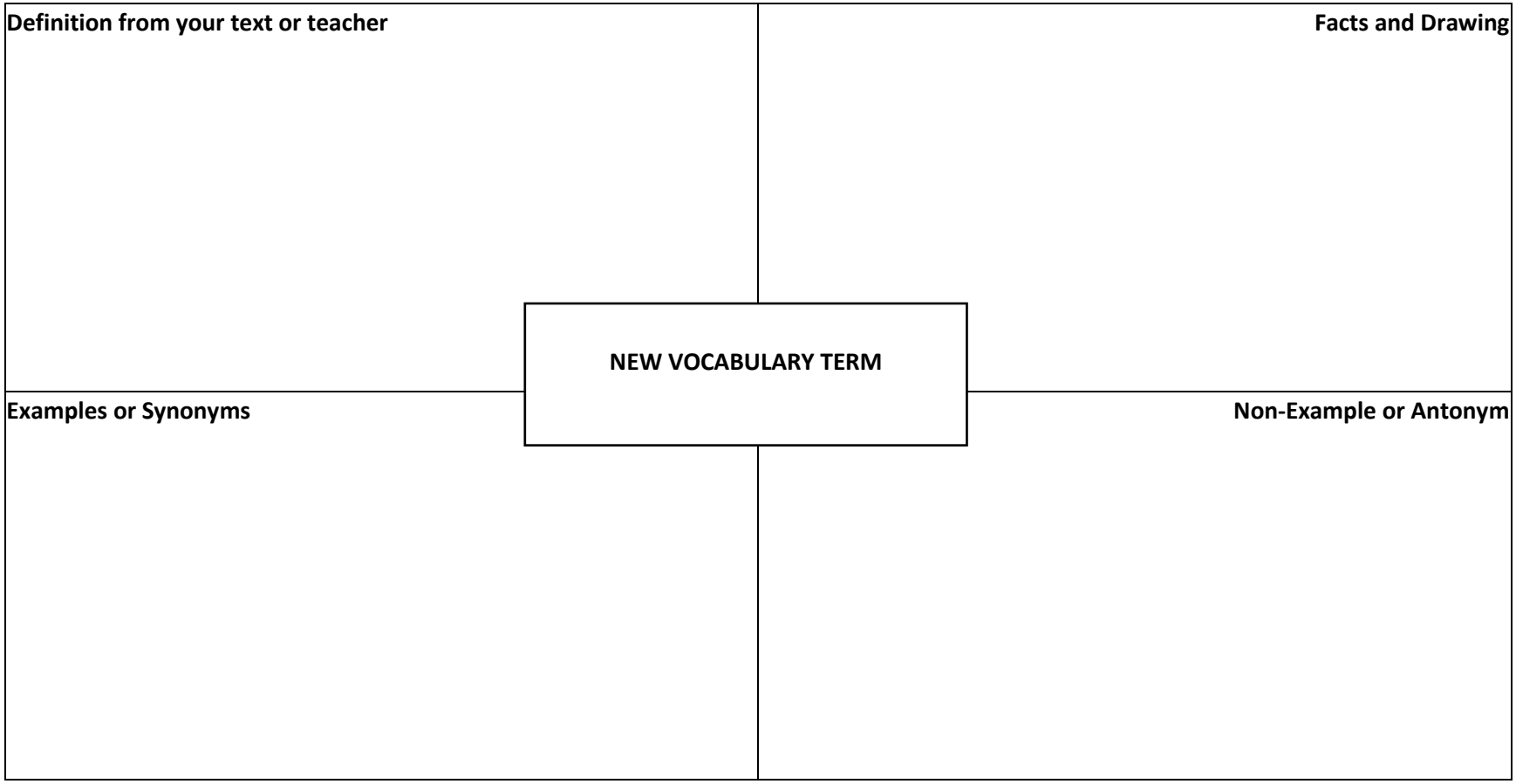
5. Are you having difficulty find like and unlike examples?

6. What can I do to make you successful?

APPENDIX H

H-FRAYER MODEL STUDENT GRAPHIC ORGANIZER SHEETS

FRAYER MODEL GRAPHIC ORGANIZER FOR STUDENT USE



APPENDIX I

FRAYER MODEL – GRADING RUBRIC

FRAYER GRAPHIC ORGANIZER RUBRIC

Scoring Categories	Below Average (0) Unacceptable	Average (1) Needs Improvement	Above Average (3) Excellent
Definition	The meaning of the word was not communicated	Meaning was partially given	Could give the correct meaning of the new term
Drawing	Drawing was not provided, or it did not show understanding of the new term	Provides a drawing that shows some understanding of the new term	Provided a drawing that showed understanding of the new term
Examples	Examples were not provided or were not similar	Provided one to two clear examples of the new term	Included at least three clear examples of the new term
Non-Examples	Non-examples were not provided or were not dissimilar	Provided a non-example that somewhat demonstrates understanding of what the new term is not	Provided one non-example that clearly demonstrated understanding of what the new term is not

(Created with the aid of the Iris Center; iris.peabody.vanderbilt.edu, 2017

APPENDIX K

POST INTERVENTION STUDENT INTERVIEW QUESTIONS

You are being interviewed to discover your opinions on using the Frayer Model in your life science class these last nine weeks.

You are **NOT** required to participate in this interview. If you choose not to participate, your grade will **NOT** be affected.

1. Which vocabulary method did you prefer to use? Why?

2. Did you find the Frayer Method easy to use?

    Why or why not?

3. If you consistently did not do your vocabulary assignments, please tell me why your struggled with this.

    What are some ways I can help you with this challenge?

4. Did you feel like this made learning new terms easier or harder for you?

    Why or why not?

5. Would you like to continue using this method for the rest of the school year?

    Why or why not?

6. How do you think I helped you learn this new technique?

7. Do you feel like I gave you enough time to work on each word in the unit?

8. What are some things you think I could have done to make all this easier to learn?

APPENDIX K

GRAPHIC RESPRENTATION OF

COMPARISON OF POST TO PRE-INTERVENTION SURVEYS

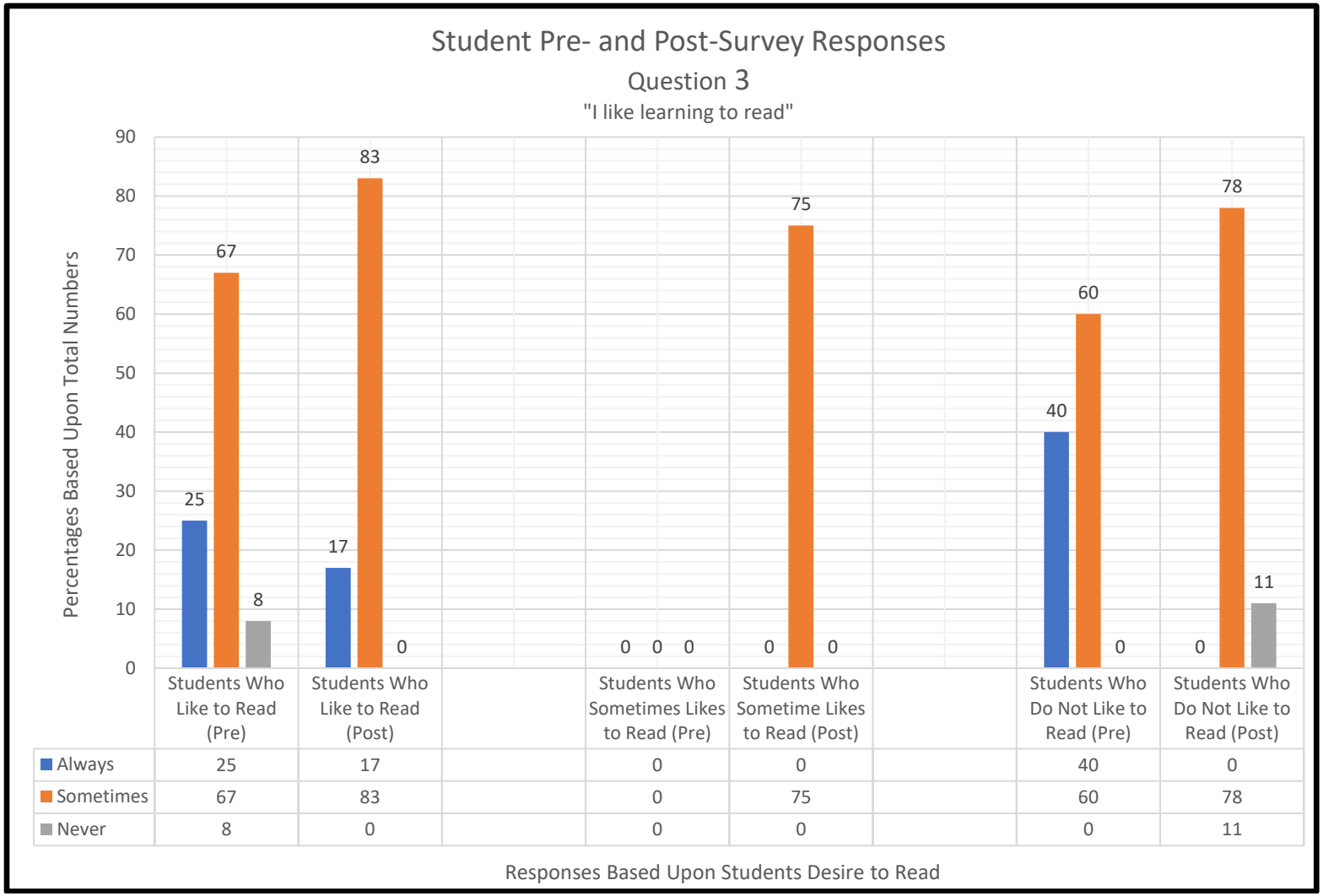


Figure 4. Analysis of the Post Intervention Survey: Pre-Data vs Post-Data-Question 3.
Note. Columns that do not equal 100% reflect students who did not answer a question, (N_{pre}=18 and N_{post}=21).

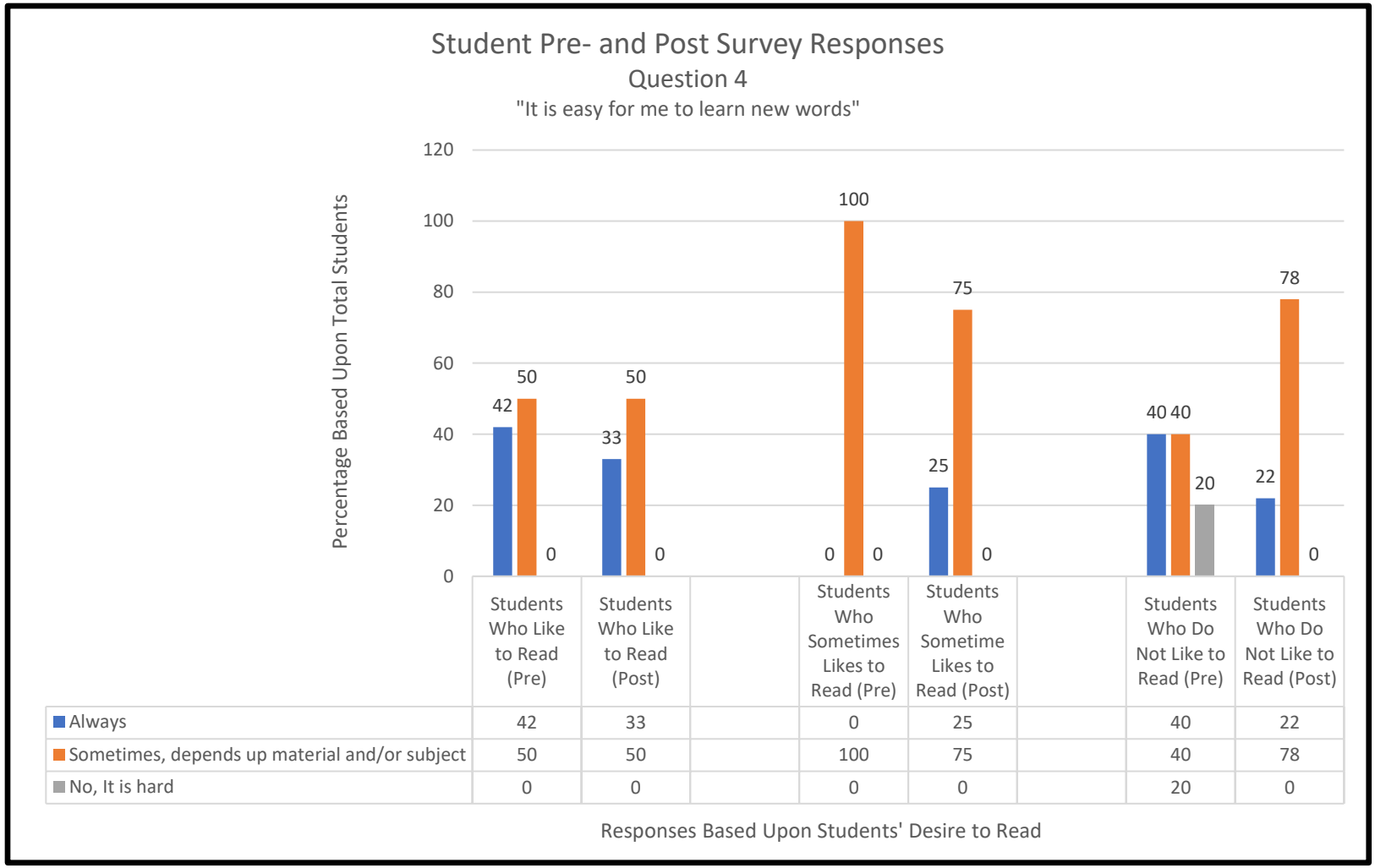


Figure 5. Analysis of the Post Intervention Survey: Pre-Data vs Post-Data-Question 4.
Note. Columns that do not equal 100% reflect students who did not answer a question, (N_{pre}=18 and N_{post}=21).

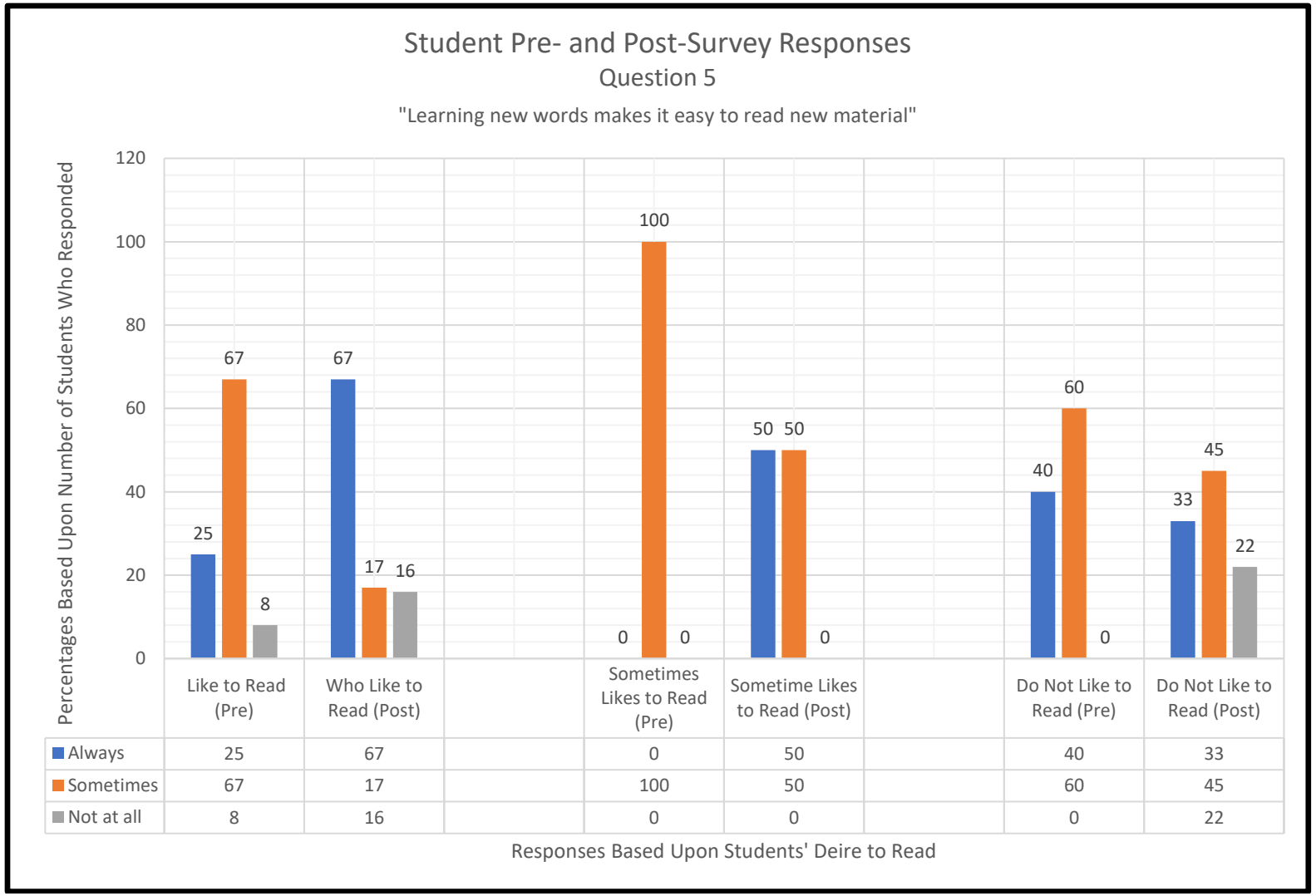


Figure 6. Analysis of the Post Intervention Survey: Pre-Data vs Post-Data-Question 5.
Note. Columns that do not equal 100% reflect students who did not answer a question, (N_{pre}=18 and N_{post}=21).

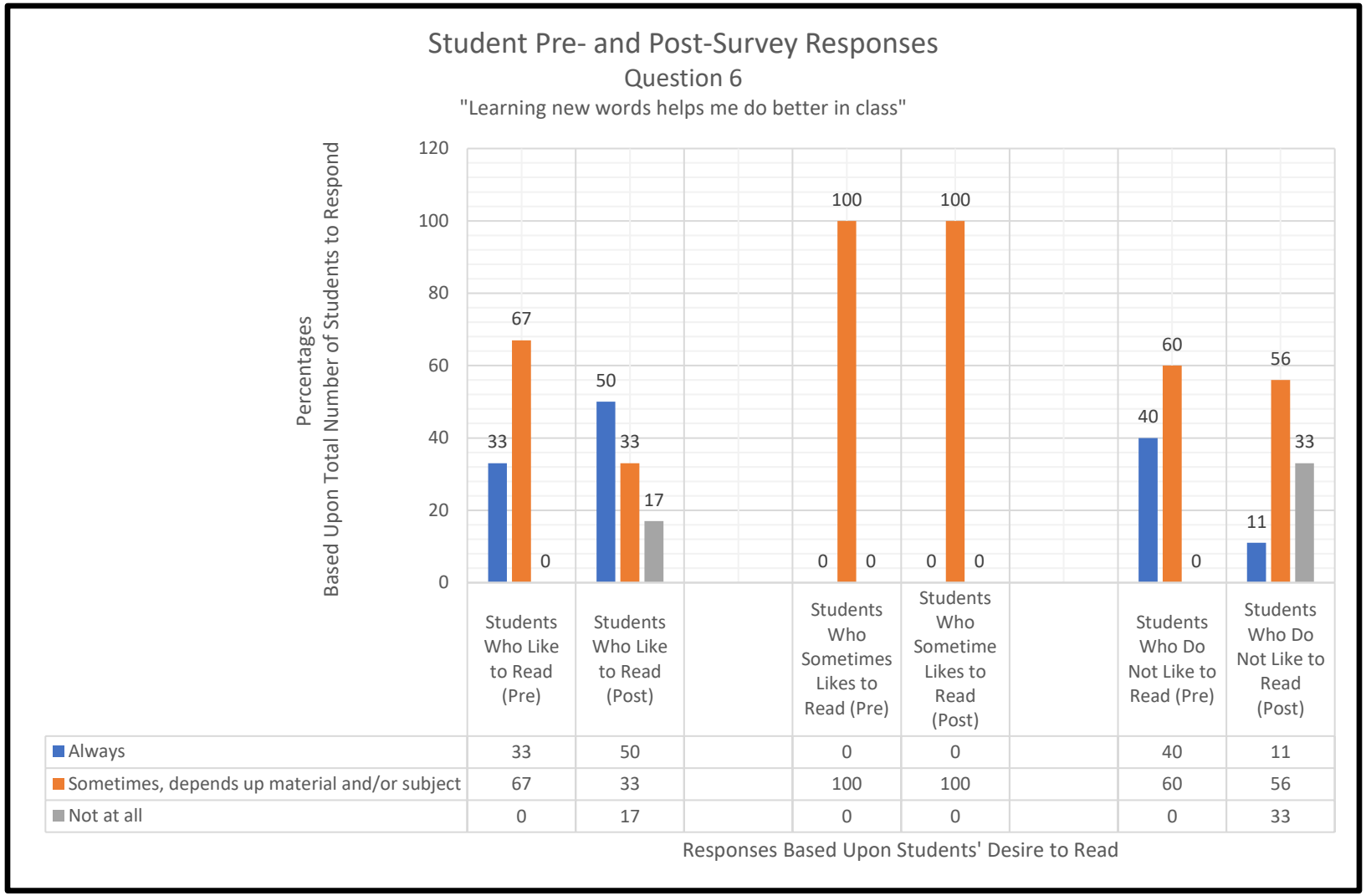


Figure 7. Analysis of the Post Intervention Survey: Pre-Data vs Post-Data-Question 6
Note. Columns that do not equal 100% reflect students who did not answer a question, (N_{pre}=18 and N_{post}=21).

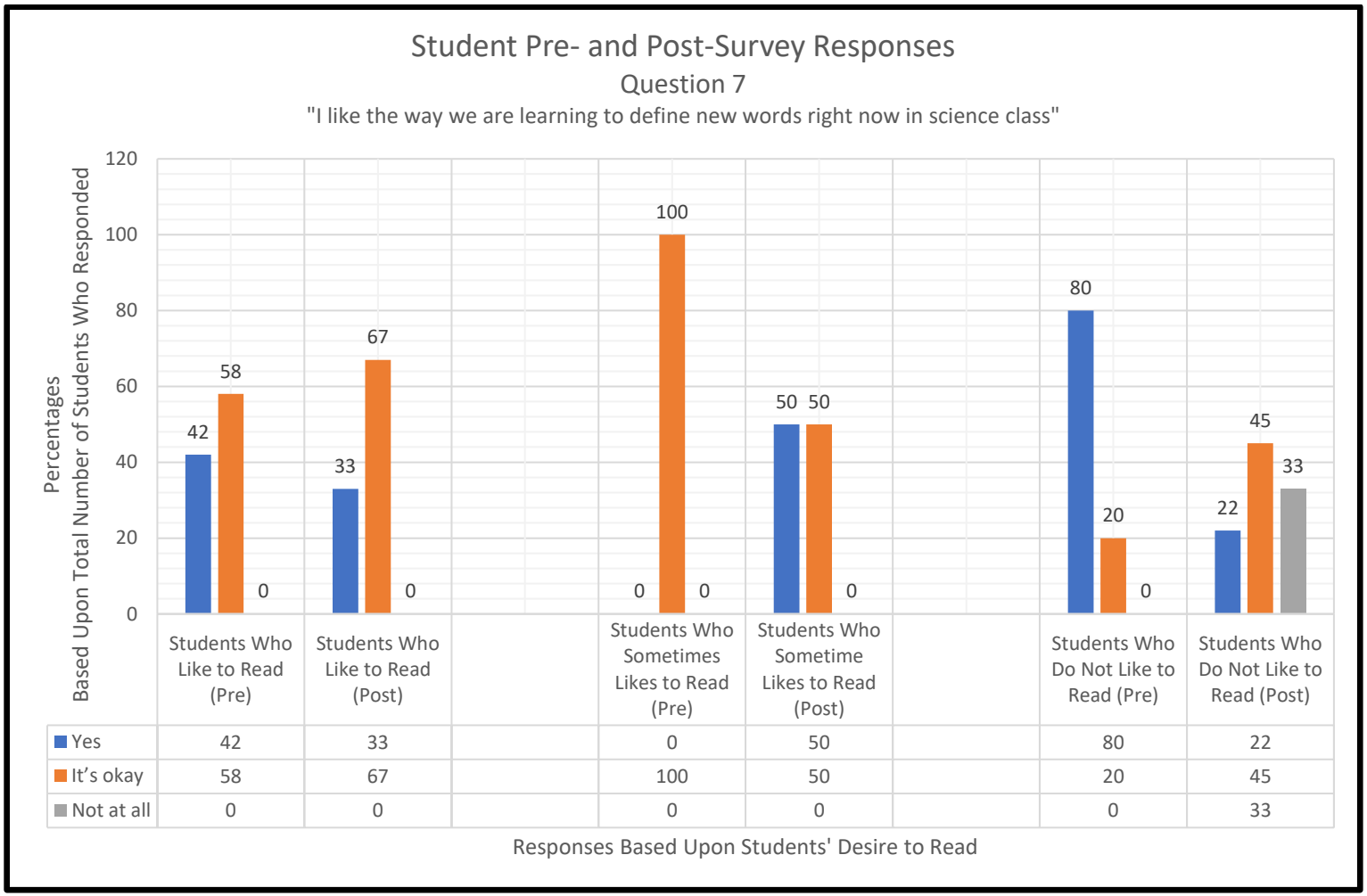


Figure 8. Analysis of the Post Intervention Survey: Pre-Data vs Post-Data-Question 7. *Note*. Columns that do not equal 100% reflect students who did not answer a question, (N_{pre}=18 and N_{post}=21)