

HOW DOES THE IMPLEMENTATION OF DIFFERENTIATED VOCABULARY
INSTRUCTION INFLUENCE THE SUCCESS OF 7th GRADE STUDENTS IN A
MIDDLE SCHOOL SCIENCE CLASSROOM?

by

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ABSTRACT

Learning academic vocabulary can be just as difficult as learning a new language. In order to help students build a strong foundation for science content and literacy in a classroom with mixed abilities and languages, this action research focused on differentiated vocabulary strategies. Students were divided into three groups based on proficiency level in the classroom and English Language Learner status. Four vocabulary strategies were implemented repeatedly during a four-week unit on Evolution. Strategies varied in level of cooperative grouping and modality. Although no increase in average test scores were measured, the strategies utilized did increase student understanding of content vocabulary. It was found that each student group responded differently to each vocabulary strategy. Overall, the majority of students expressed preference for fewer words and concepts, more study time and repetition, addition of illustrations and other visuals, and work in small cooperative groups.

INTRODUCTION AND BACKGROUND

Project Background

School and Community Demographics

Rifle Middle School (RMS) is part of the Re-2 School District and located in the heart of Rifle, Colorado on the western slope of the Rocky Mountains. RMS enrollment currently includes 754 students ranging from fifth to eighth grade. The student body consists of 49.7% Hispanic, 48.7% Caucasian and 1.6% other. Our English Language Learner (ELL) program is quite large to accommodate the high percentage of non-English speaking families in the area. Due to the depressed economy, low-incomes and Colorado's higher cost of living, the school currently has 55% of students qualifying for free and reduced lunch and is classified Title IX.

Unique to this district is the four-day school week that was implemented to save money. However, the hour of content time lost on Friday was not distributed to the other four days, but instead used to create an Intervention/Extension class for math remediation. Although having an occasional three-day weekend has been wonderful, the longer school day and 20% loss of instruction time each week has made the limited time with our students even more crucial. In addition to losing this hour of content time each week, we have adopted more rigorous curriculum standards and unit plans in preparation for the switch from the Colorado Student Assessment Program (CSAP) to the Transitional Colorado Assessment Program (TCAP). These factors, as well as others, contributed to a very challenging year.

Teaching Experience and Classroom Environment

For the past six years I taught tenth grade biology in rural Tennessee and central Florida public high schools. Upon moving this past year to Colorado, I was offered the seventh grade science position at Rifle Middle School. Although I was initially hesitant to teach middle school, I thoroughly enjoyed the students and could not have asked for a better team of teachers than my seventh grade colleagues at RMS. Though enjoyable in so many ways, this year has also been my most difficult ever. My initial apprehension to teaching middle school has given way to frustration. In this transition and feeling like a first year teacher all over again, I was able to identify several weaknesses that fueled my action research.

In adjusting my teaching style to seventh grade, I found that I was lacking in vocabulary instruction and reinforcement. I was quick to 'assume' that my students understood certain terms and concepts. My assumptions were a hindrance to them and made it exceedingly difficult for them to understand scientific concepts upon which vocabulary helps build. This especially holds true for ELL students. In addition, my classroom differentiation was quite lacking; however, this population of students needed differentiation the most in order to build a firm foundation for future growth in science content and literacy.

Action Research Question

To improve differentiation in vocabulary instruction for my seventh grade students and increase support for my ELL students, I designed my action research with this primary focus question: How does the implementation of differentiated

vocabulary instruction influence the success of 7th grade students in a middle school science classroom? More specifically, I focused on (1) the impact certain strategies have on student comprehension of scientific concepts and connections, (2) how differentiated vocabulary instruction impacted Proficient, Below Proficient and ELL student understanding of content vocabulary, and (3) what influence these strategies had on my motivation and learning as a teacher.

CONCEPTUAL FRAMEWORK

Importance of Differentiation

As educators, it is important to remember, “We cannot reach the mind we do not engage” (Tomlinson, 2005, p. 9). As classrooms become more diverse, the mixing of cultures and abilities demands more variety in teaching methods. Opportunities for content exploration should also expand to keep students actively involved in the learning process. (Brighton, Brimijoin, Callahan, Conover, Hertberg & Moon, 2003). Differentiation encourages this involvement through use of individual strengths, collaborative grouping, and student-centered strategies (Tomlinson, 2005).

In a mixed-ability classroom, providing high quality instruction for all learners is the teacher’s responsibility. Differentiation is not just a strategy, but also an entirely new way of thinking about teaching, learning and assessment (Brighton et al., 2003). Carol Ann Tomlinson (2005) identifies three different avenues of differentiation: content, process and product. Content defines ‘what’, process defines ‘how’ and product defines ‘result.’ Although content differentiation may help some students, Aida Walqui, program

director for an educational research firm based in San Francisco, recommends all content goals remain the same. If all students are to be held accountable to the same standards and measures of achievement, content differentiation is not practical (Maxwell, 2012).

For teachers new to differentiation, it is overwhelming yet energizing (Haydey, 2009). Teachers must be aware that differentiation can and will change as the year progresses. Strategies utilized for one unit may not be effective in the next, and a student's growth and development are never static (Liftig, 2010). As a result, when planning a differentiated lesson, Tomlinson (2005) considers it important to address the readiness, interest and learning profile of each student. Readiness refers to the student's level of learning and can be diagnosed with a pre-test. Interest can be discovered through building relationships with students. Learning profile refers to various modalities such as kinesthetic, visual, verbal and written as well as the student's individual preference when it comes to cooperative learning (individual vs. group) (Tomlinson, 2005). Differences in students should be seen as opportunities for learning vs. burdens to teach (Brighton et al., 2003).

Student collaboration is at the heart of differentiated learning. When actively involved in the learning process, students tend to work harder, find more value and benefit in class activities, and experience more success and accomplishment. It offers another opportunity for students to interact with peers, show ownership for learning, increase accountability, develop problem-solving skills and build independence (Tomlinson, 2005). Collaboration should include a mix of entire class, small group and individualized instruction. The most effective groups for lower students involve a

heterogeneous mix of levels while average students benefit most from homogeneous grouping. High achieving students tend to be successful in either (Brighton et al., 2003).

The goal of a teacher is to increase a student's exposure to content words, build connections with prior knowledge, and forge relationships among concepts (Sibold, 2011). To accomplish this, the first step in teaching is to identify clear goals and objectives for learning (Haydey, 2009). Purposeful planning is a must and teachers should be strong in content to identify the key ideas, concepts, and skills that students need (Brighton et al., 2003). Although differentiation of an entire curriculum of materials and activities takes time, vocabulary strategies are a great place to start (Liftig, 2010).

Value of Vocabulary Instruction

According to Ward and Williams-Rossi (2012, p. 54), "Explicit vocabulary instruction is crucial to students developing the science content knowledge necessary for increased academic achievement." A direct relationship exists between vocabulary fluency and achievement in the sciences, making quality vocabulary instruction imperative (Cox, Jackson & Tripp, 2011; Holmes, Holmes & Watts, 2012; Ward & Williams-Rossi, 2012). Academic vocabulary can be linked to content understanding, making connections among words, increased comprehension, and helping students learn new skills and strategies for independent learning (Sibold, 2011). As standards increase in rigor to meet the demands of standardized testing, understanding academic language will be of utmost importance, particularly for ELL students (Maxwell, 2012). Since a goal of science instruction is to develop "knowledge and language of science to communicate scientific explanations and ideas," (NRC, 1996, p. 144 as cited in Ward &

Williams-Rossi, 2012), “[vocabulary instruction] should be at the top of any list of interventions intended to enhance student achievement” (Marzano, 2004, p. 4 as cited in Ward & Williams-Rossi, 2012).

In the past, students have often viewed learning vocabulary as a punishment. However, vocabulary acquisition should be anticipated as an opportunity for students to better understand the world around them (Foote, Harper & Phillips, 2008). For the most effective learning to take place, both variety and differentiation of strategies demand a place in vocabulary instruction (Foote et al., 2008; Townsend, 2009). The teaching of vocabulary strategies is just as important as the vocabulary words themselves as it helps to build “word consciousness”- an increased awareness and appreciation for words (Bauer & Manyak, 2009). Academic and content vocabulary should be chosen carefully to help students understand cross-curricular texts (Holmes, et al., 2012). Essential vocabulary should be prioritized for maximum understanding and appropriate support provided (Foote et al., 2008).

ELL Struggles and Strategies

For science educators with ELL students, teaching academic science vocabulary is comparable to teaching a third language (DeLuca, 2010). In addition to the language barrier, ELL students must also overcome low academic vocabulary knowledge and often low academic success (Sibold, 2011). This presents a challenge because student performance and achievement are directly linked to a student’s background knowledge, exposure to content-specific vocabulary and scientific literacy skills (Bauer & Manyak, 2009). Although ELL programs provide some support within schools, the focus of these programs primarily falls to conversational English, not academic vocabulary or content-

specific words (Townsend, 2009). In spite of these deficiencies, the goal of the teacher remains to increase student exposure to content words, build connections with their prior knowledge, and build relationships among concepts (Sibold, 2011).

With struggling English Language Learners, it is important to make learning a successful experience. When constantly asked to do something in which one is unsuccessful, frustration, loss of self-esteem, loss of motivation and desire to learn results. To overcome this, teachers need to make the learning goals and expectations clear, provide necessary support to achieve the learning goals, and make learning relevant to continually build connections with prior knowledge and reinforce new material. Struggling students also need teachers to be a constant source of encouragement. Even small achievements in the classroom are important and should be celebrated (Tomlinson, 2005).

The wide variation in knowledge among ELL students can be overcome and the best vocabulary strategies for English speakers can also work for English learners. The more modalities involved (such as tactile objects, illustrations, concept maps, or movement), the more effective the strategy (Bauer & Manyak, 2009). When integrated with normal instruction of content, utilizing a variety of vocabulary strategies can greatly increase ELL vocabulary comprehension, almost to the point of English speaking students. These strategies should also be repeated and explained in several different contexts to maximize understanding (Bauer & Manyak, 2009; Cox et al., 2011).

Vocabulary should be revisited often with the addition of more words, images and connections (Cox et al., 2011). Several studies cite visual representations as being most effective in vocabulary instruction along with repeated exposure (Ward & Williams-

Rossi, 2012; Manyak, 2010). Through strategies that group and sort words, definitions and illustrations, connections can be made among words and concepts (Foote et al., 2008). The incorporation of concrete examples is best for authentic learning and increases vocabulary acquisition as students make connections with prior knowledge (Holmes et al., 2012). Educational researcher Robert Marzano suggests the integration of linguistic and nonlinguistic representations to help students form mental maps, draw pictures, construct graphic organizers and act out the meanings of vocabulary words or concepts (Marzano, 2004, as cited in Holmes et al., 2012).

In an after-school intervention program called Language Workshop, researchers found that middle school students improved academic vocabulary through repeated exposure to multi-modal games and activities. Some of the specific activities implemented were Matching, Academic Taboo and Pictionades (a cross between Pictionary and Charades). Through a combination of direct instruction, cooperative activities, and games infused with visuals and practice, students were able to build a stronger academic vocabulary and experience more individual and class success (Townsend, 2009). From this research into differentiation, vocabulary and ELL struggles, it was found that differentiation of vocabulary strategies is vital to student success in the sciences. Also, all students, particularly ELL, benefit from a variety of strategies, the incorporation of multiple modalities, interactive and challenging games, and peer interaction.

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METHODOLOGY

Demographics

In my descriptive study on differentiated vocabulary in a 7th grade science unit on Evolution, eighty-one students were included in my study group. Of these students, forty-three were male and thirty-eight female. Although a high percentage of the classroom student population was Hispanic (thirty-six or 44.4%), only fifteen (18.5%) were categorized as English Language Learners (ELL) based on the school's criteria. These students had been exposed to basic principles of Earth science, physical science and ecology, but has not previously been exposed to evolution.

The students were then divided into three sub-groups based in part on personal scores earned on the Geologic Time Scale Summative Unit Test (GTS) and ELL status. The following table shows the classification of students based on these two factors. Of the fifteen ELL students, two scored proficient on the GTS test and thirteen scored below proficient. Qualifications for sub-groups are displayed in Table 1.

Table 1
Student Groups

	Percent Score (%) on GTS Unit Test	Number of Students
Proficient	80% or above	46
Below Proficient	Below 80%	20
ELL (2 Proficient, 13 Below Proficient)	Receiving ELL services	15
Total		81

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A).

Treatment

This action research was implemented during a four-week unit on Evolution. In preparation for this unit, the 7th Grade Science Colorado Academic Standards (<http://www.cde.state.co.us/CoScience/StateStandards.asp>), our textbook (Holt, Rinehart, & Winston, 2005) and several middle-school friendly resources focusing on evolution were consulted (Great Source Education Group, 2005; Ochoa, 2007). From these sources, thirty words and/or concepts were identified that would give the students a strong baseline understanding of the theory of evolution. Utilizing these thirty words, resources were prepared to enhance the vocabulary strategies implemented during the unit.

Prior to the unit, students were given a Pre-Unit Survey (Appendix B) asking for favorite strategies and/or activities when learning and reviewing vocabulary. As a result of student responses, suggestions from my team, and a review of scientific literature, four strategies were chosen that would be implemented and assessed throughout this unit (Appendix C). These strategies were (1) Domino cards, (2) Pictarades, (3) No Peeking and (4) Matching cards. These strategies involved multiple modalities and varying levels of cooperative grouping. A few of these strategies were mentioned specifically in the literature review as effective strategies for ELL vocabulary acquisition (Townsend, 2009) providing further validation to their selection. Table 2 outlines a typical treatment week:

Table 2
Treatment: Weekly Schedule of Strategies

	Monday	Tuesday	Wednesday	Thursday
Vocabulary Strategy	Domino cards	Pictarades	No Peeking	Matching
Cooperative Grouping	Entire class	Small groups (3-5), entire class	Small groups (3-5)	Individual or pairs
Learning Modality	Verbal Kinesthetic	Verbal Visual Kinesthetic Written	Verbal	Verbal Visual Kinesthetic

For three weeks, students practiced these different vocabulary strategies at the beginning of class each day. For example, on Monday, students would pick a Domino card from a basket upon entering class. When class began, a selected student would move to the middle of the room and start the activity. Although strategies took almost half of each class period in the first week, as students became more proficient with vocabulary and comfortable with the strategies, the maximum amount of time spent on a strategy was fifteen minutes. The remainder of class time was spent in a traditional manner with activities such as notes and diagrams, a foldable listing current evidence for the theory of evolution, summarizing and illustrating the steps of natural selection, comparing and contrasting natural and artificial selection, watching video clips of Charles Darwin's travels to the Galapagos Islands, searching for current examples of evolution, and identifying helpful vs. harmful adaptations in a constantly changing environment.

Research Design

In preparation for the treatment, baseline data was collected from two sources: the Geologic Time Scale Summative Unit Test (GTS) and Pre-Vocabulary Assessment

(Appendix D). Student scores on the GTS not only helped categorize the students into groups but also served as a comparison for the Evolution Summative Unit Test (EVO) that followed the treatment. Test scores were recorded as a percentage.

The Pre-Vocabulary Assessment was administered after the Pre-Unit Survey. This assessment, consisting of the thirty words and/or concepts selected for the unit, was open-ended, allowing students to write as much as they knew for each word and/or concept relating to evolution. Illustrations or diagrams were also acceptable responses as long as they were related and provided clarity to a student's understanding of the word. Upon scoring the assessment, a blank or unrelated response received no credit. Half credit was given to any response that was attempted and showed some understanding of the word/concept whether through the use of key words in the explanation or a related drawing by the student. Full credit was given to any response that demonstrated a strong understanding of the word/concept evidenced by a detailed description or a sufficient description supported by a picture or diagram. Scores were recorded as a percentage.

After each vocabulary strategy was implemented for the last time during week three of the unit, students completed a three-question 'Muddiest Point' (Appendix E). Students were asked what each activity helped them learn or become more comfortable with in addition to what was still confusing or not understood. This provided qualitative data in the form of student quotes, comments and complaints. A final question served as a self-assessment of personal effort. Students were asked to circle one of several statements that described their level of engagement while involved in the activity. Each statement was assigned a number and quantitatively assessed on a Likert scale.

Following the treatment, students completed the Post-Vocabulary Assessment (Appendix D). The open-ended format and scoring method was identical to the Pre-Vocabulary Assessment. A comparison of the Pre- and Post- measured a change in student comprehension of the thirty evolution words and concepts reinforced throughout the unit.

As a final quantitative assessment, students took the Evolution Summative Unit Test that assessed student understanding and application of vocabulary content, concepts, and connections. Students prepared for this test by studying vocabulary words and any resource accumulated throughout the unit in the traditional classroom activities.

For the last qualitative assessment, students completed a Post-Unit Survey (Appendix F). This required they critique each of the four vocabulary strategies in terms of what they enjoyed the most, enjoyed the least, and lastly, how they would improve each activity. These responses were analyzed for common themes and also prompted follow-up questions in informal student interviews.

For interviews, students signed a volunteer sheet scheduling times with a small group during 'Cub Time.' Cub Time is the advisory period in which students watch daily announcements and participate in character education activities. With the list of students for each group, personal responses from the Muddiest Point and Post-Survey critique of strategies were gathered and reviewed. Follow-up questions involved asking for further explanation of written responses in addition to specific examples from students. Personal observations, thoughts, questions and ideas of the teacher were informally recorded in a journal.

Research design methods of assessment and action research focus questions are aligned in the Data Triangulation Matrix (Table 3). Again, these focus questions are based on the primary question: How does the implementation of differentiated vocabulary instruction influence the success of 7th grade students in a middle school science classroom?

Table 3
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
What kind of impact will differentiated vocabulary strategies have on student comprehension of scientific concepts and connections?	Pre- and Post-Vocabulary Assessment	Muddiest Point on Vocabulary Strategies	Geologic Time Scale (GTS) and Evolution (EVO) Summative Unit Tests
How will differentiated vocabulary instruction impact ELL and Below Proficient student understanding of content words?	Pre- and Post-Vocabulary Assessment	Muddiest Point on Vocabulary Strategies	Post-Unit Survey and Interviews
What type of influence will these strategies have on my own motivation and learning as a teacher?	Pre- and Post-Unit Survey	Student Interviews	Teacher Observation and Reflection

Reliability and validity of this action research was strengthened through the use of research-based strategies supported in the literature review, triangulation of multiple instruments, and tested surveys. Data collection was followed by multiple methods of analysis, which are reported and explained below.

DATA AND ANALYSIS

All student groups received the same treatment and completed the same methods of assessment. Data was compared within and among sub-groups to identify similarities and differences. Table 4 displays the various methods of data collection that will be analyzed in this section.

Table 4
Quantitative vs. Qualitative Instruments of Data Collection

Quantitative	Qualitative
Geologic Time Scale Summative Unit Test	Pre-Unit Survey
Pre-Vocabulary Assessment	Muddiest Point on Vocabulary Strategies
Post-Vocabulary Assessment	Post-Unit Survey
Evolution Summative Unit Test	Student Interviews
	Teacher Observation, Reflection

Pre-Treatment Surveys and Assessments

Two quantitative sources were utilized to collect baseline data on the students and to serve as a comparison for growth at the end of the treatment unit. These two sources were the Geologic Time Scale Summative Unit Test (GTS) and Pre-Vocabulary Assessment. To elicit feedback concerning struggles and strategies when learning or reviewing vocabulary, students completed a Pre-Unit Survey. This provided qualitative data in the form of suggestions and justifications for successful vocabulary strategies.

Quantitative Data

On the GTS Summative Unit Test, Proficient students averaged 90.5%, Below Proficient students averaged 72.4% and ELL students averaged 68.8%. On the Pre-Vocabulary Assessment of the thirty words and concepts identified for this unit. Proficient students averaged 41%, Below Proficient averaged 34.4% and ELL averaged 32.4%. These low pre-assessment scores were not a surprise as evolution standards are not introduced into the science curriculum prior to seventh grade. In both baseline methods of assessment, Proficient students consistently averaged the highest and ELL students averaged the lowest.

Qualitative Data

Prior to the unit on evolution, students completed a Pre-Unit Survey which focused on (1) personal struggles when learning new vocabulary words, (2) how students best like to learn new vocabulary and (3) how students best like to review vocabulary.

Students first answered the question, “When learning new vocabulary words, I struggle the most with ___ because ___.” Overall, student responses were similar, as categorized in Table 5, but the priority placed on each common response varied among Proficient, Below Proficient and ELL groups. Student comments were helpful in revealing the reasons behind these differences. Values in bold represent the highest values for each category. However, Below Proficient averages were only slightly higher than those of the ELL groups

Table 5
Personal Struggles When Learning New Vocabulary Words

	Proficient %	Below Proficient %	ELL %
Learning definitions	39.1	20	20
Spelling	13	40	33.3
New or big words	17.4	10	20
Pronunciation	6.5	20	26.7
Other	23.9	10	0

The prevalent struggle for Proficient students was learning definitions (39.1%). One student commented “some words can be very similar to others but slightly different and used in another way.” Concern with new or big words centered around a lack of exposure as revealed in comments such as “I’ve never seen them before” or “there were so many and they’re too long.” The “Other” category included many students who claimed “I don’t struggle” or merely responded “nothing.” Of all three groups, Proficient students provided the most descriptive responses and were the only ones who mentioned how similar some words can be. “Spelling” and “Pronunciation” were low on the list of struggles for Proficient students. With these mechanics less of a concern, they were able to focus more on the meaning and relationship among words. Unique to this group was a student who claimed “I struggle writing them in sentences because I struggle with sentences.” This former ELL student was removed from school several times this past year for extended trips to Mexico. Her work never indicated a struggle with writing and knowing of her concern prompted an attention to the writing process for this student.

Spelling was the biggest concern for Below Proficient students followed by pronunciation. Aside from vocabulary being full of “big words” or “long words”, one student mentioned struggling the most with “words that have letters that you can’t hear when you say the word [because] I write it without the silent letters and fail.” Others had problems with both spelling and pronunciation. One student who struggled when reading aloud commented that “I’m not a very good speller and I’ve always had problems with pronouncing things.” Learning definitions was also a struggle for Below Proficient students (equitable to pronunciation) and, as one student wrote, “they are the most important but the hardest to remember.” Unique to the Below Proficient group was a student who mentioned that she struggles with “terms [because] I don’t get enough practice with them.”

ELL students also struggled the most with spelling and pronunciation of vocabulary words (a combined 60%). “Some words are long” and “they are spelled weird” were among the most common types of responses in addition to one student’s comment, “I just don’t get it.” In regards to learning definitions, a student wrote “they don’t stick in my head” while another wrote “definitions [are] confusing sometimes.” Of all three groups, ELL student responses were the shortest and least varied.

Interestingly, when providing reasons for why vocabulary was such a struggle, the most common adjective used to describe vocabulary struggles throughout all comments was the word “hard” as expressed by 21.7% Proficient, 25% Below Proficient and 33.3% ELL students. This increase in percentages was inversely proportional to the level of

proficiency recorded in the baseline data of both the GTS Summative Unit Test and Pre-Vocabulary Assessment.

Initially, it was interesting that learning definitions was highest on the list of struggles for Proficient students yet hardly mentioned by ELL students. After reading comments, a reason became clear as I observed ELL students struggling to get past the difficulty of the mechanics of a word (spelling, pronunciation) to construct understanding. One ELL student expressed, “I don’t get the definitions because I can’t even pronounce the words” while another commented, “I can’t say them. They are spelled weird. It’s confusing and hard.” This reinforced cited literature that claimed learning science terminology is similar to learning a new language. Students must first become comfortable with a word (spelling, pronunciation) before they can understand its meaning and discover its relationship to other words (Sibold, 2011). Proficient students hardly mentioned spelling and pronunciation because they were beyond those struggles and able to focus on understanding. ELL students were consumed by difficulties with pronunciation and spelling, unable to move beyond them to understanding.

The next question addressed on the Pre-Unit Survey was, “What strategies do you like best when learning new vocabulary?” Student responses are summarized in Figure 1.

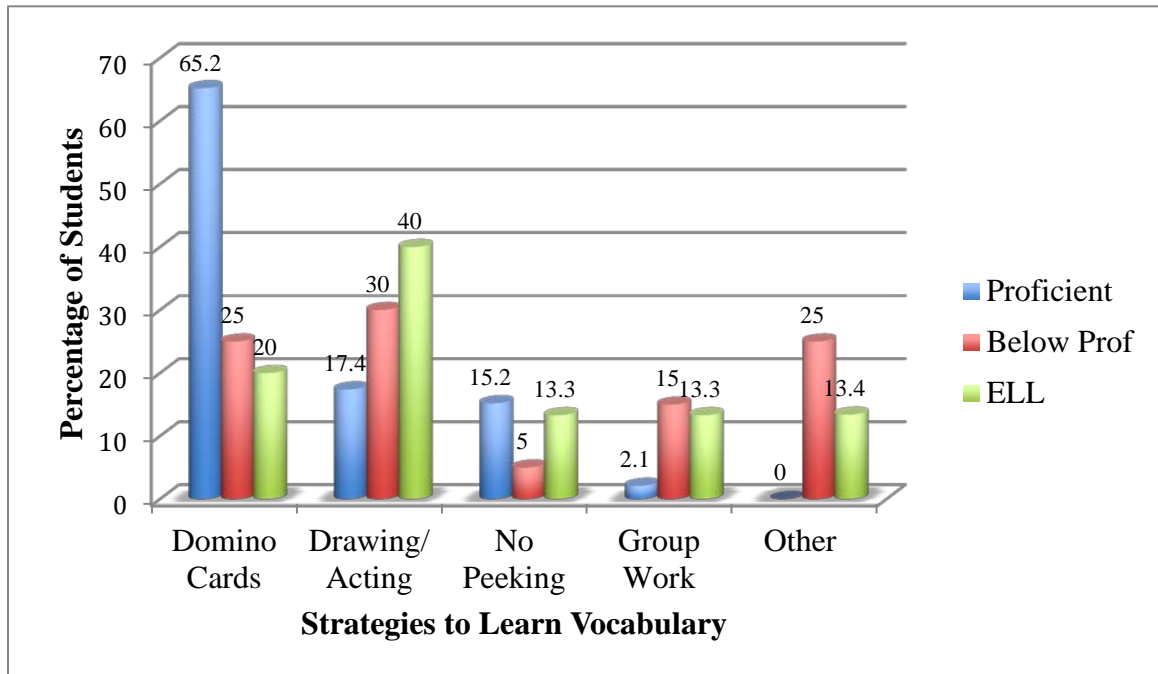


Figure 1: Strategies preferred by students when learning vocabulary ($N=81$).

Domino cards were the most common response among all groups (Prof = 65.2%, Below Prof = 25%, ELL = 20%) for a myriad of reasons. Comments provided by Proficient students explaining the popularity of Domino cards involved its fast pace, “It keeps us on the edge for our specific card,” and “It is fun and you learn it very fast.” Another student commented, “While you are waiting for your turn you learn new words,” and yet another recognized, “You really have to think and listen.” One sports-oriented student wrote, “It’s a competition and everybody is involved.” Though learning the words may be frustrating for some, one student enjoyed the challenge and made the statement during small group interviews, “Not knowing what they mean makes me think hard and makes it fun.” Below Proficient students were less descriptive but still described Domino

cards as “fun” and several acknowledged, “They help me remember definitions.” One ELL student said, “You learn a new word everyday” while another commented, “They are fun and help me memorize the words.”

Drawing and acting were the next highest responses among the ELL (40%) and Below Proficient groups (30%) though lower in the Proficient group (17.4%). One particularly artistic ELL student explained on her survey that she “liked to write the meaning, draw a picture with it and the word in bubble or cool design because you can be creative” while another wrote “drawing a picture for a word helps me a lot.” A social butterfly commented that he liked to “act out the word with some friends and I enjoy it because it’s fun.” These responses indicate the value of student-generated illustrations rather than teacher-supplied pictures and icons. Students construct more meaning through drawings and word-associated kinesthetic movement because they find the verbalization of vocabulary words to be difficult. One Below Proficient student- the same student who struggled greatly with reading aloud- said she liked “anything involving movements or hand gestures to go with the word.” Another enjoyed “acting them out because some words are funny.” While both Below Proficient and ELL groups ranked drawing and acting high on their list of strategies for learning vocabulary, Below Proficient students leaned more toward kinesthetic movement and ELL students toward drawing. This Awareness can lead to more effective differentiation in a mixed-ability classroom where various modalities and student choice improve understanding.

Another strategy preferred by Proficient students (15.2%) and ELL students (13.3%) was “No Peeking”. Very few Below Proficient students mentioned this strategy (5%). Although no comments were provided by Proficient group, one ELL student

described No Peeking as “fun and [it] helps me memorize words.” The same social butterfly mentioned above enjoys this strategy because “It lets me move around and visit with friends.”

The last trend recognized in the survey was the preference for working in groups. This was highest in Below Proficient (15%) and ELL (13.3%) groups but quite low in the Proficient students (4.3%) though one did explain “It helps my understanding of the words.” No ELL student explained why they preferred group work, but Below Proficient responses included “you can work with partners” and “[I like] just doing activities with another student.” Responses categorized in Table 5 as “Other” included those strategies that were mentioned only once, strategies that could not be feasibly implemented in the classroom and/or lack of a response.

From this survey question, a trend was recognized and continually reinforced throughout the unit. Any vocabulary strategy that involved working in a group or with partners ranked higher with Below Proficient and ELL students than Proficient. Teacher observations also supported this claim. Proficient students were more intrinsically motivated to succeed and be challenged without outside pressure whereas Below Proficient and ELL students (who often struggle) needed continual support, reinforcement and external motivation.

The final question addressed on the Pre-Unit Survey concerning vocabulary strategies was, “What strategies do you like best when reviewing new vocabulary?” Student responses to this question are summarized in Figure 2.

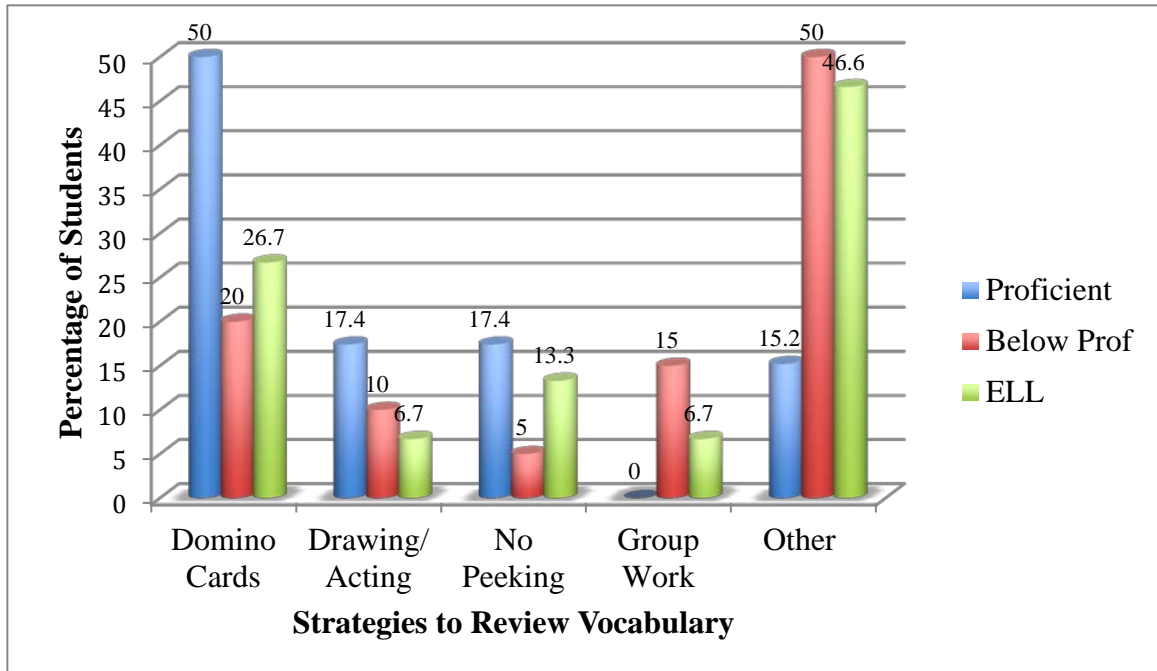


Figure 2: Strategies preferred by students when reviewing vocabulary ($N=81$).

When reviewing vocabulary, Domino cards were the most common strategy of all student groups. Fifty percent of Proficient students preferred it as well as 20% Below Proficient and 26.7% ELL. Proficient student comments still mentioned the competition, speed and fun involved in Domino cards, but several students (26.1%) also mentioned in their Post-Unit Survey that they were frustrated by “people that don’t try” and “people not paying attention.” This may explain why Domino cards dropped 15% for Proficient students and 5% for Below Proficient students as a method of reviewing vocabulary vs. learning new vocabulary. Perhaps the repetition was beneficial for some students (ELL), but Proficient and Below Proficient students became bored and lost interest. However, it was still a popular strategy and, as one Proficient student expressed in a small group interview, “I like seeing how much we’ve improved.” Another survey comment stated, “Now that you know the cards you try extra hard to show how much you learned.” A

Below Proficient student recognized “you have to remember the definition or it won’t work” and there were several comments reiterating, “It helps a lot.” Domino cards showed an increase of 6.7% from learning to reviewing vocabulary for ELL students, most likely because the words were more familiar to them as the unit progressed. After repetition of this activity, an ELL student claimed “It’s easier for me” and another wrote, “You learn more of the definition.” In a small group interview, one of my shyest ELL students said, “You need to remember the word and meaning and it, like, gets stuck in your head.” These comments provide evidence that the repetition and pace of Domino cards seems to help most students and, over time, ELL students become more comfortable reading and pronouncing scientific terminology.

No Peek remained another top choice for Proficient (17.4%) and ELL groups (13.3%) but remained low in the Below Proficient (5%) group. A Proficient student commented, “It includes a lot of memorization” while another stated, “It just helps on how to pronounce the words and learn definitions.” Several ELL students felt that it helped them “know the definitions better” and a Below Proficient student also commented, “It helps me remember.”

Group work remained consistent with Below Proficient (15%) and ELL (13.3%) students although it was not mentioned at all in the Proficient group (0%) as a strategy preferred when reviewing. One Below Proficient student liked to “talk about it as a whole class” while two mentioned they preferred “anything we can work with partners” and “practicing with somebody.” One social ELL student, in a small group interview, expressed that he would do “anything to move around and visit with my friends and partner up.” Another commented on his survey that he liked “talking with [my] group or

classmates because I enjoy getting help from others.” Prior to this comment, an assumption was made that he just liked to talk! However, his comment prompted the realization that talking within a group can be highly beneficial for ELL students when constructing meaning of words and/or concepts.

Drawing and/or acting remained the same in Proficient (17.4%) and Below Proficient groups (30%) but dropped substantially in the ELL group (6.7%). A highly artistic and advanced Proficient student wrote that she liked “making posters describing the word because it helps you visualize the words and its definition.” A Below Proficient student liked “drawing pictures of words.” No group mentioned acting as a method of review nor did an ELL student give a reason as to why drawing and/or acting was a beneficial form of reviewing vocabulary. The fact that drawing was so high on the list for helping ELL students learn new vocabulary (40%) was interesting, but when it came to reviewing vocabulary, that number dropped to 6.7%. Perhaps drawing helps construct meaning, yet once that meaning is grasped, ELL students prefer repetition and more verbal methods of review? This may also explain the increase of 6.7% in a preference for Domino cards as a method of review for ELL students.

When reviewing vocabulary, responses categorized as “Other” increased substantially from strategies for learning vocabulary to strategies for reviewing vocabulary. This response increased 15.2% for Proficient, 25% for Below Proficient and 33.2% for ELL students. A large number of students in all sub-groups neglected to list a strategy for review or commented “IDK.” Several responses could not be implemented in the classroom or were mentioned only once. A new response that appeared in the Proficient group as a form of review was writing in the form of stories or finishing

sentence prompts (13%). One student wrote, “I like to make stories with [vocab words] randomly with other people because then I get a better understanding of vocabulary.” She is exceptionally shy so the revelation that she liked to create stories with a partner or small group was novel. Surprisingly, a response opposed to reviewing was documented only once. During a small group interview, a Below Proficient student exclaimed, “I don’t like reviewing because when I learn it I understand it.” Although this type of anti-review comment stood alone, the statement “I don’t like reviewing” could apply to the majority of seventh graders. This may have been a reason behind the multitude of blank responses when students were asked to suggest strategies for reviewing vocabulary. Perhaps students thought that by failing to suggest a strategy, they would be saved from the torture of review. Also, in spite of her comment, the student who hated to review was observed to be quite involved in many of the group activities.

Post – Treatment Surveys and Assessments

At the end of the treatment, students took an Evolution Summative Unit Test (EVO) and Post-Vocabulary Assessment. The EVO scores were compared to the GTS scores that were collected as baseline data prior to the treatment. The Post-Vocabulary Assessment was compared to the Pre-Vocabulary Assessment, also collected prior to the treatment as baseline data. To collect information on student perception of the effectiveness of the four vocabulary strategies, students completed a “Muddiest Point”. They also provided feedback on a Post-Unit Survey that assessed student attitudes toward the treatment strategies.

Quantitative Data

Although the difference was not substantial, both Below Proficient and ELL student groups experienced an increase in average test scores from the GTS to the EVO Summative Unit Test. Figure 3 displays the differences in the unit tests in more detail.

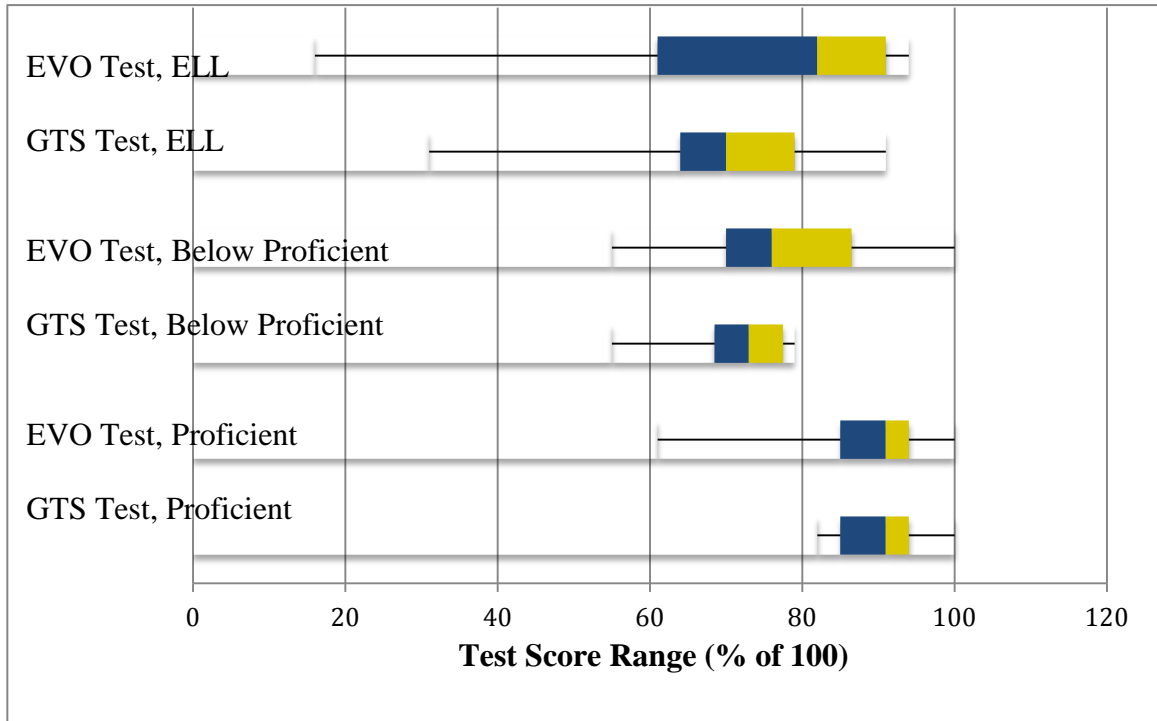


Figure 3: Comparison of GTS and EVO Summative Unit Test averages (N=81).

When comparing the two summative unit tests, Proficient average test scores decreased 2.2% (from 90.5% GTS to 88.2% EVO). The range of the GTS test was 18 and increased to 39 for the EVO test (difference of 21). The standard deviation increased from 5.7 to 8.6 (increase of 2.9). For both the GTS and EVO Proficient tests, the median was 91%. Below Proficient average test scores increased 4.8% (from 72.4% GTS to 77.2% EVO) while the range increased from 24 to 45 (difference of 21). The standard

deviation grew from 6 to 12.1 (increase of 6.1). For both the GTS and EVO Proficient tests, the median remained close at 73% (GTS) and 76% (EVO). ELL student test scores increased 3.8% (from 68.8% GTS to 72.6% EVO). The range of the GTS test was 60 and increased to 78 for the EVO test (difference of 18). The standard deviation increased from 14.2 to 24.2 (increase of 10). The median deviated dramatically from one test to the next (70% GTS and 82% EVO), something that was not observed in the Proficient or Below Proficient group scores. Among student groups, the increase in range was similar from the GTS to the EVO test yet the standard deviation almost doubled with each group. Also, the standard deviation increased as the number of students in each sub-group decreased due to a smaller sample size.

Based on the change in GTS to EVO individual test scores, eight students moved from Below Proficient to Proficient. However, nine dropped from Proficient to Below Proficient. There was no valid explanation for the practically equivalent swap of Proficient and Below Proficient students. However, the Proficient students who dropped in scores did not drop by much yet remained at the highest end of the Below Proficient score range (close to 80%). Although only two students in the ELL group started this unit with proficient scores, seven additional ELL students increased scores to the proficient range. At the end of the unit, nine ELL students earned proficient scores and six remained below proficient. Although vocabulary had always been a focus on prior units, this particular treatment brought intense vocabulary strategies and practice to the forefront and may have been responsible for the increase in the number of ELL students becoming proficient on the EVO Summative Unit Test.

More substantial than the GTS and EVO Summative Unit Test scores were the differences between Pre- and Post- Vocabulary Assessment scores for each student group. All student groups increased their average assessment score as displayed in Figure 4 and statistical trends varied greatly from the summative unit tests.

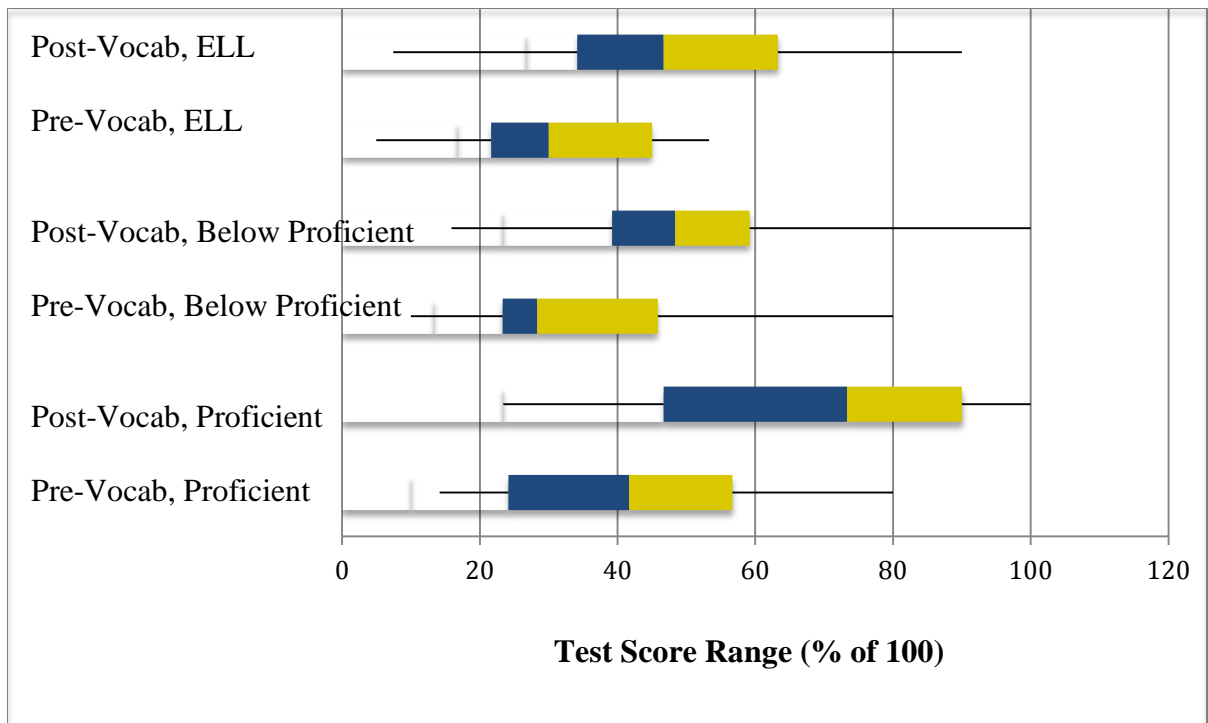


Figure 4: Comparison of Pre- and Post-Vocabulary Assessments (N=81).

When comparing the Pre- and Post- Vocabulary Assessments, Proficient average scores increased 26.9%. The range of the pre-assessment was 70 increasing to 76.7 for the post-assessment (difference of 6.7) and the standard deviation increased from 18.3 to 24.2 (increase of 5.9). The median for both pre- and post-assessments differed by 31.6% (41.7% and 73.3%, respectively) among the Proficient scores. Below Proficient average assessment scores increased 20.6% with an increase in range from 66.7 to 76.7 (difference of 10). The standard deviation grew from 16.9 to 25 (increase of 8.1) and the

median showed a 20% increase (28.4% pre- to 48.4% post). ELL student assessment scores increased 18.6% with the range showing an increase of 36.6 to 63.3 from pre- to post-assessment (difference of 26.7). The standard deviation increased from 13.1 to 21.1 (increase of 8). The median moved from 30% pre-assessment to 46.7% post-assessment (16.7% increase).

Unlike the GTS and EVO test, the standard deviation among groups for the Pre- and Post-Vocabulary Assessment were more consistent. However, the differences in range within the Proficient and Below Proficient groups was smaller than the GTS/EVO tests but more than doubled in value in the ELL group as compared to the others. The median values for the vocabulary assessments also displayed an increase among all groups whereas the median values for the summative unit test increased only in the ELL group. In terms of assessments, the Pre- and Post-Vocabulary Assessment showed more student growth than the GTS and EVO unit tests as evidenced by increased averages (mean) and higher median scores. However, the range and standard deviation increased as well pre- to post-assessment. This could mean that, although the treatment may have worked for the majority of students, some remained low and experienced no positive impact from the vocabulary strategies. Although used for baseline data to group students as proficient and below proficient, the GTS Summative Unit Test may not have been the best comparison for the EVO Summative Unit Test. For future studies, a pre-test of concepts in evolution may serve more accurate in terms of pre/post assessments.

Qualitative Data

The Muddiest Point and Post-Unit Survey included questions designed to elicit student qualitative feedback on the vocabulary strategies. Muddiest Point feedback

focused on (1) what was learned and/or better understood, (2) what was not understood or still confusing, and (3) a self-evaluation of personal effort during each vocabulary strategy. Based on Muddiest Point feedback, some students were asked to explain their responses further during informal small group interviews.

Several themes surfaced when students completed the Muddiest Point for each vocabulary strategy. All student groups admitted that they became more comfortable with the content vocabulary and definitions although some strategies were ranked much higher than others. Proficient and ELL students ranked No Peeking and Domino cards the highest (60.9% and 58.7%) as did ELL (66.7% for both). Proficient comments included, “This activity helped me learn certain words that I had no idea what they meant but now I feel more comfortable” and “This made me learn some of the harder words that are not that easy to pronounce.” An ELL student commented that “[No Peeking] makes you think hard for your vocab word.” Below Proficient students ranked Matching above all others (60%) for learning vocabulary and definitions. One student commented in interviews, “I learned more than I used to and it helped me remember words.” Strategies that were ranked the lowest in terms of helping students understand vocabulary and definitions included Matching for ELL (26.7%, “I still don’t understand most of the words”), Pictarades for Proficient (40%, “How are we supposed to know if we are guessing the word or definition?”) and No Peeking for Below Proficient (45%, “Some of the words are really long and hard to sound out or say”).

Another theme that surfaced made reference to similarities among words and definitions. This was a source of confusion for all student groups, particularly ELL and Below Proficient. These comments were most prevalent in Domino cards and No

Peeking, two strategies that relied heavily on verbal modalities for learning. One ELL student commented, “The thing that is still confusing are some words or definitions that seem the same.” Below Proficient students felt more confusion among words when playing Domino cards (55%) vs. No Peek (35%) as evidenced by the remark, “Some of the definitions confuse me a little because many seem like they stand for two words not one.” ELL students ranked those two strategies fairly equal (46.7%) in terms of similar words and definitions causing a hindrance to learning. Proficient students struggled as well (32.6% Domino cards, 19.6% No Peeking), but were more aware of key words and phrases used to discern similar words and definitions. This was identified in a Proficient student’s claim, “I got better at recognizing key words for memorizing some definitions.”

The use of group-generated drawings and teacher-chosen illustrations for Pictarades and Matching proved to be a double-edged sword. The benefit of drawings and illustrations was recognized in all student groups but the pictures were also identified as a source of confusion. One Proficient student said that “[Pictarades] helped me paint a picture in my head and to understand vocab words but sometimes the pictures drawn were a little confusing to guess.” Although helping students better visualize words and concepts, certain pictures suggested multiple words and therefore caused frustration within students and among groups. For example, 30.4% of Proficient students felt that student-drawn pictures helped them visualize words and concepts better, but 32.6% also felt they were hard to understand. This was mirrored in other groups, especially ELL. When playing Pictarades, 33.3% felt the pictures helped and 33.3% felt they were hard to understand. A common feeling was that drawing “helped me understand how the certain word happened” but “sometimes I don’t understand what the person is doing.”

Illustrations used for Matching cards proved less confusing for Proficient and Below Proficient students. In both Pictarades and Matching, the number of students who felt the pictures helped (25%, 30%) were more than double the number that felt they were not helpful (10%, 15%). This was not the same for ELL students who felt the teacher-chosen illustrations were more confusing (46.7%) than helpful (33.3%) because “some of the pictures look like the same thing.” Student-generated pictures are of benefit to ELL students because it helps them acquire a deeper more personal understanding of the word and concepts surrounding the word.

Working with a partner or group contributed to understanding in three of the strategies. “Speaking out loud with the entire class helped my vocabulary,” was a comment written by a Below Proficient student. Below Proficient students valued group work the highest (25%) in Domino cards but, as the size of the group interaction decreased, so did its value (No Peeking, 10% and Matching 5%). This was the opposite for ELL students who valued group work in Domino cards and Matching (13.3%). In an interview, one ELL student said, “I think you pay more attention because the whole class depends on you so you learn more.” Although the benefit of working with a group was cited in Proficient students’ Muddiest Point, values were very low compared to Below Proficient and ELL groups (2.2%, 4.3%). Proficient students often became frustrated with their teammates if rules were not followed (“Why do people blurt out answers instead of letting people figure it out themselves?”) or people failed to show effort (“Why do people not participate in the activity?”). Interestingly, not a single person in any group attributed an increased understanding to teamwork in Pictarades. This activity involved working

with small groups but sharing with the entire class. In spite of it being the most animated strategy, its benefit to learning and personal understanding was questionable.

No Peeking helped several Proficient and Below Proficient students make connections among words and definitions. One Proficient student described it as “learn[ing] to connect different things to come up with one answer.” Twenty-five percent of Below Proficient students claimed this strategy contributed to a better understanding of concepts (“I learned how to explain words and remember explanations”) while 17.4% of Proficient students felt that it built relationships among words (“I learned to connect vocabulary words with examples or definitions easier”). No ELL student made reference to building connections among words or acquiring a deeper understanding of concepts on the Muddiest Point. This was most likely due to the verbal modality of No Peeking. With scientific vocabulary, ELL students were still building a basic understanding of each word and definition, not exploring multiple contexts and relationships among words.

One vocabulary strategy in particular received many comments that “It didn’t help me learn.” Twenty percent of Below Proficient, 17.4% Proficient and 13.3% ELL felt that Pictarades, although fun and entertaining, did not contribute to their understanding of vocabulary and definitions. In a small group interview, a Proficient student asked, “How do you tell the difference between some words?” Factors contributing to the ineffective nature of this activity were identified by student comments such as, “I get mixed up with cards with the same meaning” and “some people’s drawings are so bad so it’s hard to guess their word.”

Finally, help with memorization was another comment that appeared for Domino cards but only within the Proficient (15.2%) and Below Proficient groups (10%). The

strategy's repetitive nature, quick pace and class involvement contributed to student recall of words and definitions. As one student wrote, "It helped me learn by making me memorize because we did them a lot," while another commented, "This activity helped me remember words easier and pay more attention."

When asked to self-evaluate the amount of effort (engagement level) students invested into each strategy (referred to as "effort ranking"), Proficient students ranked Pictarades the highest with 97.5% claiming they gave solid or best effort. This was interesting because Pictarades was identified in the Muddiest Point to be the least beneficial. However, this strategy received the most "fun" comments and seemed to be the most engaging (most likely due to the lack of artistic ability of most students and the hilarity that resulted). Domino cards also received a high effort ranking (93.3%) with Matching and No Peeking averaging 87.5%.

Below Proficient students were fairly consistent with a 75-80% effort ranking. ELL students demonstrated the greatest extreme in effort depending on the strategy. No Peeking received the highest effort ranking (90%) while Matching averaged the lowest (66.7%). Although No Peeking was one of the most difficult strategies for ELL students (due to its strictly verbal nature), students were observed listening closely to their group members and appeared to "enjoy working together" to come up with alternate clues and explanations for a vocabulary word. Also, this group interaction exposed many of them to words and definitions in multiple contexts. As one ELL student wrote, "The new people I'm learning with made it easier to improve." Matching the vocabulary word, definition and illustration quickly became frustrating for ELL students. Questions such as, "Why do we have so many cards?" and struggles with "the words with the really long definitions"

surfaced in the Muddiest Point. A common concern among ELL was that “some of the pictures and definitions are hard to find where they go.” These factors led to a lower effort ranking by both ELL (66.7%) and Below Proficient students (75%).

The culminating and most descriptive qualitative method of data collection was the Post-Unit Survey. It provided detailed commentary on each vocabulary strategy in terms of (1) what students enjoyed the most, (2) what students enjoyed the least, and (3) how students would improve each activity. Based on Post-Unit Survey feedback, some students were asked to explain responses further during informal small group interviews.

Domino cards appealed to each group of students for many reasons. One high-achieving student commented, “It is very fast-paced and the feeling for wanting to win helps you remember the definitions.” This competitive nature was expressed in 23.9% of Proficient student responses. Many students liked learning through repetition and “the challenge of changing words every round” while others identified that “[they] liked being able to move around and have fun” (32.6% Proficient, 30% Below Proficient). A high percentage of students (30.4%) referred to learning as the most enjoyable factor in Domino cards through interview statements such as, “I enjoy the fact that I am learning in a different way” and “I enjoyed most that this helped my vocabulary because while I am waiting for my turn I learn the other words.” One highly intelligent student who struggles with focusing in class admitted, “I didn’t like this activity to be honest, but I enjoyed the learning.” A few wrote comments such as “I enjoyed that it involved everybody” and “This got everyone involved in learning.” This social aspect of the game was praised the most by Below Proficient students (25%) who were driven more by peer involvement than self-motivation or competition. The biggest frustration was “some people didn’t pay

attention or seem to care” as recognized by 45.7% Proficient and 30% Below Proficient students. Although a few ELL students liked Domino cards because “we did it in class together and helped each other,” one very shy and sensitive ELL student wrote, “I really didn’t like this activity because some people are faster and some are slower.” Another ELL student commented in interviews, “I did not like that if we read slow we had too much pressure.” This suggests that a motivator for one group (such as speed and competition for Proficient students) may be a hindrance to learning in another. ELL students had to overcome more issues with pronunciation when reading aloud (20%) than the other student groups, but several admitted to becoming more comfortable and confident as the unit progressed. Suggestions for improving Domino cards included “giving people more time to prepare and study their cards” (30% Below Proficient) in addition to “let us interrupt others if we recognize our word” (26.7% ELL). The same shy student who mentioned fast and slow readers suggested that “being grouped with [other students in] the same reading level” would make her feel more comfortable. One Proficient student requested more practice and wrote, “in smaller groups every person would get three cards instead of one or two.” Every student group expressed a desire for more class involvement and less “drifting off.”

Pictarades had, by far, the highest level of engagement among student groups but was the least effective in terms of learning. Every group expressed “you have fun with friends and you get to draw or act” in multiple ways (80% ELL, 60.9% Proficient, 45% Below Proficient) but very few mentioned the benefit of “being able to improve my vocabulary by looking at drawings and trying to define the word.” Only a few Proficient students made connections such as “you get to draw your own visual of the meaning” or

“[we get to] figure out ways to show certain concepts.” One Below Proficient student said he benefitted from “seeing the meaning of a vocab word,” but the majority of comments related to “fun,” “guessing,” and “some people gave crappy drawings.” A frustration that surfaced within Proficient and Below Proficient groups was “not too many people participated fully.” One Proficient student thought this might be remedied by “letting groups choose their own cards” and “having each person in a group be specifically assigned to do something” while several Below Proficient students thought the “teacher shouldn’t pick people to be in groups.” Lack of artistic ability particularly bothered one ELL student so she suggested, “Take the people that can’t draw and take them to art class.” This frustration was mirrored in other groups (37% Proficient, 15% Below Proficient, 26.7% ELL) and statements such as “some pictures were hard to figure out” were prevalent. ELL students struggled with “when you have to explain why you think it’s a word and somebody in your group can’t explain it.” This was most likely difficult due to the conceptual vs. concrete nature of many of the vocabulary words and ELL struggles with verbalization.

No Peeking was the favorite of Proficient students who felt challenged by “trying to describe words without using the actual definition or word.” Although it was a struggle for ELL students (26.7% claimed “I don’t like this one”), 26.1% of Proficient students enjoyed “how this activity had me thinking about all of the connections trying to be made.” Group work was again a motivator for Below Proficient and ELL students (35%, 20%) who enjoyed “trying to guess and work as a team.” One ELL student commented, “Everyone has to talk and everyone gets to participate. You learn with fun.” However, these two groups also found it most difficult to come up with explanations for words. One

Below Proficient student, when interviewed, said, “Some people would get tired of giving examples and they would just give [the answer] away and that’s not the point.” Another ELL student expressed, “My teammates did not explain the word in a understandable way.” A different type of frustration was shared by a Proficient student who claimed, “People in my group were being completely ridiculous and cheated.” Cheating (by giving away words) and lack of group cooperation was documented by 21.7% of Proficient students but did not appear to bother or be noticed by other student groups. In terms of guessing, each group had a different opinion. Below Proficient students enjoyed trying to guess the word or concept (35%) whereas Proficient students preferred the explanation (26.1%). However, many ELL students disliked both guessing and explaining (26.7%). One ELL student suggested that students be allowed to “pick [our own] partners so we can feel more comfortable.” A Proficient student humorously wrote, “I would let humans choose other human partners.” In spite of two groups claiming “this activity needs no improving” (23.9% Proficient, 25% Below Proficient), several students in each group thought the strategy might be more effective “by doing it with the whole class” rather than small groups.

Matching cards received some of the highest rankings from students who enjoyed working with the partner of their choice (17.4% Proficient, 15% Below Proficient, 26.7% ELL). All other strategies involved heterogeneous, teacher-assigned groups or the entire class. Many students were grateful to finally “work with our own friends/partners” and one Proficient student commented, “You got to work with a partner and that made it more easy and more helpful.” For Proficient students, this strategy was challenging yet frustrating. Students liked “being able to see all the words and definitions with icons to

represent them” (17.4%) and enjoyed “the complexity of thinking of multiple definitions at a time” (21.7%). One recognized that “it takes a lot of background knowledge and thinking” (a struggle for ELL students). However, 41.3% Proficient also felt that “[some of] the pictures in this activity were misleading” (as did 45% Below Proficient and 26.7% ELL). A few remarked, “I practically did all the work” and “It got boring quick.” One young lady found it “not horrible, but definitely not my favorite.” The students who struggled with Matching cards also felt that “there were too many words,” as expressed by 26.7% ELL, 15% Below Proficient and 10.9% Proficient. Although one Below Proficient student admitted, “After a while it got easier,” a more common expression was, “I get mixed up with the pictures and get lost. Then I just give up.” This trend was primarily observed in groups where Below Proficient and ELL students were paired together. Although all groups liked the addition of pictures to the words and definitions, every group asked for fewer words (17.4% Proficient, 20% Below Proficient and ELL) and less similar words. A comment for improvement provided by 20% of Below Proficient students involved students studying more and “working a lot harder with a partner.” They also would have liked larger groups vs. pairs thus increasing social interaction (a common theme for Below Proficient students among all strategies). Proficient (15.2%) and ELL (13.3%) students also expressed a desire to create their own pictures for better understanding. One ELL student felt that she could “make pictures that don’t look like each other” while a Proficient student wrote, “I would make the pictures more sensible to the word.” Although teacher-chosen pictures were provided in an effort to save time, student-created images would have been more effective toward student understanding and therefore worth the additional time it would have required.

INTERPRETATION AND CONCLUSION

This action research provides evidence that differentiation of vocabulary instruction does influence the success of seventh grade students in a middle school science classroom. In response to my first action research question regarding how various vocabulary strategies impacted student comprehension of scientific concepts and connections, no significant impact was observed on the GTS and EVO Summative Unit Tests. However, scores did increase on the Pre- and Post-Vocabulary Assessment. Student comments on the Muddiest Point also acknowledged a deeper understanding of evolutionary concepts due to the differentiated vocabulary strategies.

Little change was noted in the average or median of the GTS and EVO tests and the number of students classified as Proficient and Below Proficient did not change overall. The number of ELL students who were proficient did increase (two pre-treatment to nine post-treatment), most likely a result of the intensive implementation of the differentiated vocabulary strategies during this treatment. The decision to use the GTS as baseline data for classifying students may not have been the most accurate diagnostic measurement of student proficiency nor the best comparison for the EVO test. In the future, a more efficient pre-test, in which questions are better aligned to the instruction is recommended to allow an assessment of initial student comprehension and a more accurate student database that could be consulted to classify student proficiency (such as TCAP or Acuity). Averages on the Pre- and Post-Vocabulary Assessment did increase (as did the median) and, upon finishing the post-assessment, many students were proud of how much more they knew and understood about evolution.

From the Muddiest Point, some student groups did claim to gain comprehension of scientific concepts and connections with certain vocabulary strategies. Repetition from Domino cards contributed to an increased level of understanding in all groups and helped ELL students with pronunciation of scientific terminology. Proficient and Below Proficient students made deeper connections among words and concepts while creating alternate explanations for No Peeking. The use of images and illustrations contributed to a deeper understanding in Matching and Pictarades, but student-generated pictures would have been more beneficial, especially for ELL students. Group interaction was a great motivator for Below Proficient students and contributed to contextual understanding for ELL students when placed in a heterogeneous group. Peer groups had less influence on Proficient students who tended to be more self-motivated.

In response to my second action research question as to how differentiated vocabulary instruction would impact student understanding of content vocabulary, students did gain proficiency in describing and explaining evolutionary words and concepts. This was evident from the Pre- and Post- Vocabulary Assessment where student averages increased 26.9% for Proficient, 20.6% for Below Proficient and 18.6% for ELL. Student comments on the Muddiest Point, Post-Unit Survey and student interviews also verified that different strategies were more effective for different student groups. Proficient students were self-motivated and increased achievement when involved in highly verbal, fast paced, competitive strategies such as Domino cards. Below Proficient students were more engaged when working in small groups such as No Peeking or when held accountable for participation during a class activity like Domino cards. ELL students, though self-conscious about

pronouncing scientific terminology in front of peers, benefitted the most from repetitive strategies that encouraged them to talk such as Domino cards. They gained understanding when exposed to words and definitions in multiple contexts as in No Peeking. The addition of pictures and illustrations gave ELL students one more avenue with which to construct meaning among vocabulary words although student-generated pictures would have been more valuable. In spite of these obstacles, ELL students became more comfortable with evolution words, concepts and definitions as the unit progressed. This indicates that ELL students would benefit most from exposure to scientific terminology early and often. If fears of spelling and pronunciation are dispelled before a unit begins, ELL students can move beyond the mechanics of the words and definitions and focus on gaining a deeper, more conceptual understanding.

In response to my third action research question, the implementation of differentiated vocabulary strategies greatly influenced my motivation and learning as a teacher. First, it made me realize how unique my students were and how valuable student feedback could be. I had never before made connections between proficiency levels and learning modalities until small group interviews and more purposeful observation of students participating in vocabulary strategies. I was oblivious to ELL struggles with spelling and had no idea about the level of self-consciousness many students experienced when pronouncing new scientific terminology in front of the class or in a group.

I learned that students at various proficiency levels possess different motivations, strengths, and comfort levels. Effective strategies should contribute to student understanding and help make learning a successful experience. I need to differentiate

further by incorporating multiple learning modalities and providing a choice in activities. This will help students build their academic and content vocabulary in a way that is most meaningful and lasting to them.

VALUE

This action research could not have come at a better time. In my transition from tenth grade Biology to seventh grade Science, I became so overwhelmed with changes that my teaching practices faltered and I consistently questioned my career choice. I felt a failure in the classroom and had no clue how to relate to seventh grade students. However, my students were fun and they were forgiving. Once I began asking for feedback, I was amazed by how open and honest they could be. They reassured me, encouraged me and laughed with me. Based on this experience, my approach to helping next year's seventh grade students build a strong foundation in science will be quite different. I will have a better understanding of what my students need from me, not only as a teacher, but also as an adult.

In preparation for the school year, I plan to identify the essential academic and content vocabulary for each unit. Since my background is primarily high school Biology, I forget that seventh graders are still new to science and are not expected to know "everything" at the end of the year. As a detailed person, I find it difficult to teach broad vs. deep and have often confused my students this past year with content they are not ready to understand or conceptualize. In addition to differentiated vocabulary strategies, essential academic vocabulary will become the center of my "Word Wall" used for reference. Essential content vocabulary will be accumulated in a "Word Journal." This

journal will include words, definitions, illustrations, etc. and can continue to be a resource even after students leave seventh grade.

From day one, I need to expose students to scientific terminology and images that they will encounter later in the year through low-pressure warm-ups and station-supported vocabulary activities. This will help students gain familiarity and fluency with essential vocabulary rather than overwhelming them with new words on the first day of a new unit. This has been my common, yet ineffective, practice. I expected students to comprehend words and definitions in addition to making connections and identifying relationships- quickly. For students who are struggling with everyday language, this is overwhelming and frustrating. The equivalent for me would be attending an in-service in which the principal spoke only in educational acronyms.

In addition to the careful selection and early exposure of vocabulary words, I need to make a conscious effort to learn individual student modalities, interests and struggles early in the year. Differentiation will be at the backbone of my teaching practice in order to meet individual needs, but I must first learn what those needs are. This will help in the continued use of the vocabulary strategies utilized during the treatment and the addition of other effective strategies to my teaching practice.

In reference to the strategies chosen for this treatment, I will continue the use of Domino cards as a whole-class strategy but only after ELL students have had sufficient exposure to the words and definitions. No Peeking will benefit from the addition of visuals as an added reference to the key words and phrases students “hint” to guess the word. Pictarades will be more effective when used within a unit that has more concrete

information and examples (ex: photosynthesis) vs. highly conceptual (ex: evolution). This should eliminate some of the frustration experienced by students when one drawing could represent multiple words or concepts. Matching cards will incorporate student-created illustrations rather than teacher-chosen pictures. This will allow students to draw, create, and build a deeper understanding of words and concepts.

Finally, my planning will once again become more purposeful. In the past few years I have slipped into reactive planning vs. proactive. My lessons have been less prepared and less effective while my days have become more stressful and frustrating. Not only do I want to provide my students with more personal success, but I would like to share in that success as well. This action research has deepened my understanding of my students' needs and brought back the motivation to meet those needs through differentiation. I will continue to build upon my experience this past year, gather and refine more effective vocabulary strategies, and infuse differentiation into the rest of my teaching practice.

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APPENDICES

APPENDIX A

IRB EXEMPTION FORM



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Jennifer Hood and Walt Woolbaugh
FROM: Mark Quinn, Chair *Mark Quinn, Chair*
DATE: February 4, 2013
RE: "How Does the Implementation of Differentiated Vocabulary Instruction through the Use of Learning Stations influence the success of 7th Grade Students in a Middle School Science Class?" [JH020413-EX]

The above research, described in your submission of February 4, 2013, 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:

- (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.
- (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-UNIT SURVEY

Pre-Unit Survey

Name _____ Block _____

<p>When learning new vocabulary words, I struggle the most with _____ because _____.</p>	
<p>What strategies do you like best when LEARNING new vocabulary?</p>	
<p>Why?</p>	
<p>What strategies do you like best when REVIEWING new vocabulary?</p>	
<p>Why?</p>	

APPENDIX C

VOCABULARY STRATEGIES

Vocabulary Strategy #1

Name: Domino cards

Modalities: Verbal, Kinesthetic

Cooperative Grouping: Entire class

Domino Cards: Each student received one or more cards. These cards are divided into two parts. The top part has a word and the bottom part has a definition of another word. One student starts in the middle of the room and says, "I am looking for (the definition)" and reads the bottom of the card. The other students (seated at this time) look at their card to see if they have the word that matches that definition. If they do, they jump up, race to the middle of the room, and say, "I am (the word). I am looking for..." and they read the next definition. This continues in a domino pattern with students studying their card, hearing the definitions read by other students, moving to the middle when they have a match, etc. Once each card has been read and students are back to the beginning, students would switch cards with someone across the room and a new person would start. To make it more competitive, time each class and record the times on the board to see which class completes all thirty words and definitions with the fastest time. A typical warm-up of Domino cards involved three switches to give more practice, repetition and to expose students to more words and definitions. Students were not allowed to interrupt others and, if no one recognized the definition being read, other students could help out. An example of Domino cards is below.

adaptation	evolution	species
change over time (such as living organisms, geology of the Earth, etc.)	a group of organisms that are closely related and can mate to produce fertile offspring	groups of individuals of the same species living in the same area that can interbreed
population	biological evolution	comparative anatomy
the process of genetic change in a population that is inherited over several generations; descent with modification	the study of anatomical features (body structures) of several different species (ex: comparing a human arm to a cat leg)	the evolution of one species in response to another (ex: insects & flowers that need to be pollinated)

Vocabulary Strategy #2

Name: Pictarades

Modalities: Verbal, Visual, Kinesthetic, Written

Cooperative Grouping: Small heterogeneous groups (3-5) to entire class

Pictarades: Students were arranged in small heterogeneous groups of 3-4 students. Each group was given a white board, marker and eraser. One person from each group randomly drew a vocabulary card from a basket and took it back to their group. Groups were given five minutes to discuss the word/concept and its meaning, decide on a drawing that represented the word or discuss how they would act it out. Groups volunteered to go up front to draw or act out their word/concept. Other student groups had to guess but could not raise their hand to supply an answer until the answer was written on their white board and every person in the group could justify the response. This required all students to understand why a particular word/concept was chosen to go with the drawing or acting. Points were kept on the board for groups that successfully identified the word or concept. Once a word or concept was identified, another group went to the front.

Vocabulary Strategy #3

Name: No Peeking

Modalities: Verbal

Cooperative Grouping: Small heterogeneous groups (3-5)

No Peeking: Students were arranged in small heterogeneous groups. Each group received a stack of thirty cards, face down, containing the vocabulary words and/or concepts. One person in the group must grab a card (without looking at it), place it to their forehead, and others in the group must provide hints to get the person to guess the card. Hints could not include the exact definition or exact word. Hints could include key words and related words or examples. One person in the group (the person to the right of the card holder) acted as “judge” to make sure no rules for hints were broken. If a rule was broken, that card was shuffled back into the deck and another person took a turn. To make it more competitive, some groups competed against each other to see who got through the cards first.



Vocabulary Strategy #4

Name: Matching cards

Modalities: Verbal, Visual, Kinesthetic

Cooperative Grouping: Individual or pairs (student preference)

Matching cards: Each student pair (or individual) received a small plastic bag with ninety cards inside. The cards represented the thirty words/concepts for the unit. Thirty of the cards had the word listed. Thirty cards had the definition. Thirty cards had a picture or icon representing a word and definition. Pictures were teacher-chosen rather than student created to save time. Students were to match each word with the appropriate definition and icon/picture. The goal during week 1 of the unit was to successfully match 10. The goal for week 2 was to successfully match 20. The goal for week 3 was to successfully match all of them (30). The teacher circulates among groups addressing questions, offering suggestions, and overturning correct matches. An example of matching cards is below.

<p>when the traits of species within a population are slightly different from each other</p>	<p>variation</p>	
<p>the process in which humans select which plants and animals to reproduce based on certain desired traits</p>	<p>artificial selection (selective breeding)</p>	

APPENDIX D

PRE- & POST-VOCABULARY ASSESSMENT

Evolution Vocab Pre-Test

Name _____ Block _____

adaptation	
evolution	
species	
population	
biological evolution	

Evolution Vocab Post-Test

Name _____ Block _____

adaptation	
evolution	
species	
population	
biological evolution	

APPENDIX E

MUDDIEST POINT

MUDDIEST POINT

What did this activity help you learn or become more comfortable with?	
What is still confusing and/or what do you still not understand?	
Do you feel that you gave your personal best during this activity? (circle the one statement that applies)	I did my absolute best and gave my all I gave solid effort, but not my all I could have given a lot more I gave no effort at all

APPENDIX F

POST-UNIT SURVEY

POST-UNIT SURVEY

What did you enjoy the most about this activity?	
What did you enjoy the least about this activity?	
How would you improve this activity?	