THE EFFECT OF INTRODUCED LITERACY STRATEGIES ON THE USE OF ACADEMIC CONTENT VOCABULARY IN A HIGH SCHOOL BIOLOGY CLASSROOM

by

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ABSTRACT

The implementation of selected literacy strategies provides content-based resources for students in a high school biology class to better understand the scientific vocabulary. Throughout the course of this research students utilized two type of graphic organizers, science vocabulary awareness chart and double bubble compare and contrast, as well as one type of study model, SQ3R, with the goal of achieving a better understanding of the scientific vocabulary. In particular vocabulary involved with the concepts of DNA, Ecology, and Evolution. The concept of Mendelian genetics was used as the comparison concept for the data analysis. This research study showed an increase in student confidence in regards to their ability to read the text while utilizing the literacy strategies. Though there was no significant statistical improvement on their assessment scores, student participation increased as they gained confidence while using the literacy strategies. The students indicated that the study model, SQ3R, was their preferred literacy strategy as it allowed them to critically process the vocabulary and concepts they were reading.

INTRODUCTION AND BACKGROUND

Cesar E. Chavez High School is one of three public high schools located in Delano, California. Delano California is the second largest city in Kern County (City Facts, 2019) second to Bakersfield. Delano is located in the northern part of Kern County found along one of California's most used highways, the 99, as Californians refer to our highways or interstates. In recent years Delano and the smaller communities around the main city have seen a population increase of nearly 65% from 1990 to 2005 and this is expected to increase another 28% by the year 2020 (City Facts, 2019). Delano as well as the smaller communities that are located in the Central Valley are primarily farming communities.

I was born and raised in a community very similar that is just north of Delano called Tulare. I still reside in Tulare and commute to Delano to work. Since graduating from California State University Bakersfield in 2012 with a Bachelor of Arts (B.A.) in Natural Sciences majoring in Biology and minoring in Geology, I also completed the teacher credential program through the same university, I have spent my whole teaching career, seven years, primarily in Delano. During my first year I completed the credential program by student teaching at Delano High School and subbing at all three sites in Delano and as well as subbing at the high schools in Tulare. Toward that end of that transition year I became a long-term sub at Cesar E. Chavez high school in Delano and was able to secure the full-time position of biology teacher, effectively taking over the position that I initially subbed for. I am currently in my sixth year of full-time teaching and sincerely love my job every day. I have taught our 9th grade integrated science course because of the nature of my B.A. and 10th grade biology. This is the first year that I am

teaching a physical science course due to our increased class sizes. I am also a Track and Field coach during the spring semester, the events that I specialize in are the shotput and discuss throws. This year I have made the transition from assistant coach to head coach and look forward to a great season.

Cesar E. Chavez High School was the second high school built in Delano, established in 2003, and each high school in the city of Delano is classified as a Title I school. This means the majority of students are from socioeconomically disadvantaged households. Every public school in California is mandated by law to publish a School Accountability Report Card (SARC), which contains information about school condition and performance on state tests. Eighty-nine percent of the student population was designated as socioeconomically disadvantaged in our SARC for Cesar E. Chavez in the 2016-2017 school year. The students are predominantly from families that are farm laborers. Other students' families include teachers, doctors, or business owners. The majority of the community is Hispanic or Filipino. According to our 2016-2017 SARC report, the campus had a total enrollment of 1,409 students. Of the total population of enrolled students, 87% were Hispanic or Latino and 9% were Filipino. Of the 1,409 students enrolled about 25% are English Learners (EL) and 8.4% are designated as students with disabilities.

The average class size ranges from 28 to 37 students. The class sizes have increased due to the increase in enrollment from one year to the next. The 217-2018 school year saw the largest population with a total enrollment of about 1,500 students, with little variation in the population size at the start of the 2018-2019 school year. The

school year is broken into two semesters which then are subdivided into four quarters, each quarter lasting about 10 weeks. The school administration has outlined the science department so that the majority of freshmen will be taking biology, because of this new step to better prepare students for the California Science Test (CST) we have a full blending of the biology courses offered this year, 2018-2019. The science department is still offering a freshman integrated science class which is set up to teach students a quarter of each sciences such as biology, earth science, chemistry, and physics. The freshmen course is an elective that will meet graduation requirements as an elective credit, not a science credit, because of the credit the students get for the course not all students take this course. There are three paths available for students to take as part of the science curriculum. The primary path taken by students are the college prep (CP) classes, the second option is considered the general path for students who may be part of the special education department or who are low in academic standing, there is a third option for students in the honors path, or Pre-Advanced Placement (A.P.). In the CP option students will take biology their sophomore year and chemistry in their junior year with the option to take CP physics as a senior. Students in the general classes will take life science, biology without the lab component, as sophomores, and physical science in their junior year. The general path does not have the option for physics as it is students who are simply meeting graduation requirements. In the AP path students will take biology Pre-A.P. as sophomores, honors chemistry as juniors, and the majority will take AP Physics as seniors. The state of California only requires two years of science as a minimum to meet graduation requirements, so the majority of students will complete this

during their sophomore and junior years. It is the students who wish to continue on to college that will take three years of science in high school; biology, chemistry, and physics.

The overall standardized test scores meet or exceeded state standards as described in the 2016-2017 SARC. Of the 99% of EL students tested in 2016-2017, 29% of them met or exceeded that standard. I believe this number can be improved upon by helping EL's in every subject, not simply relying on the English teachers or the special education department. California state tests are incorporating more science-based questions in all state mandated tests; this is due to the state adopting Common Core Standards and the Next Generation Science Standards (NGSS). Because of this movement, science teachers have an increased responsibility to incorporate more literacy skills in the classroom. The foundation of the literacy skills starts with an understanding of vocabulary.

Considering the student population and the increased demand by the state, I have focused my research on the improvement of student understanding of scientific vocabulary through the introduction of literacy in the Biology science classroom. Literacy has always been valued and with the introduction of the NGSS the focus of literacy has entered the science classroom in a new way. By introducing several ways for students to be engaged in reading in a science classroom, students' reading comprehension and standardized test scores will increase. The focus must start in the classroom first before we can look at the state standardized test scores. Within the classroom vocabulary and literacy skills will be developed to aid in student comprehension. The main question that the research will answer: will implementing

different literacy strategies or techniques improve student vocabulary comprehension?

To answer the main research question, the following sub questions will address the methodology.

- Will using graphic organizers help students establish and retain relationships between the reading and vocabulary?
- By using the Survey, Question, Read, Recite, and Review (SQ3R) strategy, will there be an improvement in student vocabulary retention?

CONCEPTUAL FRAMEWORK

Teaching in today's secondary school science classroom presents many unique opportunities and challenges. From the increased amount of multicultural and multi-language individuals, to creating equal opportunity environments with the implementation of the Next Generation Science Standards (NGSS), the possibilities are limitless. The United States has an increasing influx of families from different countries which is ultimately witnessed in the classroom at all grade levels (Greathouse and Lincoln, 2008). It was approximated that 10.5% of the U.S. population were English Language Learners (ELL) in a report conducted in 2004 and 2005 (Payan and Nettles, 2008). California is one of the six states that hold the majority of the ELL population and has been a fast-growing population ever since. With this increased diversity there is an increased amount of pressure to be able to relate science content to students on a personal level. Teachers must provide ways for students to make connections between their experiences at home to activate prior knowledge (Greathouse & Lincoln, 2008). The NGSS have laid the ground work by providing a framework of science and engineering

practices, eight practices in total, to guide science teachers in implementing the best methodologies to meet the needs of all learners. Practice eight establishes that students should be able to obtain, evaluate, and communicate ideas based on the academic content that they are learning, this particular practice is not only important for all student but very important, and often difficult, for ELL students. By activating prior knowledge students will increase their capacity for learning and with it a greater comprehension of new information.

Being able to activate the curiosity or prior knowledge of any student, no matter their background or home life, requires teachers to be able to utilize different modes of teaching. In a study done by Osborne and Collins (2001) student perceptions were taken into account for science curriculum. The study found that students felt that the scientific knowledge was an important component of their overall education. One of the reasons students were in favor of the scientific information was that it provided them with an understanding about the physical world around them. Students in the same study also identified that many aspects of understanding the scientific knowledge were difficult, especially the unfamiliar vocabulary they were being introduced to in a science classroom. The researchers of the study did not take into account the teaching methodologies of the instructors the students were exposed to, but students did express that they became more engaged if the teachers made the lessons ‘fun’. Making a lesson more engaging could have been the result of how the teachers presented the information; whether it was through presentations, organization of the work, or instances when students were conducting practical hands on activities. In a comparative study done by

Lyons (2006) students understood the real-world application of scientific knowledge through the emphasis implied by their teachers, but their experiences in school science classrooms often fell short of making science meaningful on a personal level.

Students should become immersed in their contextual learning through the implementation of various engaging activities. The lecture and memorization format that was very familiar in the classroom are no longer effective for the students or the teachers. Science classrooms have been forced to change with the installment of the NGSS. One particular mode of learning in a science classroom that has been enhanced with the introduction of the NGSS is literacy in a science classroom. Literacy has always been a foundation of education, but with an increase in student diversity and the movement away from memorization as a top priority, science teachers are using different innovative methodologies to integrate science vocabulary with literacy skills. Often the major key to understanding a sentence is being able to understand the vocabulary in use (Pang, 2013). Literacy is no longer perceived to be the sole responsibility of English teachers. Osborne (2002) stated that knowing the vocabulary of science without the understanding of the content is like knowing the words of a foreign language without the comprehension of its grammar or its modalities of expression. The learning of science has often been aligned to learning a foreign language because of its complexities. “Science cannot be understood without an exploration of its language” (Osborne, 2002). Simply memorizing the information that has been presented does not allow the students to explore the possibilities of science. Science teachers in today’s increasingly diverse classrooms must have the skills to demonstrate to students how to read science text and obtain

information. Being able to decode and pronounce the scientific vocabulary aid in the students expected retention of the content material (Carnine & Carnine, 2004).

One such medium to aid students in this quest is implementing the use of graphic organizers. Graphic organizers are a widely used strategy in a verity of ways to summarize reading content, organize facts, and compare and contrast as the students read (Pang, 2013). The most available resource used for a science classroom is the textbook provided by the school, though reading such texts are often difficult for the students, ELL or not, both conceptually and linguistically (Roman, Jones, Basarada, & Hironaka, 2016). Science texts require students to be able to infer how the textbooks function as a unit to understand the meaning of scientific vocabulary and context. Akhondi (2011) goes on to explain that graphic organizers are utilized as way for students to identify major ideas within a text. Through the texting of signal words, like scientific content vocabulary, students will be able to use a graphic organizer to comprehend and retain what they have read (Akhondi, Malayeri, & Samad, 2011). Thinking Maps Inc. (2017) has conducted research into human brains as well as education to develop their eight visual patterns. The research done was on the basis that all learners are different and thus require different formats to learn. By providing a format for students to visualize their abstract thoughts they will make a better connection to the material (Hyerle &Yeager, 2017). Because of the complexity and challenge that scientific texts present to students there is a large variety of graphic organizers available to teachers. This variety will equip students with the tools to access scientific content and comprehend the information presented to them (Roman, Takahashi, Park, & Stodden, 2016).

Another strategy that teachers can utilize to help students understand scientific content vocabulary and promote literacy is the SQ3R reading comprehension strategy that was first formulated by F.P. Robinson (Roberts, et al. 2012). This strategy has a built-in set of steps for students to follow as they are reading a scientific text; SQ3R stands for Survey, Question, Read, Recite, and Review. Roberts et al. (2012) goes on to list the steps of the SQ3R strategy that teachers will apply when implementing this in the classroom; Students will survey the text before they start to read, this means looking through the assigned reading or text to skim and process the material at a glance. The students then will question while they explore the text during the survey portion. Students will question as they read, it can begin as simple as asking themselves if they know what the chapter is about. This question they will address while they read. The next step is to recite the text the students have read; this can be done by having the students summarize what they have read with a partner or for themselves on a piece of paper. The final step is to review the material the students have read (Roberts et al. 2012).

The SQ3R strategy requires little to no teacher preparation before implementation and is designed to help students question the material they are reading (Martin, 2002). The goal of introducing the above strategies is to make the science texts more accessible to the students and allow them to comprehend what they are learning from the text as it applies to the world around them. Students are expected to retain the content material and apply the information for state tests as well as meeting the NGSS objectives for the science courses. The literacy strategies of graphic organizers and SQ3R will aid the

student in development of content specific vocabulary, an important skill for all students but particularly the ELL students.

METHODOLOGY

Students are required to comprehend the subject matter content of high school biology, in order to do this, they must become masters of the content specific vocabulary. Before beginning treatment, approval for the experiment was obtained from Montana State University's Institutional Review Board (IRB) who are the governing body involved when research subjects are human to ensure human rights are not violated by the treatment (Appendix A). Permission must also be obtained from the students and parents in order to be able to collect their data whether it is in the form of surveys, demographics, or assessments. This permission is approved by the IRB before being distributed to the students and parents (Appendix B). The purpose of this study is to help students utilize a literacy strategy in order to become masters of the content specific vocabulary (Table 1). The research question is; will implementing different literacy strategies or techniques improve student vocabulary comprehension? And the following sub questions will address the types of strategies to be implemented; 1) Will using graphic organizers help students establish and retain relationships between the reading and vocabulary? And 2) by using the SQ3R strategy, will there be an improvement in student vocabulary retention?

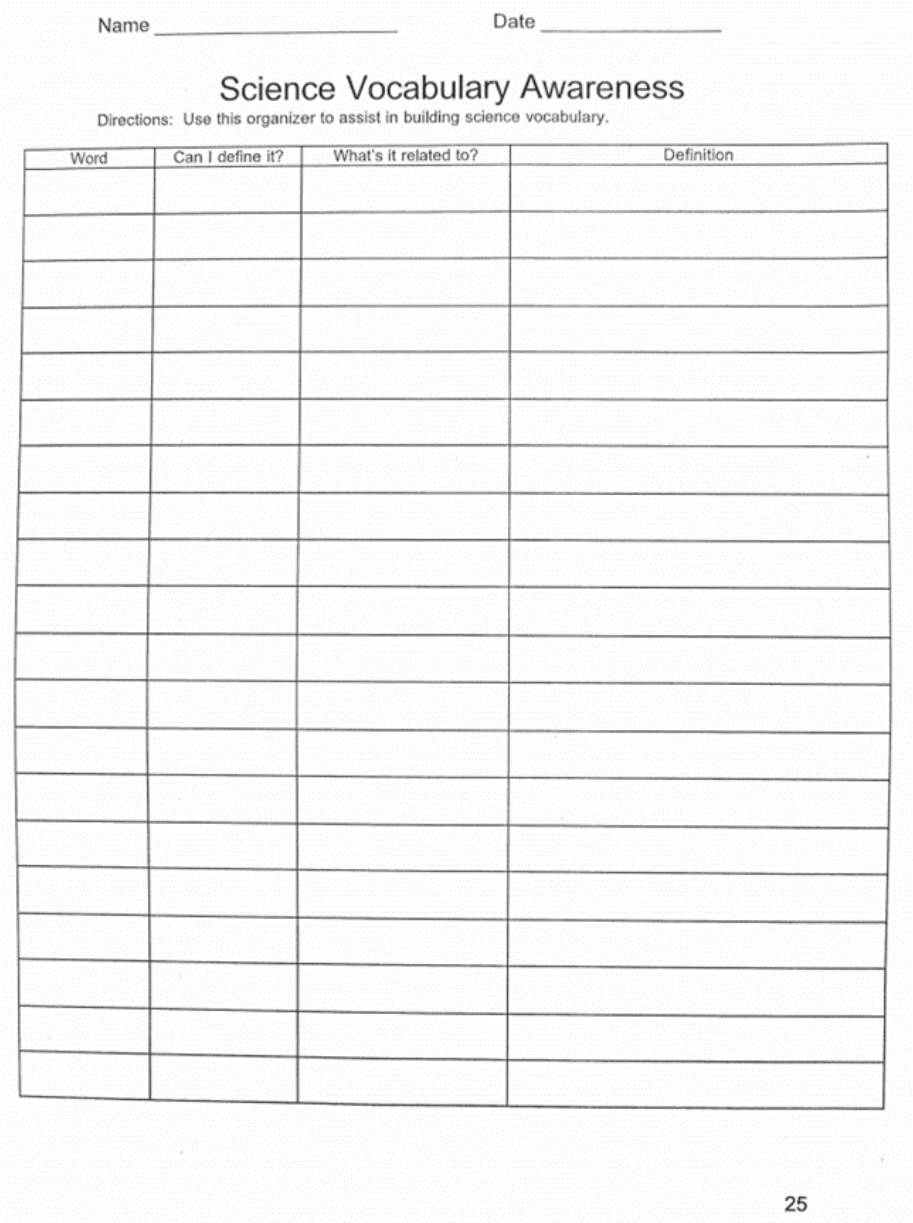
Table 1
Data Triangulation Matrix

Research Question	*Qualitative*	*Quantitative*
Will implementing different literacy strategies or techniques improve student vocabulary comprehension?	• Survey • Student Interview • Teacher Observations • Student Work	• Student Performance on Assessments
SQ. 1: Will using graphic organizers help students establish and retain relationships between the reading and vocabulary?	• Survey • Student work	• Student Performance on Assessments
SQ. 2: By using the SQ3R strategy, will there be an improvement in student vocabulary retention?	• Survey • Interview • Student work	• Student Performance on Assessments

The student demographics of my school are largely first or second-generation Americans that have a first language that is not English. This designates the students as ELL's and science vocabulary can be even more difficult for this group of students. In order to answer the research questions, I selected two graphic organizers to help students focus on vocabulary and then the SQ3R strategy was implemented in the format of a worksheet found in the Teacher Workbooks (2003) Science Organizers Series. One graphic organizer is called Science Vocabulary Awareness (Teacher Workbooks, 2003) and the other is referenced as a Double Bubble Compare and Contrast Thinking Map (Hyerle & Yeager, 2017). Treatment will take place over the course of 4 units, this includes the subject content of Mendelian Genetics, Protein Synthesis, Evolution, and Ecology.

The vocabulary learned in respect to Mendelian Genetics will be considered the control as no additional vocabulary practice was implemented. I will start the data collection with a survey (Appendix C). This survey will help me establish an idea of student's response to the current, non-treatment, mode of teaching and then the treatment mode of teaching. A post-treatment survey will be given at the very end of the research. This survey focuses on the student's overall impression of their confidence in the vocabulary skills they possess, while the assessments will provide more in-depth account of vocabulary skills gained. A content specific post-test will also be administered at the end of every unit to determine the impacts of each treatment on student performance.

As the students learn about protein synthesis, they will utilize the science vocabulary awareness organizer (Figure 1). This graphic organizer has the students write the word they are learning, establish if they can define it before reading the text, make work or concept associations by writing what the word is related to, and then define the word. Utilizing this graphic organizer helps the students make connections between what they have already learned and what they are currently learning. At the end of this unit the student vocabulary worksheets will be collected and the unit assessment will provide quantitative data collection to compare to the control assessment for the unit on Mendelian genetics.



Name _____ Date _____

Science Vocabulary Awareness

Directions: Use this organizer to assist in building science vocabulary.

Word	Can I define it?	What's it related to?	Definition

25

Figure 1. Vocabulary awareness worksheet from teacher workbooks.

The next graphic organizer used is the Double Bubble: Compare and Contrast thinking map (Figure 2). This graphic organizer has students work with two vocabulary words at a time to compare and contrast the similarities between the words as well as the differences. This organizer will be implemented as a review for the assessment after the vocabulary has been taught in the individual lessons leading up to the Evolution Unit

assessment. The students will be given a list of vocabulary words that relate to the material that had been covered. From this list they were to provide four complete maps, which would ultimately have the students working with eight vocabulary words. The choice of which words will be used will be determined by the student's preferences. Students were provided a guideline on which words to use in a compare and contrast manner, specifically looking at words they had difficulty with. As this treatment was used to review and inform the students study habits for the assessment.

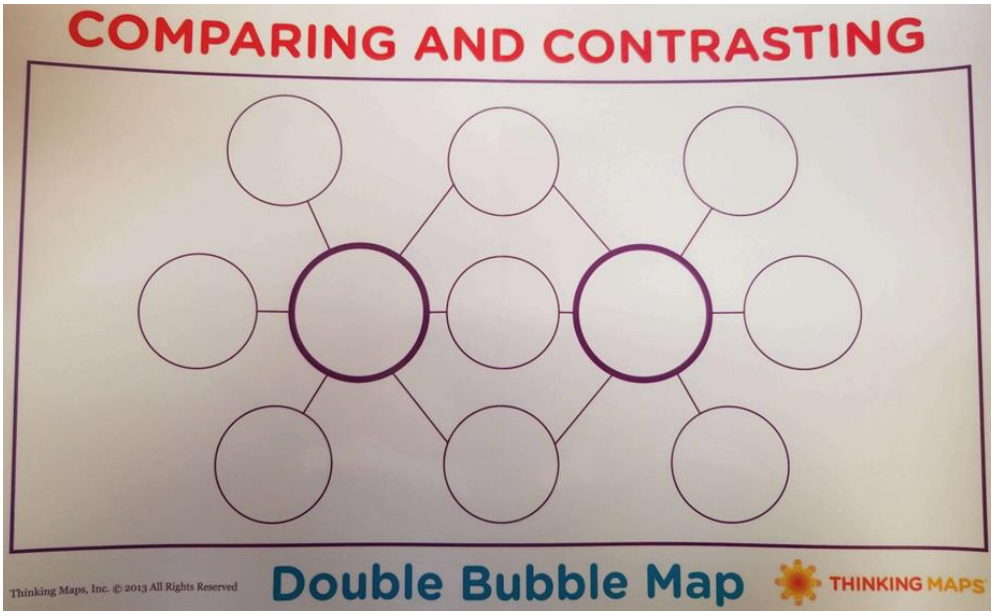


Figure 2. Double bubble: comparing and contrasting format by thinking maps inc.

For the Ecology unit, students will work with the SQ3R treatment (Figure 3). This unit and strategy will allow for the students to express cross cutting concepts, which are an important part of NGSS and demonstrate to student's real-world applications of the scientific vocabulary and content that impacts the day to day life of human beings and other organisms. This treatment was implemented in stages due to the length and chapters involved for this unit. The stages for this treatment involved students holding themselves

accountable for their work by placing a check mark in the recite category to signify they recited the information that they wrote to themselves, the next stage the students would recite their information to their partners, providing the name of their partner that they recited the information to, and the final stage the person they recited it to was required to sign off that they received the information from the students. If the student was not able to finish their work in class, they were allowed to obtain a parent or sibling sign off when they took it home as homework.

SQ3R Chart

Directions: This chart is helpful when reading a passage. Use one chart for each major section.

Survey Write the m important titles.	
Question Write a who, what, when, where, and why question.	
Read Read all information to answer questions.	
Recite Orally answer questions.	
Review Create summaries and main ideas from the passage.	

Figure 3. The SQ3R literacy strategy to organize concepts.

For each strategy student work will be collected, teacher observations will be noted, and formative assessment data will be collected. For the formative assessments I will implement the CCHS Science Department Formative Assessment of Core Standards (FACS). The FACS are unit summative assessments that science department at my site have implemented that contain multiple choice questions as well as essay questions (Appendix D). I will compare students' scores for the comparison unit of Mendelian genetics with protein synthesis, evolution, and ecology. Each FACS has been aligned with content specific questions that allow for the assessment of student content specific vocabulary (Table 2). Throughout the research teacher observations will be recorded as well as a post treatment student interview. Student work will also be collected and organized to establish if there is an improvement in the vocabulary retention based on the treatments.

Table 2
Treatment Matched with Content and Assessment Name

CONTENT	TEST NAME	TREATMENT
MENDELIAN- GENETICS	FACS 3	Comparison/No Treatment
PROTEIN SYNTHESIS	FACS 4	Vocabulary Awareness
EVOLUTION	FACS 5	Double Bubble
ECOLOGY	FACS 6	SQ3R

In determining if graphic organizers or the SQ3R methodology have improved student learning and retention or not will be evident in the data collected throughout the course of the study. The merits of this project will improve teaching strategies in my classroom among my students and I will be able to share that information with my department so that we can improve student learning for the sciences. There are limitations to my methodology, such as student response to the strategies I've chosen to use as part

of my study. The limitations can include the pairing of treatment with the content topic, it may not fit the best with the content when paired with another teachers teaching style. Another limitation that can occur would be with the teachers modeling of the treatment. A complete understanding of the treatments before implementation is required as to not confuse the students, this is also true when a teacher is trying new methodology with a class. It is also important to keep in mind that while one method may be compatible with one group of students, it may not be with another group. Understanding the students' needs will determine the course of action taken by the teacher.

DATA ANALYSIS

Student data was collected through pre- and post-treatment surveys and FACS assessments for each unit. The FACS are divided into two parts: multiple choice and essay responses; with totals of the students overall scores taken into account. As set down by the departments' protocol for students taking the FACS, we have alterative versions of the assessments, this is done to reduce the temptation for cheating on the student's part and second to provide a retake opportunity for the students. All students are provided with a retake opportunity and it is left up to the instructor on whether to add the scores together or to take the student's best score. For the purpose of this study students' scores from both FACS attempts were added together. This provided a total of 40 available points for the students. Students' assessment scores for pre-treatment and during treatment were measured and a descriptive analysis ran for each in Microsoft Excel (Table 3). The resulting descriptive data analysis collected for this study indicates that the means were very similar between the treatments with the genetics unit, no treatment,

being the lowest mean with the ecology unit being the highest mean. The mean is a measurement that correlates the central tendency of a data set. However, the standard deviation indicates that the evolution unit is the lowest with the genetics unit having the highest. The range indicates the greatest difference in student scores being with the genetics unit, while the least amount of difference occurred with the evolution unit. The standard deviation measured indicates that the greatest disbursement from the mean occurred with the genetics unit, while the least amount occurred with the evolution unit.

Table 3
Descriptive Statistics for Student Assessment

Unit	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Range	Min	Max	Skewness
Mendelian Genetics	18.65	0.63	19	16	7.04	49.59	34	2	36	0.11
Protein Synthesis	22.54	0.63	23	22	7.01	49.19	32	8	40	-0.01
Evolution	22.05	0.43	22	22	4.82	23.22	22	10	32	-0.32
Ecology	23.67	0.61	25	26	6.75	45.50	28	8	36	

Note. (*N=124*)

This information was then used to conduct two sample t-tests to determine statistical value of the data. The program R studio was used to input the data and run the statistical tests. The Mendelian genetics unit is used as the pre-treatment assessment and compared to each unit individually to gain insight on weather that particular treatment has a statistically significant difference. The two-sample t-tests were run with a 95%

confidence interval, operating with a null hypothesis that there is not difference between the comparison and the treatment assessments and alternative hypothesis is that the true difference in means is not equal to zero. The results of the t-tests show no statistically significant differences between the treatments, which results in failing to reject the null hypothesis (Table 4).

Table 4
Results of Two-sample t-tests

Assessment Comparison	t-value	Degrees of freedom	p-value
Pre-test vs. Vocabulary Awareness Treatment	-4.355	246	1.954e-05
Pre-test vs. Double Bubble Treatment	-4.4307	217.46	1.489e-05
Pre-test vs. SQ3R Treatment	-5.7464	245.55	2.69e-08

Note. (*N*=124)

Likert style survey questions were utilized during the pre-and post-treatment surveys. Students were asked in the pre-treatment evaluation if they had ever used a graphic organizer prior to this class and 66% said they had while 34% indicated that they had not used one previously (Figure 4).

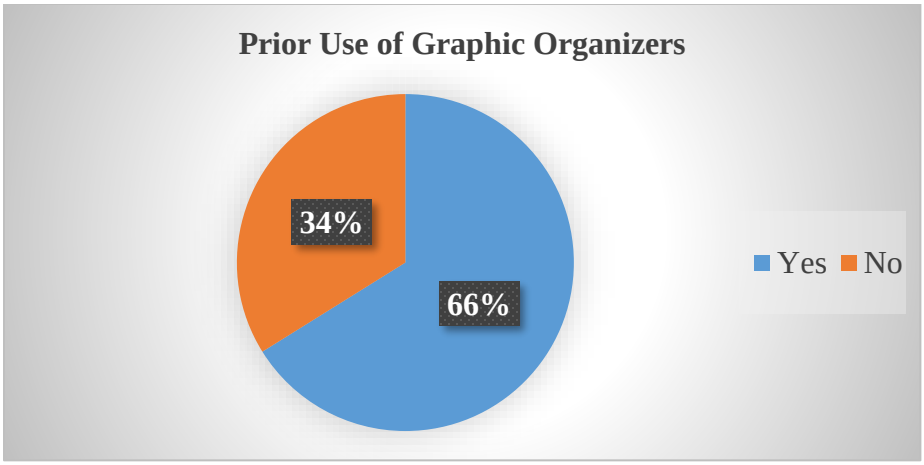


Figure 4. Student use of graphic organizers prior to treatment, (*N*=124).

Students' confidence while reading the textbook was taken into consideration (Table 5). The pre- and post-treatment survey measured student confidence in regards to reading the textbook and there was a clear positive shift from the pre-treatment to the post-treatment. About 55% of the students expressed that they were either extremely or very confident with their level of reading ability with the textbook, that percentage increased to 67% post-treatment.

Table 5
Student Responses to Confidence Level While Reading the Textbook

	Extremely/Very	Somewhat	Not So/Not at all
Pre -Question 1	68	49	7
Post – Question 1	83	38	3

Note. (*N*=124)

Students' responses to the level of helpfulness of the methodology for reading the textbook were taken into account for pre- and post-treatment (Table 6). Students responded that for the pre-treatment 57% of them found the methodology extremely to very helpful for reading the textbook. For the post treatment, that percentage moved to 69% that found the treatment methodologies more helpful.

Table 6
Student Responses to Level of Helpfulness with Current Reading Methodology

	Extremely/Very	Somewhat	Not So/Not at all
Pre- Treatment	71	44	9
Post- Treatment	85	35	4

Note. (*N*=124)

In the post treatment survey students were asked about their preference in treatment, due to the fact that there were three treatments total, I wanted to gain some insight into the students thought process about these treatments (Figure 5). Students demonstrated an overwhelming preference for the SQ3R treatment, at total of 61% of

students who participated preferred that method. The second most preferred treatment was the vocabulary awareness with 31% of students measured that found this to be the most helpful for them.

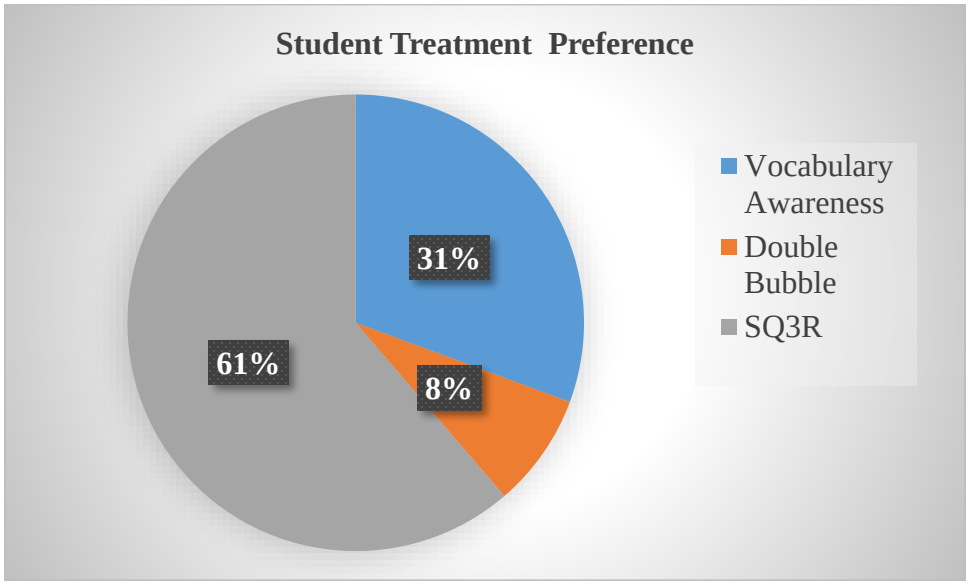


Figure 5. Student indicated treatment preference, (*N*=124).

Students were asked to clarify why they chose the particular treatment that they did on their survey. The post treatment survey was utilized to aid in this as well as post treatment interviews and observations. Students indicated that they felt more involved with the reading and content through the SQ3R treatment rather than the Double-Bubble comparing contrasting or even the vocabulary awareness.

INTERPRETATION AND CONCLUSION

The main goal of this research project was to demonstrate that introduced and specialized literacy strategies would improve the students understanding of the content material. Through the statistical analysis of the student's assessment scores the results indicate a failure to reject the null hypothesis based on the p-values. In each treatment case there was no significant difference between the student's test scores for pre- or post-

treatments. Although the treatments are strategies that have been utilized in classrooms before, my study shows that for my students there were no difference between the treatments in regards to their assessment scores. On a low number of individual assessment scores there were improvements observed, this was not true of the whole. This was not the case in observations made during each treatment period and there was a very distinct confidence increase from pre- to post-treatment.

Students indicated a 12% increase in confidence from before treatment to post treatment. So even though there was no statistical indication that the treatments helped students remember the content specific vocabulary on the assessments, they feel more confident about working on the material and learning about the scientific concepts. The conclusion from this indicates that modeling for the student's different strategies to help them learn really improved their confidence. This is also reflected in Greathouse and Lincoln's work (2008) in exploring how science information is presented to students, providing varied ways of learning information will provide a greater opportunity for all learners to succeed. They also discuss that organization is a key component in making the concepts of science more accessible for all learning. With the treatments that I chose for this research study, students became more confident with the material because the treatments added to their resources of how to understand the concepts.

There were a small handful of students that improved their assessment scores from the pre-treatment to the post treatment. For these students I was able to differentiate instruction that worked for them. Even though the assessment data did not indicate a difference between treatments, I observed great differences in the students as they

worked with the treatments. Students responses to strategy preference was overwhelming for the SQ3R, a full 61% of students preferred that method. One student indicated that, "It helped me break down the chapter and understand it better." Another student stated that, "It helped me study" because that is an area that the student has issues with, studying at home. There were several students that indicated that the recite portion of the method helped them remember and understand because they had to say it out loud to someone else. There was a student who found the questioning aspect most helpful, "This chart [SQ3R] allowed me to make my own questions, stimulating my brain to therefore remember what I have learned when answering my questions." With the student inputs about this strategy have really given it value for me. It gave the students an opportunity to demonstrate higher order thinking and a different interaction with the content, not just with vocabulary. Students felt that the different parts were more beneficial for them and that they could ask their own questions, which the book did not necessarily cover, and figure out the answers for themselves. This is supported by the key routine for students to understand the text that is outlined by Martin (2002), the routine includes noting clarification of ideas, questioning the material, and re-read the material to determine understanding. According to Martin, by implementing these tactics students will be able to comprehend the text they are reading. We can see this being established with the SQ3R methodology and the students respond to the organization of that particular treatment.

Thirty-one percent of the students preferred the vocabulary awareness strategy. This strategy allowed the students to list the vocabulary that was being used and keep it organized for them as they studied. One student stated, "I found that the vocabulary

awareness chart was more organized." The organization of this strategy was observed, the students were able to keep track of which words they were using and this strategy became a quick reference for the unit. The data show that this unit, protein synthesis, had the second highest in range, standard deviation, and variance when compared to the other treatments. It was second highest only to the pre-treatment assessment.

The data indicates that the unit for evolution had the least amount of differences between students' scores, lowest standard deviation, and lowest variance. The treatment for this unit was the double bubble comparing and contrasting organizer, which was observed to be the strategy the students were less receptive to. Only 8% of students felt that the double-bubble comparing and contrasting graphic organizer was the most helpful for them. Though I am not sure why there was such a low preference for this strategy the students that did find it helpful sited the fact that they had to think about the words they were working with. One student stated, "I had to think more about the word which helped me remember it." Or another student said, "It [comparing and contrasting] helps you become familiar with two or more words and how they are alike or different."

The strategies were utilized to benefit all students however, this study did not examine the relationship between the use of these strategies and the scores of the ELL learners amongst the study population. This information would be an avenue to explore at a later time, if the ELL students' scores did improve through the use of these literacy strategies. This would be an option for future study.

VALUE

With the implementation of this study, the use of graphic organizers and the SQ3R, I have improved my teaching methods and how I model information for the students. By conducting this study, I was able to break down the content vocabulary in new and different ways. This new pathway of breaking down vocabulary provides me with a better understanding of my students needs as well as reflect on how I provide the information to the students. How we as instructors' model for our student's matters, and with this study it was more evident that how I model the information for one class was not the way I needed to model it for another class. The strategies were received nearly the same from the students that were part of study throughout the five periods that they were presented to. Though the majority of the students did prefer the SQ3R, this was great information for me as a teacher. I feel, based on what I observed, that it was the organization involved with this strategy that the students responded well to. There were some that liked being able to list the information, others that liked to see and explore the differences, but the majority preferred to read the text and gather information that way.

This leaves me with a desire to continue to work with these strategies, I believe that if utilized together throughout the course of the year the students would benefit from these differentiated instructional strategies. These are strategies that can be shaped to fit the needs of my future students and the needs of the curriculum.

By conducting this research, I was able to devise a set of platforms for instruction that did help students, even if it didn't change their overall test scores. I will be able to utilize the information that I gathered from this research and apply it to new

methodology, continue to model the information for students in different ways, and improve students of science content vocabulary.

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APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

MONTANA
STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Zabrina Hollabaugh and Marcie Reuer

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

DATE: October 26, 2018

RE: *"The Effect of Introduced Literacy Strategies on the Use of Academic Content Vocabulary in a High School Biology Classroom" [ZH102618-EX]*

The above research, described in your submission of October 26, 2018, 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

INSTITUTIONAL REVIEW BOARD APPROVED PERMISSION FORM

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH AT MONTANA STATE UNIVERSITY.

The Effect of Introduced Literacy Strategies on the Use of Academic Content Vocabulary in a High School Biology Classroom.

You are being asked to participate in a research study of instructional strategies. This may help us obtain a better understanding of how students learn and through that learning achieve a good understand of the subject of Science.

Participated in this study is voluntary. If you agree to participate you will be asked to take part in the introduction of new instructional strategies to better help the students learn the information in class. This will be done in the form of surveys, worksheets, books readings, tests and participation in class. Part of the data collected for this research will be done in the form of surveys, participation is voluntary and you can choose to not answer any questions you do not want to answer and/or stop at any time. Participation or non-participate will not affect students grades or class standing. All comparison data and experimental data will be obtaining from all students. The information will be kept anonymous; the students will be assigned numbers to keep their identity anonymous. The confidentiality of you and your student's information is very important to me and I will keep all research material locked. The introduction of these strategies is to also help me become a better teacher for your student(s) and for future students. There are no foreseen risks to your students if they participate in this study. Again their grade and class standing will not be impacted no matter if they participate or not.

Should you have questions about the research, please do not hesitate to contact me at my school email: zhollabaugh@djuhsd.org

If you have additional questions about the rights of human subjects please contact the Chair of the Institutional Review Board, Mark Quinn, (406) 994-4707 [mquinn@montana.edu].

Agreement:

By signing this form, I agree to be in the research study described above.

Student Signature: _____

Student Name (printed): _____

Parent Signature: _____

Date: _____

APPROVED
MSU IRB
10/26/2018
Date approved

processed by expedited review

APPENDIX C

PRE-TREATMENT STUDENT SURVEY

Pre-Treatment Treatment Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. How confident do you feel while reading the textbook?
    a. Extremely Confident
    b. Very Confident
    c. Somewhat Confident
    d. Not So Confident
    e. Not At All Confident

2. Do you find the current way of reading the textbook helpful?
    a. Extremely Helpful
    b. Very Helpful
    c. Somewhat Helpful
    d. Not So Helpful
    e. Not At All Helpful

3. Have you ever used a graphic organizer before?
    a. Yes
    b. No

4. How confident are you about the vocabulary for this topic?
    a. Extremely Confident
    b. Very Confident
    c. Somewhat Confident
    d. Not So Confident
    e. Not At All Confident

5. List 5 vocabulary words that you are confident about for this content area.

APPENDIX D

FORMATIVE ASSESSMENT OF CORE STANDARDS

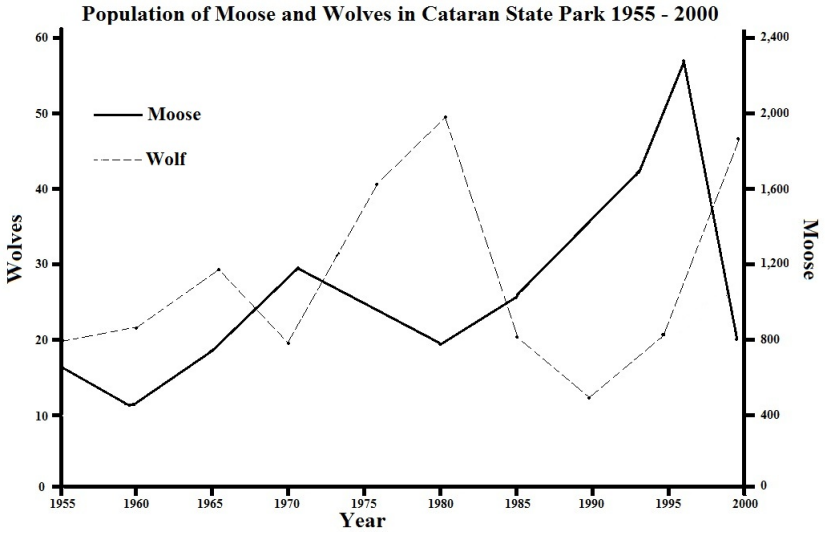
SAMPLE OF MUPLITPLE CHOICE QUESITONS

Which factor may have played a role in the development of the polar bear in Alaska and the brown bear in Russia into two separate species?

A) artificial selection **C)** asexual reproduction
B) geographic isolation **D)** mitotic cell division

Natural selection can best be defined as

A) elimination of the smallest organisms by the largest organisms.
B) survival of the strongest organisms.
C) survival of those organisms genetically best adapted to the environment.
D) survival and reproduction of those organisms that occupy the largest area in the environment.



Examining the data trends in the graph above, we see that as the population of wolves increases, the population of moose *(LS2-8)*

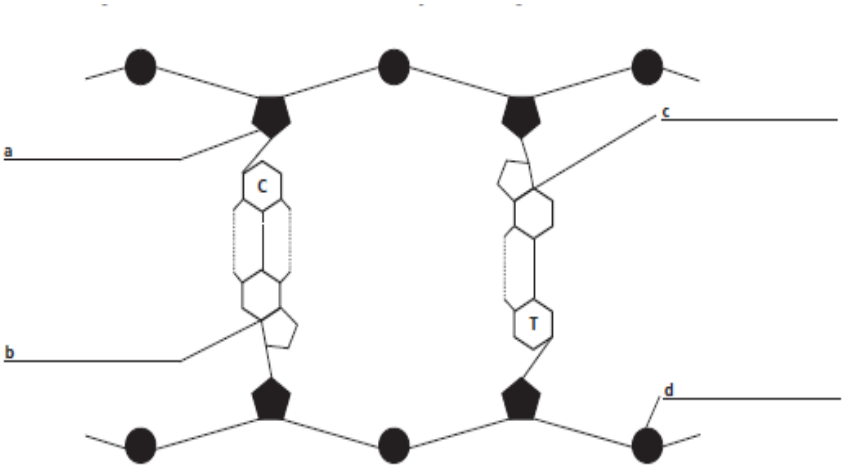
A) increases. **B)** decreases. **C)** changes very little. **D)** doesn't change at all.

APPENDIX E

FORMATIVE ASSESSMENT OF CORE STANDARDS

SAMPLE OF ESSAY QUESITONS

The diagram below shows two nucleotide base pairs in a segment of a DNA molecule. [HS-LS 1-1]

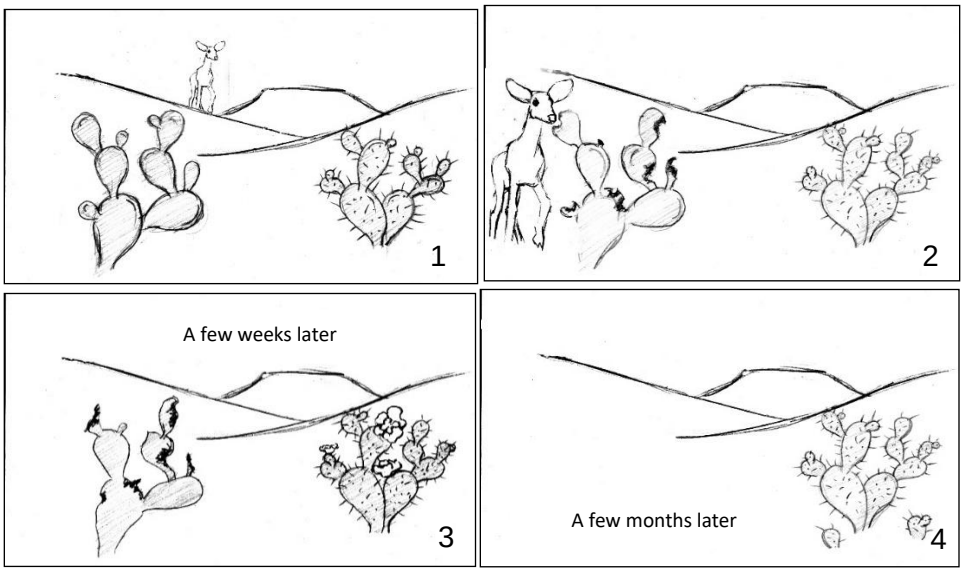


a. **Label each part of the figure in the spaces provided. (2pts)**

b. **What are the three parts of a DNA nucleotide? (1pt)**

c. **If 20% of the nucleotides in a DNA molecule contain guanine, what percentages of the nucleotides contain each of the other three bases? Explain your reasoning. (2pts)**

Below is a series of pictures representing changes in a population of cacti. Pictures 1 and 2 show what happened when a deer came to eat, picture 3 shows the cacti a few weeks later and picture 4 shows the situation a few months later. Answer the following question based on this image. (5 points possible) HS-LS4-4



a. Which cactus would a deer more likely eat, the one on the left or the one on the right? What effect does the deer's behavior have on the survival and reproduction on **EACH** of the two types of cactus? ***(4 Points Max)***

(Each of the underlined and CAPITALIZED words/ phrases represent one (1) possible point for the response)

What evolutionary process is occurring in the sequence of images? ***(1pt max)***

APPENDIX F

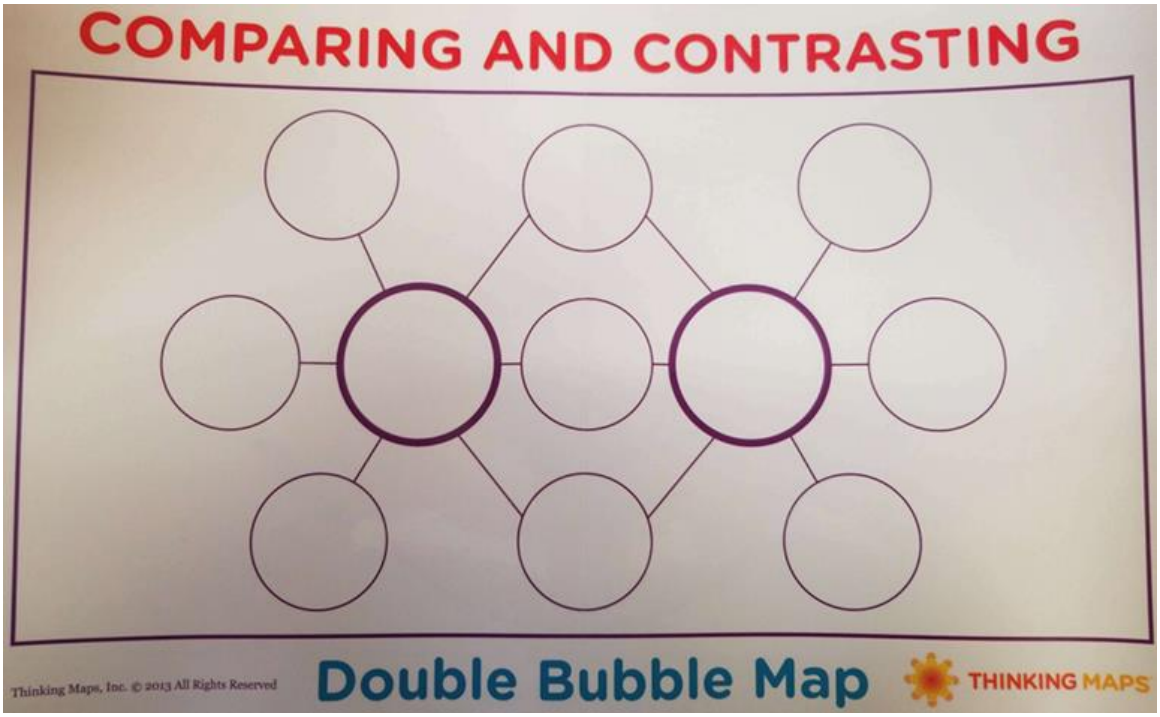
LITERACY STRATEGIES

Name: _____ Date: _____

SCIENCE VOCAULARY AWARENESS

Directions: Use this organizer to assist in building science vocabulary.

Word	Can I define it?	What's it related to?	Definition


COMPARING AND CONTRASTING
Thinking Maps, Inc. © 2013 All Rights Reserved
Double Bubble Map
THINKING MAPS

Name: _____ Date: _____

SQ3R Chart

Directions: This chart is helpful when reading a passage. Use one chart for each major section.

Survey Write the m important titles.	
Question Write a who, what, when, where, and why question.	
Read Read all information to answer questions.	
Recite Orally answer questions.	

Review Create summaries and main ideas from the passage.	

APPENDIX G

POST-TREATMENT STUDENT SURVEY

Post Treatment Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. How confident do you feel while reading the textbook?
    a. Extremely Confident
    b. Very Confident
    c. Somewhat Confident
    d. Not So Confident
    e. Not At All Confident

2. Do you find the current way of reading the textbook helpful?
    a. Extremely Helpful
    b. Very Helpful
    c. Somewhat Helpful
    d. Not So Helpful
    e. Not At All Helpful

3. Which method do you find the most useful when studying vocabulary in this class?
    a. Vocabulary Awareness Organizer
    b. Double Bubble: Compare and Contrast Organizer
    c. SQ3R Organizer

4. Briefly explain why you choose that particular organizer. (How was it helpful to your learning?)

5. Which topic are you more confident in regards to the vocabulary?
    a. Mendelian Genetics
    b. DNA
    c. Evolution
    d. Ecology

6. List 5 vocabulary words that you are confident about for that content area.

APPENDIX H

INTERVIEW QUESTIONS

Interview Questions:

1. Which content area did you enjoy learning about the most?

2. Why did you pick that particular area?

3. Which method helped you remember vocabulary more?

4. How did it help?

5. What are some areas of improvement that you would like to see?

6. What would help you remember or understand science vocabulary more?