THE EFFECTS OF EXPLICIT SCIENCE VOCABULARY INSTRUCTION ON VOCABULARY ACQUISITION ON THE FLATHEAD INDIAN RESERVATION

by

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Explicit vocabulary instruction is a teaching strategy that involves a teacher selecting three to five vocabulary words and focusing instruction around those words. When working with students who are English Language Learners or struggle with vocabulary acquisition, this strategy is thought to be very successful. Students on the Flathead Indian Reservation often struggle with vocabulary acquisition. In addition to this, some Native American students are also labeled English Language Learners; thus, the amount of explicit instruction was increased over several units. Significant gains were observed in each of the three units, but because these gains did not correlate with the increase of instruction, the quantitative data was inconclusive. These gains do indicate that the baseline of 22% instructional time was an adequate amount of instruction to improve scientific vocabulary acquisition.
INTRODUCTION AND BACKGROUND

Teaching on the Flathead Indian Reservation offers a unique experience of working with a diverse classroom in a rural setting. Arlee High School is one of seven high schools on the Flathead Indian Reservation and has 120 students with 64% of Native American descent, 32% Caucasian, and 4% Hispanic. Of these students, 88 or 73% qualify for free and reduced lunch (J. Taylor, personal communication, December 1, 2015). The Native American students in the school and particularly the Native American English language learners (ELLs) have demonstrated lower performance on district-wide assessments, individual classroom assessments and state assessments. According to Marsha Riddle Buly, “American Indian/Alaskan Native students are often labeled as struggling readers based on the results of large-scale standardized tests yet little empirical data about specific strengths and needs exists” (2005, p. 29). With this in mind Arlee High School has placed a large emphasis on student literacy both by increasing professional development opportunities and by hiring literacy specialists. This has led the focus of this action research (AR) to be on scientific vocabulary acquisition. AR is an investigation conducted by educators in their classrooms with the intent to gain knowledge about their students and about themselves, and to ultimately elicit change (Mills, 2014). Along with improving all of the students’ vocabulary skills, there is interest in seeing if certain treatments reach different groups of students at a higher rate. Two populations of students were observed: Native American and non-Native. The groups were further disaggregated by gender.
With vocabulary acquisition at the forefront of my AR, various explicit vocabulary techniques were experimented with, hoping to increase students’ ability to acquire new vocabulary words, be more engaged in class, and be better prepared for summative assessments. Explicit vocabulary instruction occurs when the teacher selects certain content words, usually three to five a lesson, and the words are taught in-depth as the focus of the lesson. This allows the student to acquire the knowledge needed to understand the word in context (Hanson & Padua, 2011). Two types of explicit vocabulary instruction were used: visual and written. Visual vocabulary instruction included list-group-label, the creation of a word wall, creating Frayer models, and word maps. Written vocabulary instruction included possible sentences, compare and contrast, and vocabulary inferences. This context suggests the following primary research question and three secondary questions.

Primary Question:

- What effect did explicit science vocabulary instruction have on students’ ability to acquire new vocabulary terms?

Secondary Questions:

- Did the use of visual vocabulary instruction have a more positive effect on Native American students’ vocabulary acquisition then compared to written instruction?
- Did the use of explicit vocabulary instruction increase student engagement levels?
- Did an increase of explicit vocabulary instruction increase students’ perceived preparedness before summative assessments?
Theoretical Background

One of the most important things to remember when working with Native American students is that often times there is a disconnect between the cultures and languages of these students’ homes and that of the school system (St. Charles & Costantino, 2000). It has been suggested that one reason is the difference between the varieties of English that they use in comparison to their non-Native peers and teachers. Another cultural difference lies in the use of less direct cues to show that they are listening. These differences as well as many others have been outlined in Reading and the Native American Learner Research Report, a report completed by Joe St. Charles and Magda Costantino (2000), in order to provide information to policy makers and teachers.

These significant differences between the language used at home and the language used in classrooms is the reason that some Native American students are labeled ELL. “Although many American Indians are fluent speakers of standard English, Indian English is the first language learned by two-thirds of American Indian youth today” (Leap, 1993, as cited in St. Charles & Costantino, 2000, p. 21). This poses a huge challenge for these students as it is estimated that an educated adult speaker of English knows approximately sixty thousand words (Pinker, 1994, as cited in Freeman & Freeman, 2009). In order to help these students, it is recommended that wait-time be increased, that the teacher carefully selects what words to teach, that the material is culturally relevant and that it is taught in a loving, supportive and challenging environment (Freeman & Freeman, 2009; St. Charles & Costantino, 2000).
Other literature suggests that the use of the gradual release of responsibility model can also improve the vocabulary acquisition skills of high school ELL students (Fisher & Frey, 2008). This idea has three main components: demonstration, practice with peers, and independent application. This model places the responsibility more on the student and also supports the findings of Kim and Linan-Thompson (2013) who suggest that student ownership paired with direct instruction improves vocabulary acquisition.

By better understanding Native American students and how ELL students learn, selecting appropriate methods for classroom activities gives students the best opportunity to succeed. Such concepts as Indian English and the sociolinguistic discontinuity of Native American students are often overlooked in schools, and focusing on these concepts can make sure these students’ needs are met.

**Research Direction**

Several studies have been conducted looking at both Native American students and ELL students and their vocabulary and reading skills. One such study focused on 35 American Indian 4th graders at a reservation school in the northwestern United States (Riddle Buly, 2005). In order to assess the students’ vocabulary knowledge two different tools were used: three years of data on vocabulary from the Gates-MacGinitie Reading Tests (GMRT), and the Peabody Picture Vocabulary Test – Revised (PPVT-R). The biggest findings from this research was that students’ average score on the PPVT-R, an orally assessed test, indicated average vocabulary knowledge but the average score on the GMRT, a written test, indicated students’ levels were almost two years below their current grade level. The ability to identify words from pictures but not after reading a
passage “suggests that the students know substantially more isolated word meanings than they demonstrate on paper/pencil tests” (Riddle Buly, 2005, p. 46). These results show the importance of oral and visual instruction in comparison with written instruction in young Native American students.

Daryl J. Wilcox (1996) also found that Native American students tend to approach work more visually and because of this helped implement the TOWER+EDITS strategy into the Winnebago Public Schools system. The TOWER+EDITS strategy is a sequence of tools that allows students to visualize and monitor their own work. This process includes thinking, organizing, writing, editing and rewriting as well as embellishing, deleting errors, inserting corrections, tallying progress, and submitting the paper for grading. Wilcox looked specifically at two Native American male students who were exposed to the treatment for four months. The first student saw his word count in essays improve five-fold over pre-treatment writing and most importantly his vocabulary grade level increased two grades post-treatment. The second student saw similar increases and both students started willingly making revisions to their original work. This research further supports the claims that Native American students prefer visual instruction and can benefit from modeled instruction; this is a common theme in Native American vocabulary research (Hopkins & Bean, 1999; Riddle Buly, 2005; Wilcox, 1996). This research shows that not only is visual instruction beneficial to vocabulary development but also can improve students’ willingness to engage in the writing process.

Another sub-group in our school is ELL students. According to Woori Kim and Sylvia Linan-Thompson (2013) ELLs, especially those with learning disabilities, struggle
with content vocabulary. The use of a self-regulation vocabulary teaching approach shows signs of helping this demographic group learn content vocabulary. For their study, Kim and Linan-Thompson observed four 3rd grade Spanish-speaking ELLs and subjected them to a vocabulary routine, which included self-regulation. This process included self-goal setting, activating prior word knowledge, the use of a student-friendly definition, using examples and pictures to provide meaning, providing activities using the word, and reviewing the word with self-monitoring. Their data found that self-regulation coupled with direct instruction led to significant improvement in science word acquisition. This research shows the importance, yet again, of using direct instruction in order to help students and it also provides another method that can be used in order to reach students and promote maximum vocabulary acquisition.

Ana Taboada (2011) also conducted research with Spanish-speaking ELL elementary students and found a direct link between ELLs’ scientific vocabulary and their reading comprehension. She asserts, “this finding expands previous literature not only because it reiterates the influence of general vocabulary on reading comprehension of diverse readers, but because it indicates the contribution of a general, broad type of vocabulary to comprehension of a specific domain (e.g., science)” (p. 915).

All of these previous researchers (Hopkins & Bean, 1999; Kim & Linan-Thompson, 2013; Riddle Buly, 2005; Taboada, 2011; Wilcox, 1996) show the importance of direct instruction, visual instruction and student-driven instruction, when working with ELL or Native American students.
Methods

As high-stakes testing has placed a huge emphasis on reading skills, many articles and books have been written to help teachers meet their students’ literacy needs. One strategy that has appeared in the resources is teaching vocabulary explicitly. Explicit vocabulary instruction is made up of four strategies: providing student friendly definitions, using words in context, multiple exposures, and active involvement (Hanson & Padua, 2011). When teaching vocabulary words explicitly teachers can provide direct instruction on about 8-10 words per week and improve students’ abilities to understand their academic reading assignments.

Another common treatment from these resources is the use of graphic organizers (Daniels & Zemelman, 2004; Fisher & Frey, 2008; Jackson & Narvaez, 2013; Young, 2005). Graphic organizers “allow students to position vocabulary in physical space in order to represent conceptual relationships” (Fisher & Frey, 2008, p. 74). These tools come in a wide variety, ranging from Venn diagrams, word maps, two-column charts, vocabulary trees, Frayer models, all the way to interactive word walls. Fisher & Frey (2008) have created a figure on page 77 of their text that lists six common graphic organizers.

The most hands-on of the graphic organizers is the interactive word wall (Jackson & Narvaez, 2013). In the article, “Interactive Word Walls: Create a Tool to Increase Science Vocabulary in Five Easy Steps,” the authors detail the steps it takes to make this tool. Once the wall is made, students physically manipulate their vocabulary words and make connections between these words. Logistically it can be a challenge to
find space for this tool and the planning time that it requires, but it has been shown that these walls help students visualize connections between words and unify terms and concepts. Along with step-by-step instructions, the authors provided a rubric for assessing these word walls. The rubric provides a good, better, best approach to allow for teacher reflection about the construction of the wall (Jackson, Tripp, & Cox, 2011 as cited in Jackson & Narvaez, 2013). The biggest limitation of graphic organizers is time. Thus it is imperative that teachers select the right words to incorporate into these activities. When selecting words teachers should look at each word and determine if it is representative of an important concept, is repeated throughout the unit, can be used in another content area, and consider if it is going to overburden the cognitive load (Fisher & Frey, 2008).

Another great resource for visual vocabulary instruction is Edyth Young’s “The Language of Science, The Language of Students: Bridging the Gap with Engaged Learning Vocabulary Strategies” (2005). Young outlines several strategies that focus on making the learning personal and visual. Such activities include personal clue cards, vocabulary TV visualization, rate your words, and definition maps. Another useful tool is the Science Vocabulary Questionnaire (Young, 1996 as cited in Young, 2005). This questionnaire can be used as a reflective tool, pre or post instruction, in order to evaluate the use of effective vocabulary strategies. Hanson and Padua (2011) also discuss the importance of collecting pre-and post-instruction data and suggest using a vocabulary check. A vocabulary check asks students to rate their understanding of words prior to
explicit instruction and then has them provide meanings, use the words in sentences, or create drawings to show understanding of the words.

Along with visual instruction it has been noted that “students consolidate their understanding when they compose using academic vocabulary” (Fisher & Frey, 2008, p. 114). The most common way to have students demonstrate this is by using specific words to construct sentences. When constructing sentences students pull from previous knowledge and demonstrate to the teacher the level of understanding they have for each word used. This activity is much more difficult than using graphic organizers and usually is done after the learner has had opportunities to work with the word.

**Gaps in the Literature**

This background research (Hopkins & Bean, 1999; Kim & Linan-Thompson, 2013; Riddle Buly, 2005; Taboada, 2011; Wilcox, 1996) leads to several exciting conclusions, primarily the importance of direct instruction, visual instruction and student-driven instruction, when working with ELL or Native American students. However, like any research there are some limitations. One limitation is time. Using best practices in vocabulary instruction takes lots of planning time and classroom time. If teachers select appropriate words and strategies this time will not be wasted. Another limitation of this research is demographics. Even though I have found resources pertaining to Native American students and ELL students, many of the resources include the use of only elementary-aged children, Spanish-speaking ELLs and pigeonholing all Native American students into one category and not taking into account the differences associated with different reservations and tribes.
METHODOLOGY

The sample included both sections of biology taught at Arlee High School. The first section was a 5th period class, which met from 1:59-2:59 pm Monday through Thursday, and had 19 students, and the second section was a 6th period class, which met from 2:02-3:02 pm Monday through Thursday, and had 12 students. Every student in these classes was used in order to increase the sample size and provide the most diverse demographic possible. Of the 31 students, 14 were females, 9 of whom are of Native American descent and 17 were males, 12 of whom are of Native American descent. The sample included 30 sophomores and 1 freshman. Four of the students had individual education plans (IEPs) and three of the students are identified as ELLs. Two of the ELLs also have IEPs. Many of the students are from low social economic families with 73% of the student body qualifying for free or reduced lunch (J. Taylor, personal communication, December 1, 2015). Some of the treatment work was completed in group activities, but overall the students’ work was assessed as individuals and they were asked to participate in individual surveys and interviews.

To fully grasp the students’ response to the added vocabulary instruction, it was important to conduct the treatment over several units. On average each of the units used in biology covers approximately four weeks, or 16 class periods (as Arlee High School is on a four-day school week). During the treatment the three units covered 17 class periods, 18 class periods, and 18 class periods respectively and 5 to 6 weeks depending on holidays and school activities. Since vocabulary instruction was already used in the classroom, it was decided that the most reasonable way to gauge the effectiveness of
vocabulary instruction, was to increase the number of days in which explicit vocabulary instruction was used in each unit. At the start of each unit students were asked to take a pre-test over the vocabulary that was going to be presented in that unit. The pre-tests took the form of knowledge ratings. Knowledge ratings (Blachowicz, 1986) allow students to analyze what they already know about each word by asking them how confident or familiar they are with the word. An adaptation of a knowledge rating asks students to also include a definition, synonym, or other descriptor in order to demonstrate knowledge of the vocabulary word listed.

After this pre-assessment each student was provided with a list of the vocabulary words that would be covered during that unit. These words were content specific biology words (i.e. mitosis) and are located in Appendix A. During the first unit, which had 18 periods, four periods of explicit instruction were implemented or 22% of the unit’s class periods. The second unit included six periods out of 17 or 35% of the class time and finally, the third unit included eight periods out of 18 or 44% of the class time. Table 1 outlines the treatment plan for the three units and the data that was collected.
Table 1

<table>
<thead>
<tr>
<th>Treatment Plan</th>
<th>Number of Periods</th>
<th>Type of Instruction</th>
<th>Data Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1 Cell Division</strong></td>
<td>4 Periods (or 22.2%)</td>
<td>Visual Instruction</td>
<td>Pre-Vocabulary Test, Teacher Journal, Student Survey, On Task Tally Chart</td>
</tr>
<tr>
<td><strong>Week 1: 11/9 – 11/12</strong></td>
<td>List-Group-Label</td>
<td>Written Instruction</td>
<td><strong>Week 2: 11/16 – 11/19</strong></td>
</tr>
<tr>
<td>4 periods</td>
<td></td>
<td></td>
<td>Possible Sentences</td>
</tr>
<tr>
<td><strong>Week 3 &amp; Week 4: 11/23 – 11/24</strong></td>
<td>Word Maps</td>
<td>Visual Instruction</td>
<td>Teacher Journal</td>
</tr>
<tr>
<td>6 periods</td>
<td></td>
<td></td>
<td><strong>Week 5: 12/7 – 12/10</strong></td>
</tr>
<tr>
<td>4 periods</td>
<td>Compare and Contrast</td>
<td>Written Instruction</td>
<td>Post-Vocabulary Test, Teacher Journal, Student Survey</td>
</tr>
<tr>
<td><strong>Unit 2 Protein Synthesis</strong></td>
<td>6 Periods (or 35.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Week 1 &amp; Week 2: 12/14 – 12/17</strong></td>
<td>Vocabulary Inferences</td>
<td>Written Instruction</td>
<td>Pre-Vocabulary Test, Teacher Journal, On Task Tally Chart</td>
</tr>
<tr>
<td>12/21 – 12/22</td>
<td></td>
<td></td>
<td><strong>Week 3: 1/4 – 1/7</strong></td>
</tr>
<tr>
<td>6 periods</td>
<td>Interactive Word Wall &amp; Frayer Models</td>
<td>Visual Instruction</td>
<td>Teacher Journal, Student Survey, On Task Tally Chart</td>
</tr>
<tr>
<td><strong>Week 4: 1/11 – 1/14</strong></td>
<td>Possible Sentences &amp; Compare and Contrast</td>
<td>Written Instruction</td>
<td>Teacher Journal</td>
</tr>
<tr>
<td>4 periods</td>
<td></td>
<td></td>
<td><strong>Week 5: 1/19 -1/21</strong></td>
</tr>
<tr>
<td>3 periods</td>
<td>Interactive Word Wall</td>
<td>Visual Instruction</td>
<td>Post-Vocabulary Test, Teacher Journal, Student Survey</td>
</tr>
<tr>
<td><strong>Unit 3 Genetics</strong></td>
<td>8 Periods (or 44.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Week 1: 1/25 – 1/28</strong></td>
<td>Possible Sentences &amp; Vocabulary Inferences</td>
<td>Written Instruction</td>
<td>Pre-Vocabulary Test, Teacher Journal, On Task Tally Chart</td>
</tr>
<tr>
<td>4 periods</td>
<td></td>
<td></td>
<td><strong>Week 2: 2/1 – 2/4</strong></td>
</tr>
<tr>
<td>4 periods</td>
<td>Frayer Models &amp; Interactive Word Wall</td>
<td>Visual Instruction</td>
<td>Teacher Journal, On Task Tally Chart</td>
</tr>
<tr>
<td><strong>Week 3 &amp; Week 4: 2/8 -2/11</strong></td>
<td>Possible Sentences &amp; Compare and Contrast</td>
<td>Written Instruction</td>
<td>Teacher Journal</td>
</tr>
<tr>
<td>2/17 – 2/18</td>
<td></td>
<td></td>
<td><strong>Week 5 &amp; Week 6: 2/22 – 2/24</strong></td>
</tr>
<tr>
<td>5 periods</td>
<td>List-Group-Label &amp; Interactive Word Wall</td>
<td>Visual Instruction</td>
<td>Post-Vocabulary Test, Teacher Journal, Student Survey</td>
</tr>
<tr>
<td>2/29 – 3/1</td>
<td></td>
<td></td>
<td>5 periods</td>
</tr>
</tbody>
</table>

The visual instruction methods include Frayer Models and Word Maps, which are graphic organizers where students place one vocabulary word in the middle of their paper
and provide various pieces of information about the word in the space around it. Another method, List-Group-Label, is an activity that allows students to rearrange groups of vocabulary words that have been placed on sticky notes into groups of their choice and then defend their choices to their peers. Finally, Word Walls are a visual tool in which vocabulary words are placed onto a large sheet of paper hung from the wall and students are able to write in definitions or paste items that relate to the words on the wall.

The written vocabulary exercises include the following: Possible Sentences, where students are asked to write sentences prior to doing classroom reading and then compare their original response with newly acquired information; Compare and Contrast, in which students compare and contrast three different vocabulary words; and Vocabulary Inferences, in which students are asked what they think words mean and why they think that. Examples of all of these explicit vocabulary lessons and the forms used to collect data can be found in Appendix B.

While each unit was underway an on-task tally chart was also used, which can be seen in Appendix C. An on-task tally chart is a tool that takes a snapshot of several students’ behavior over a thirty-minute period of time, monitoring their exact behavior every five minutes. During the thirty-minute time the observer records whether the students were on-task and what academic skill they were doing or if they were off-task and what exactly was prompting this behavior. With the inability to complete this portion of the data collection while instructing, an outside observer, in this case the principal, came into the 5th period section several times throughout the treatment to collect data. Each time he observed the same five students who were selected by a stratified random
selection process, insuring there was one male Native American student, one female Native American student, one male non-Native student, one female non-Native student, and one male ELL. To help examine engagement in the activity, the type of classroom instruction was also noted while the on-task tally chart was completed.

In order to gather more personal data, two surveys were created. The first survey, the student engagement survey, was administered three times. It was first administered the week before the first unit began on November 4th, the second time was about halfway through the treatment period on January 6th, and the final time was at the end of the treatment period on February 29th. This survey is a Likert style survey with four possible choices: strongly agree, agree, disagree, and strongly disagree. Numbers were used in place of the four choices in order to optimize data analysis. The second survey, the student pre-test survey, was used prior to the final summative vocabulary assessment during each treatment unit. The survey provides multiple options for each question including questions that look at the perceived effectiveness of the various vocabulary treatments. Both the student engagement survey and the student pre-test survey are located in Appendix C.

The last piece of data collected was a teacher journal. The teacher journal was used to record some quick thoughts on how lessons were perceived and how students seemed to grasp the vocabulary being taught in class. At the end of each unit, a more detailed entry focused on which activities were thought to be the most successful, some of the challenges the instructor faced throughout the unit, and overall feelings regarding the unit.
In order to answer the research questions, data triangulation and the use of ample collection methods must be used. Table 2 shows each of my focus questions and the data that was used in answering those questions.

Table 2

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>What effect did explicit vocabulary instruction have on students’ ability to acquire new vocabulary terms?</td>
<td>Pre &amp; Post Vocabulary Tests</td>
</tr>
<tr>
<td></td>
<td>CATs/Vocabulary Instruction</td>
</tr>
<tr>
<td></td>
<td>Teacher Daily Journal</td>
</tr>
<tr>
<td>Did the use of visual vocabulary instruction have a more positive effect on Native American students’ vocabulary acquisition then compared to written instruction?</td>
<td>Pre &amp; Post Vocabulary Tests</td>
</tr>
<tr>
<td></td>
<td>On-Task Tally Chart</td>
</tr>
<tr>
<td></td>
<td>Student Engagement Survey &amp; Student Pre-Test Survey</td>
</tr>
<tr>
<td></td>
<td>Teacher Daily Journal</td>
</tr>
<tr>
<td>Did the use of explicit vocabulary instruction increase student engagement levels?</td>
<td>Student Engagement Survey</td>
</tr>
<tr>
<td></td>
<td>On-Task Tally Chart</td>
</tr>
<tr>
<td></td>
<td>Teacher Daily Journal</td>
</tr>
<tr>
<td>Did an increase of explicit vocabulary instruction increase students’ perceived preparedness before summative assessments?</td>
<td>Student Pre-Test Survey</td>
</tr>
<tr>
<td></td>
<td>Pre &amp; Post Vocabulary Tests</td>
</tr>
<tr>
<td></td>
<td>Teacher Daily Journal</td>
</tr>
</tbody>
</table>

Along with the large amounts of quantitative data that these data collection tools gathered it was valuable to also make sure that qualitative data was being collected. Most of the qualitative data collected came from a couple of open-ended questions on the
student surveys. These questions asked students such things as, what they thought was the most difficult part about biology and what vocabulary exercise they found the most useful and why they felt that way. This data in conjunction with the qualitative data helped paint a more complete picture of what the students were thinking and experiencing throughout the treatment.

During this process it was important to make sure that the research was both valid and reliable. When discussing validity, Mills (2014) discusses the importance of making sure that data is accurately assessed for meaning, that data is reported in an unbiased manner, and that the researcher is subjected to peer review. In order to make sure that this was occurring, a support team was utilized to take a second look at the data and help unveil patterns or themes that the researcher might have missed. Another science teacher was also used to help score the final unit assessments in order to check that they were being scored accurately for understanding and to help determine the difficulty of each unit.

Mills (2014) also discusses reliability as a measure of how trustworthy the data is in terms of measuring what it is supposed to measure. By using data triangulation and wide variety of both quantitative and qualitative data collection tools, the appropriate steps have been taken to show that the treatment used was reliable.

The methods described in this section received an exemption by the Montana State University’s Institutional Review Board, on November 5th, 2015 and can be found in Appendix D.
DATA AND ANALYSIS

Vocabulary Acquisition

The main purpose for this AR project was to see if increasing the amount of explicit vocabulary instruction would have a positive impact on students’ abilities to acquire new vocabulary words. In order to accurately assess the effectiveness of the treatment, a comparison of the pre- and post-assessments, student surveys, and teacher observations were used. The pre- and post-assessments were given as Knowledge Ratings (Appendix E) and each answer was scored as either a two, which showed mastery of the word, a one, which showed a very basic understanding, or a zero, in which no understanding was demonstrated. Table 3 shows the average scores, the standard deviation, and the range for the pre- and post-assessments.

Table 3
Pre- and Post-Assessment Data, N=31.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1 Cell Division</strong></td>
<td></td>
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</tr>
<tr>
<td>Pre</td>
<td>8.7%</td>
<td>5.8</td>
<td>25.0%</td>
</tr>
<tr>
<td>Post</td>
<td>69.4%</td>
<td>23.6</td>
<td>77.3%</td>
</tr>
<tr>
<td><strong>Unit 2 Protein Synthesis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>5.5%</td>
<td>3.8</td>
<td>13.9%</td>
</tr>
<tr>
<td>Post</td>
<td>58.1%</td>
<td>27.5</td>
<td>91.7%</td>
</tr>
<tr>
<td><strong>Unit 3 Genetics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>9.3%</td>
<td>8.4</td>
<td>32.5%</td>
</tr>
<tr>
<td>Post</td>
<td>68.7%</td>
<td>19.4</td>
<td>70.0%</td>
</tr>
</tbody>
</table>
As Table 3 shows, large gains were observed from the pre-assessment to the post-assessment. However, with the large gains came a wider distribution of scores shown by the standard deviation value increasing from 5.8 to 23.6 for Unit 1, 3.8 to 27.5 for Unit 2, and 8.4 to 19.4 for Unit 3.

While Table 3 reveals the results of the whole class, looking at the data by demographics shows a more detailed account of what is going on (Figure 1). The average normalized gain is one statistical tool that can help us examine student success throughout a treatment, and it is calculated by comparing the gain from the pre- to post-assessment to the maximum gain possible (Hake, 1998).

![Figure 1. Average normalized gains based on demographics, (N=31).](image)

Across all demographics Unit 2 had the lowest classroom average normalized gain at .56 which was 10% lower than Units 1 and 3. When looking at the individual demographics the non-Native females (N=5) saw the highest average normalized gains across all three units, .90, .84, and .84 respectively and the Native American girls (N=9) and ELLs (N=3).
saw the lowest average normalized gains, but were the only groups to see their largest
gains in Unit 3. The average normalized gains for the Native American girls, was .53,
.43, and .59 respectively and was .43, .38, and .60 for the ELLs. Traditionally, at Arlee
High School the non-Native females have outperformed their peers in science
assessments and the Native American girls and ELLs have been some of the lowest
performing students in science assessments and this data holds true to that trend. Seeing
their largest gains in Unit 3 might also imply that the extended vocabulary exercises were
most beneficial to the lower achieving students.

To better understand just the post-unit assessment data, it is important to take a
closer look at the variation in the individual post-assessment scores (Figure 2). During
Unit 1, 50% of the students scored above 75.0%, in Unit 2 that number dropped to 61.1%
and in Unit 3 it was 67.5%. In all three units the high score was 100% and the top 25%
of the class received at least an 80%. This indicates that Unit 2, which covered the
process of protein synthesis, was the most difficult unit for the students and provided the
widest range of scores, where Unit 3, which covered genetics, provided the smallest
distribution of scores.
Figure 2. Score variation in post-unit assessment data, (N=31).

Another tool used to gather data was the student engagement survey which was conducted on three different times and asked students the open ended question, “What do you think is the most difficult part of biology?” The answers to this question (Appendix F), were coded thematically and observed for change. Figure 3 shows the four main categories students’ answers fell into and percentage of students who answered per category.
Figure 3. What students thought was the most difficult part of biology.

As the treatment progressed more students believed that vocabulary was the hardest part of biology, with the percentage changing from 10%, to 13%, to 23%. In total, 10 different students or 32% mentioned vocabulary as the hardest part. Four of the students mentioned vocabulary on two of the three surveys, where the other six mentioned vocabulary on only one survey. A comparison of the two groups of students who mentioned vocabulary, ones who mentioned vocabulary twice and the ones that mentioned it once, to the class average normalized gains across all three units (Figure 4), shows that the students who mentioned vocabulary twice were another demographic of students who saw gains increase from Unit 1 to Unit 3. The average normalized gains for this group were, .52, .51, and .60 respectively. Students who mentioned vocabulary only one time, with five of the six stating it at the end of the treatment, show higher average normalized gains then the class average. This data shows that as the students were introduced to more vocabulary instruction they became more aware of the importance of
vocabulary and perceived this awareness as difficulty. Those who truly found the vocabulary difficult and mentioned it several times did see gains with the increase of instruction.

![Average normalized gains for students who mentioned vocabulary as the most difficult part of class.](image)

*Figure 4.* Average normalized gains for students who mentioned vocabulary as the most difficult part of class.

The other survey that was utilized throughout the treatment was the student pre-test survey. Prior to each unit’s final assessment, students were asked if they felt like the vocabulary activities completed in class prepared them for the test. Results of this question can be seen in Figure 5, below.
Figure 5. How students felt about the vocabulary activities preparing them.

This figure shows that as the treatment progressed a majority of my students believed that the activities in class prepared them for the test. To quantify the survey data, a scale was created where a one represented strongly agree, a two represented agree, a three represented disagree, and a four represented strongly disagree. More specifically Table 4 shows the mean, mode, and percentage of students who would at least agree with the above statement.

Table 4

<table>
<thead>
<tr>
<th>Effectiveness of Vocabulary Activities: Student Opinion Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Unit 1 (N=31)</td>
</tr>
<tr>
<td>Unit 2 (N=30)</td>
</tr>
<tr>
<td>Unit 3 (N=31)</td>
</tr>
<tr>
<td>Unit Averages</td>
</tr>
</tbody>
</table>
Table 4 further reiterates that the students felt the activities that were done in class prepared them for the test with 80.65% of them responding that they at least agree before the Unit 1 assessment and that number increasing to 90.32% before the Unit 3 assessment. Also the table shows that the most common response was a two, which means that they agree, and the class average for this category was 2.05. With nine out of 10 students reporting that they found the activities useful in the preparation for the test, it is safe to say that as the amount of explicit instruction increased so did the students feelings about how helpful it was. Student responses also reiterate this point.

When asked on the same survey why they felt certain explicit vocabulary activities were helpful in preparing them for the test, one female non-Native student said, “you look at every aspect of the word, not just the definition.” Other quotes from students echo this sentiment: “It helped me think about what words could mean.” Also, “It makes you think about the words more,” and “It helped me connect them to other jobs in life, which helped with what they mean.” These sentiments were reported throughout the three-unit treatment and by students in each of the demographics.

Throughout the treatment only one student, a Native American female, reported that she disagreed with the vocabulary activities helping her prepare for the test. This student showed normalized gains of .36, .40, and .28 for the three units respectively. These gains indicate that this student showed the biggest improvement on the unit the class tended to struggle the most with and also that for this particular student the amount of instruction on the third unit was not as effective. It is impossible to determine exactly
why she saw her lowest gains in Unit 3 but based on her survey responses she did not
find much value in the instruction and might have engaged less, the more that it was used.

Throughout the entire treatment period a teacher journal was kept to record
observations and thoughts about the effectiveness of the vocabulary instruction. The first
trend that was noticed was the difference between the written and the visual instruction.
From a classroom management standpoint, the written activities were primarily done by
students individually with a small amount of collaboration, whereas the visual activities
were done in groups and involved less writing but much more collaboration amongst
group members. In the classes, there were several students who did not like to work in
groups and thus they did not enjoy the visual activities and oftentimes tried to minimize
engagement in the task. On the flipside, a majority of the students clearly enjoyed the
group work and were much easier to keep on task within groups than when working on
written activities by themselves. The most common entry that was written down in the
teacher journal simply said, “Attendance.” Since it was repeatedly noted that the students
missed a high percentage of class, it was decided to also include attendance data.

When examining attendance data, it was important to keep track of percentage of
classes attended throughout the AR as well as the percentage of vocabulary lesson days
attended (Figure 6 & Figure 7).
Figure 6. Student attendance throughout the three-unit treatment period.

Figure 7. Student attendance on vocabulary activity days.

The attendance data shows that all three units were attended at about the same rate. Native American students tended to miss more class periods throughout the
treatment than non-Native students and the ELL demographic saw a decrease in attendance from 91% in Unit 1, to 84% in Unit 2, and 78% in Unit 3. Looking specifically at the attendance on explicit vocabulary instruction days, four of the five demographics saw a decrease in their attendance from Unit 1 to Unit 3. The ELL students saw the largest decrease in vocabulary day attendance. Attendance decreased by 17% from Unit 1 to Unit 2 and 20% from Unit 2 to Unit 3. It is important to remember that the number of days increased each unit, so another important way to consider the data is by number of days rather than percentages. The ELL students on average were present to receive four days of instruction in Unit 1, 4.98 days in Unit 2, and 5.04 days in Unit 3. The Native American Male and Females also saw a decrease from Unit 1 to Unit 3, although at a much slower rate than the ELLs. By Unit 3 instead of learning on all eight vocabulary days, on average they were learning on 6.56 days.

**Visual Versus Written Explicit Vocabulary Instruction**

Another important component of this AR was to see if visual instruction had a bigger impact on Native American students as previous research indicated. When addressing this question one of the major pieces of evidence comes from the results of the on-task tally chart (Table 5). The on-task tally chart was completed six different times throughout the treatment, twice on non-vocabulary lessons, twice during visual explicit vocabulary instruction and twice during written explicit vocabulary instruction. The students were selected randomly to match the demographics of the class and if one was absent during the observation, a student from the same demographic was randomly
selected as the replacement. Once the sheet was completed the data was compiled to reveal the percentage of on-task and off-task behavior observed (Table 5).

Table 5
*Percentage of Students On Task by Demographic*

<table>
<thead>
<tr>
<th></th>
<th>% of observations that were reported as on-task for Native American Students (N=3)</th>
<th>% of observations that were reported as on-task for non-Native Students (N=2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Activity #1</td>
<td>61.33</td>
<td>58.50</td>
</tr>
<tr>
<td>Visual Activity #2</td>
<td>100</td>
<td>66.50</td>
</tr>
<tr>
<td>Written Activity #1</td>
<td>61.33</td>
<td>58.00</td>
</tr>
<tr>
<td>Written Activity #2</td>
<td>61.00</td>
<td>75.00</td>
</tr>
<tr>
<td>Non-Vocabulary #1</td>
<td>55.67</td>
<td>75.00</td>
</tr>
<tr>
<td>Non-Vocabulary #2</td>
<td>72.33</td>
<td>66.50</td>
</tr>
<tr>
<td>On-Task Averages</td>
<td>68.61</td>
<td>66.58</td>
</tr>
</tbody>
</table>

As the data shows, the lesson that the Native American students most actively participated in was visual activity #2 which had 100% of students engaged at each five-minute interval. This activity dealt with the construction of an interactive word wall. This activity includes group work and opportunities for students to use art, research skills, and a variety of other skills. This wide variety of skills and the group setting could have been big factors in why the students were more engaged during this activity. When averaging the data by the type of activity that was performed, a better understanding of the data can be achieved (Figure 8).
Figure 8. Frequency of students who were on-task and off-task.

Figure 8 shows that Native American students saw a large change in on-task behavior during the visual vocabulary lessons. The on-task behavior ranged from just over 61% for the written vocabulary lessons to just over 80% during the visual lessons; in comparison the non-native students saw their behavior range from just over 62% for visual vocabulary lessons to just over 70% for non-vocabulary lessons.

The student pre-test survey asked students which vocabulary activities they enjoyed the most, they enjoyed the least, they thought were the most helpful in preparing them for the assessment, and they thought did the least amount to prepare them for the assessment.
Figure 9. Difference between types of explicit vocabulary instruction according to Native American students, (N=62).

Figure 9 shows that when asked which activities were the most helpful and which activities were the most enjoyable, about 70% of the time a visual activity was selected by Native American students. Likewise, when asked which activities were the least helpful and which activities were least enjoyed, about 35% of the time a visual activity was selected.

When asked what made the different vocabulary activities enjoyable or beneficial many students simply stated “because it was fun,” but a few of the students mentioned the visual components of the activity. A Native American male student stated, “We drew pictures, and helped each other out when we didn’t know the word.” Another student, a Native American female, mentioned about her groups’ word wall, “We got to have it all nice and organized easy to study and understand.” When discussing Frayer models one student stated, “Gave me a visual representation,” while another mentioned that “you
don’t just learn one thing through the Frayer model. It forces you to know more than just the definition.”

Based on the observations it was noted that there was only a small handful of students, four of whom were Native American males, who did not enjoy the visual activities because of the group element involved. They withdrew from some of the larger explicit vocabulary activities, such as the word wall and list-group-label. However, it was noticed that these students did work well on the Frayer models, which are a more individual task.

**Student Engagement**

By increasing the amount of explicit vocabulary instruction, the instructor was also hoping to see an increase in students’ engagement levels. In order to assess student engagement, the student engagement survey was administered three different times, pre-treatment, middle of the treatment, and the end of the treatment. A scale was created where a one represented strongly agree, a two represented agree, a three represented disagree, and a four represented strongly disagree in order to analyze the data. When focusing on student engagement the following questions from the survey were found to be the most important.

1. I am motivated to do my best in biology.
2. I always try my best in biology.
3. I actively participate in biology class each day.
4. I think it is important to get good grades in biology.
5. I want to get good grades in school.
6. I do biology work at home.
7. I am more motivated to work when I am in a group.
These seven questions were then classified into four categories of student engagement, effort (1, 2, & 3), grades (4 & 5), homework (6), and peers (7). Table 6 looks at the frequency of student responses for each of these questions over the course of the AR.

Table 6
Student Engagement Survey Response Frequencies

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre N=30</td>
<td>Mid N=31</td>
<td>Post N=31</td>
<td>Pre N=30</td>
</tr>
<tr>
<td>#1</td>
<td>8</td>
<td>12</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>#2</td>
<td>9</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>#3</td>
<td>8</td>
<td>8</td>
<td>7*</td>
<td>17</td>
</tr>
<tr>
<td>#4</td>
<td>20</td>
<td>23</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>#5</td>
<td>23</td>
<td>24</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>#6</td>
<td>9</td>
<td>10</td>
<td>10*</td>
<td>17</td>
</tr>
<tr>
<td>#7</td>
<td>6</td>
<td>6</td>
<td>5*</td>
<td>17</td>
</tr>
</tbody>
</table>

*One student did not answer this question

Effort is the first category of motivation that was looked at. Table 7 shows the mean and percentage of students who would at least agree with the following statements throughout the treatment based on responses to the three questions in the effort category.
Table 7
Student Engagement: Effort Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pre-Treatment (N=30)</th>
<th>Mid-Treatment (N=31)</th>
<th>Post-Treatment (N=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.92</td>
<td>1.89</td>
<td>1.88</td>
</tr>
<tr>
<td>% of students who agree or strongly agree</td>
<td>81.11%</td>
<td>82.80%</td>
<td>82.61%</td>
</tr>
</tbody>
</table>

Table 7 shows that the students are motivated to do well with over 80% of them responding that they at least agree with the three questions. The percentage of students who agree also increases 1.5% from the start of the treatment to the end of the treatment. Also the table shows that the average decreased slightly over the course of the treatment, falling from 1.92 to 1.88, which falls between strongly agree and agree. This shows that the treatment did not have a big impact on whether or not students were motivated to do well, but that the students for the most part want to succeed.

Figure 10 looks closer at the effort category as it shows the change of each demographics’ engagement in terms of effort from the beginning to the end of the treatment.
As Figure 10 illustrates, many of the demographics saw their engagement levels stay about the same with the exception of the ELLs. The ELLs saw a steady increase in motivation throughout the treatment period, increasing from 33% to almost 90% of responses agreeing with the effort questions.

The second category of engagement deals with students’ interest in grades. Table 8 outlines the mean and the percentage of students that agreed or strongly agreed with questions regarding grades.

Table 8
Student Engagement: Grades Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pre-Treatment (N=30)</th>
<th>Mid-Treatment (N=31)</th>
<th>Post-Treatment (N=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.38</td>
<td>1.27</td>
<td>1.32</td>
</tr>
<tr>
<td>% of students who agree or strongly agree</td>
<td>95.00%</td>
<td>96.77%</td>
<td>96.77%</td>
</tr>
</tbody>
</table>
From the start of the treatment to the end, the average score for these questions changed from 1.38 to 1.32, showing an increase in students who strongly agree with these statements. The percentage of students who agreed that grades drive engagement also increased 1.77%. This again shows that the treatment was not very effective at increasing the percentage of students who were motivated by grades, but that the percentage of students who were motivated, was already high prior to the treatment.

When looking at how each demographics’ opinions on grades changed throughout the treatment, the only two groups that didn’t 100% agree from the beginning where the Native American boys and the ELLs. Figure 11 shows how these two demographics changed throughout the treatment.

![Figure 11](image_url)  
*Figure 11. Frequency of Native American males and ELLs who were motivated by grades.*
The figure reveals that the ELL students increased after the treatment started and the Native American males group had a very slight increase, 1.5%, by the middle of the treatment.

Of the four categories the only area that showed a decrease in engagement as the treatment progressed was homework. Table 9 looks at the homework data from the survey.

Table 9
Student Engagement: Homework Statistics

<table>
<thead>
<tr>
<th></th>
<th>Pre-Treatment (N=30)</th>
<th>Mid-Treatment (N=31)</th>
<th>Post-Treatment (N=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.87</td>
<td>1.97</td>
<td>1.97</td>
</tr>
<tr>
<td>% of students who agree or strongly agree</td>
<td>86.67%</td>
<td>74.19%</td>
<td>73.33%</td>
</tr>
</tbody>
</table>

From the start of the treatment to the end, the mean score on the survey decreased from 1.87 to 1.97, moving closer to the agree and farther away from strongly agree. The amount of students who agreed or strongly agreed with completing homework also decreased, going from an 86.67% to 73.33%, a decrease of 13.34%.

The demographic group who showed the most change in their homework engagement was the Native American students. For all three surveys all of the non-Native students said that they complete homework, but a decrease was seen in Native American males and females. Figure 12 investigates this change throughout the treatment.
As the figure shows, only one of the three ELLs agreed that they do homework and that student remained constant throughout the treatment. Looking at the Native American males, the percentage of students who were completing homework decreased from just over 70% to 50% and the females decreased from just under 90% to 75%. This shows a reduction in homework being done of 20% for the males and 15% for the females. This decrease in homework completion might have been attributed to external factors, such as the end of basketball season, or internal factors, such as the perception that they did not need to study or do outside work because we were doing an increased amount of vocabulary work so they felt prepared.

The final area of engagement that was monitored was group work. Table 10 shows the results of the student survey question; I am more motivated to work when I am in a group.
Table 10  
*Student Engagement: Peers Statistics*

<table>
<thead>
<tr>
<th></th>
<th>Pre-Treatment (N=30)</th>
<th>Mid-Treatment (N=31)</th>
<th>Post-Treatment (N=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>2.13</td>
<td>2.16</td>
<td>2.10</td>
</tr>
<tr>
<td><strong>% of students who agree or strongly agree</strong></td>
<td>76.67%</td>
<td>67.74%</td>
<td>80.00%</td>
</tr>
</tbody>
</table>

The mean only slightly decreased but the percentage of students who agreed or strongly agreed, that group work was motivating for them rose from 67.74% midway through the treatment to 80% by the end of the treatment. When examining the data closer we can see the demographics of students who affected these outcomes the most. Figure 13 examines how each demographics’ opinion about group engagement changed throughout the treatment.

*Figure 13. Students who felt group work motivated them.*
From the beginning to the end of the treatment, females saw an increase in group engagement where the males saw a decrease or no change. Native American females saw an increase of just over 10% and non-Native females saw an increase of 20%. Likewise, Native American males saw a decrease of about 5% and the ELLs saw a decrease of 33%.

The other tool used to monitor student engagement from the start of the treatment to the end was the on-task tally chart. The tally chart was used six different times throughout the treatment, starting on Nov. 10th, 2015 and ending on Feb. 2nd, 2016. Figure 14 shows the percentage of on-task observations made on each date it was administered.

![Percentage of on-task behavior observed](image)

*Figure 14. Percentage of on-task behavior observed, (N=5).*

From the onset of the treatment until the start of the last month, the five students observed using the on-task tally sheet fluctuated between 60% and 70% for on-task behavior. It wasn’t until the last observation date that a large increase of on-task
behavior was observed. That peak was 87% and corresponds with a visual explicit vocabulary activity that was taught later in the treatment. A few explanations for the noticeable increase come to mind: it might be an outlier, as the consistency of the earlier observations is hard to deny; it could indicate students’ increased comfort with the treatment and subsequent compliance; or, corresponding to student surveys, it could reflect students’ increased belief in the importance of vocabulary instruction.

**Student Perception**

The last part of the AR focused on whether or not increasing explicit vocabulary instruction increased students’ perceived preparedness for the summative assessments. The first piece of data that was analyzed was the pre-test survey. Each student was asked what grade they thought they would get; these responses were then compared to what grade they actually got in Figure 15.

*Figure 15. Actual grades received compared to the students’ perceived grades, (N=31).*
As the figure shows, students typically believe that they are going to do better than they actually do. The number of students who thought they would receive a grade of C or higher stayed relatively consistent throughout the treatment, 23, 20, and 22 respectively. These projections were optimistic with only 19, 12, and 14 students actually receiving a grade of C or higher. Counter to this, the students who do well typically under-sell their abilities with more A’s being received then projected.

The pre-test survey also asks the students if they feel prepared for the test. Figure 16 shows how the response to that question changed from Unit 1 to Unit 3.

![Chart showing student responses to whether or not they felt prepared for the summative assessment.](image)

*Figure 16. Student responses to whether or not they felt prepared for the summative assessment.*

This data shows that from Unit 1 to Unit 3 there was a positive change in the students’ feelings about whether they were prepared for the assessment even if their actual grades did not reflect this confidence. Unit 1 had 54.84% of students strongly agree or agree,
while the responses to Unit 2, which had two fewer students answer this question, was 58.62%. Unit 3 had 61.29% strongly agree or agree.

After being asked if they were prepared for the assessment, students were asked whether the students thought the classroom activities helped them, the vocabulary activities helped them, and if the teacher helped them feel prepared for the summative assessments. Figure 17 looks at the number of students who agreed or strongly agreed that the classroom activities, vocabulary activities, or the teacher helped prepare them.

![Figure 17](image_url)

**Figure 17.** What helped prepare students for the summative assessments.

Based on the student survey data, the number of students who felt the teacher prepared them stayed consistent across all three units, but there was a change in those who felt vocabulary activities helped and that the classroom activities helped. From Unit 1 to Unit 3, the number of students who reported being helped by the vocabulary units rose from 25 students to 28 students by the end or a 12% increase and the number of students
reporting that classroom activities helped them decrease from 30 to 28 or about a 7% decrease.

The pre-test survey also asked students to discuss the amount of time they studied before each test. The options they could choose from were less than an hour, one to two hours, two to three hours, more than three hours, and didn’t study at all. Figure 18 looks at the amount of studying the students reported before each unit summative assessment.

![Figure 18. Amount of studying done prior to the summative assessment.](image)

As Figure 18 shows, students reported increasing the amount they studied from Unit 1 to Unit 2 and then they reported a decrease in studying from Unit 2 to Unit 3. Unit 1 had 22.51% of students report that they did not study, compared to 10% and 22.51% for Units 2 and 3 respectively. Of the remaining students that studied, 29.03% in Unit 1, 73.33% in Unit 2, and 45.16% in Unit 3 reported studying more than one hour.

During the treatment the two areas of concern that kept recurring in the teacher journal were attendance and homework completion. Though the students claimed to have
studied more before the assessments (Figure 18), attendance levels on vocabulary days decreased, especially for Native American males and ELLs (Figure 7), and the amount of homework being completed as reported on the Student Engagement Survey also decreased for Native American students (Figure 12). Attendance has always been a concern at Arlee High School and as the treatment progressed the students got deeper into basketball season which usually is accompanied by lower attendance due to the high number of participants and the student support. With the added instruction the students also became more aware of the importance of vocabulary which made them believe that they were studying more for the assessments.

**INTERPRETATION AND CONCLUSION**

**Action Research Questions**

The overall intent of the AR was to increase student vocabulary acquisition. It was hoped to be achieved by using explicit science vocabulary instruction, a strategy that has been shown to help students acquire a deeper understanding of individual words (Hanson & Padua, 2011). Since some of these strategies had already been incorporated into the biology classroom, the AR started with a baseline of 22% of class time devoted to explicit instruction and it increased throughout the treatment. Several types of data were collected to answer this question, the comparison of pre- and post-assessments providing the bulk of the information. Though the data gathered proved to be inconclusive on whether or not increasing instructional time from 22% to 44% benefited students, it did reveal that students improved drastically from the pre- to post-assessment in all three units. Two demographic groups did see increases throughout the treatment,
Native American females and the ELL students. Even though these two demographics saw decreases in attendance on vocabulary instruction days, they still progressively received more days of vocabulary instruction throughout the research project.

The second question looked at the difference between using visual or written instruction with Native American students. When looking at on-task behavior the Native American students showed an increase of 19% from written activities to visual. This data coupled with the high percentage of students who responded they most benefited from and preferred visual activities, has led to the belief that using visual explicit science vocabulary instruction is more beneficial for Native American students than using written explicit science vocabulary instruction. The types of visual explicit science vocabulary instruction used also is important to consider as different strategies, ones with group components or individual components, worked for different learners.

Student engagement is a critical component to a student’s ability to learn new concepts. With this in mind it was important to monitor student engagement throughout the treatment. Four categories of student engagement were closely observed: effort, grades, homework, and peers. When looking at these categories, effort, grades, and peers saw a very slight increase across all demographics throughout the treatment, and homework saw a pretty sharp decrease. The groups of students who saw the biggest increase in engagement when it came to effort were ELLs and Native American males. On the flipside the Native American students accounted for the large decrease in homework engagement. The decrease in homework engagement was also coupled with a
higher rate of absenteeism and the end of basketball season, a time in which many students see decreases in academic achievement.

The last question focused on student preparation for assessments. One piece of data focused on the grade that students thought they would receive on the final assessment of each unit. The data shows that students who perform poorly on the assessment, a D or lower, often believe they are going to do better. These findings match much of the research that suggests, lower level students lack the metacognitive skills needed to discern what one has answered correctly versus incorrectly (Kruger & Dunning, 1999). Likewise, those who get A’s, often think they are going to perform worse. Again this matches the research and is referred to as “The Burden of Expertise,” where researchers noticed upper level individuals “underestimate their ability and test performance relative to their peers” (Kruger & Dunning, 1999, p. 1131). When asked if they felt prepared, the number of students who felt they were prepared increased by 7% from the beginning of the treatment to the end, even though their grades did not reflect this confidence. There was also an increase in the number of students who felt the vocabulary activities prepared them for the test. This data confirmed that the added vocabulary activities made students feel like they were more prepared for tests even though they did not necessarily prove this on the assessments.

Effectiveness of Treatment

When looking at the effectiveness of the treatment there were three main areas that needed to be addressed: does the increase of vocabulary instruction benefit the students, does it benefit the teacher, and does the data show how much explicit
instruction is the right amount. The students’ academic performance showed that using explicit science vocabulary instruction improved students’ performance on summative vocabulary assessments; however, it did not indicate that having 44% vocabulary instructional time was any more effective than 22% instructional time. The increase appeared to be most beneficial for Native American and ELL students. The surveys were also used to see the benefits of increased vocabulary instruction on the students. One pattern that emerged was the increase in the number of students who believed that vocabulary was the most difficult part of biology, from the beginning to the end of the treatment and the percentage of students who found the vocabulary activities beneficial. This shows that as more time was spent completing vocabulary activities students started to become aware of how important it is to the understanding of biological concepts.

From the educator’s perspective using explicit vocabulary instruction is a proven method that can benefit students’ vocabulary skills. Each unit in the treatment saw a huge increase in post-assessment scores when compared to pre-assessment scores, and students’ overall opinions about explicit instruction were positive, especially visual activities. It was found that many of the activities were very useful and engaging for the students, but that some of the written activities, such as vocabulary inferences and possible sentences, were not as positively received and the students did not put forth their best effort. It was also noted that the instructor enjoyed providing examples for the visual activities and listening to the student driven conversations these activities promoted.

When looking at the whole treatment it is not clear how much explicit science vocabulary instruction is the right amount to maximize student vocabulary acquisition.
The data does show that this style of instruction improves student performance and that Native American and ELL students seem to see bigger gains with an increased level of instruction, if the instruction is more visual in nature. With that said it is believed that using at least 22% of instructional time is adequate when teaching units heavy in content vocabulary.

VALUE

According to Mills (2014), action research is designed to help teachers gain information about their students and themselves, and to elicit positive changes in their teaching practices. Throughout my treatment I found out some very interesting things about my students. First, I learned that many of my students are confident in their academic abilities and overall want to do well in my class and in school. Unfortunately, with this confidence came a lack of homework completion, low test scores, and for certain demographics low attendance rates. With this in mind next year I will try to implement new methods for completing homework, which include utilizing our Chromebooks more and Google Classroom. I also hope to work with our administrators in implementing Check and Connect into our high school next year which should also improve attendance and school performance. My AR also led me to discover that for my Native American students and ELL students they prefer and perform better when given visual activities in small group settings. The ability to discuss the activity with their peers and to see a more visual representation of the word seemed to improve vocabulary acquisition and attitudes about class. I also found out that my students are very inquisitive and love biology because they like “learning new, fun, or cool facts about
humans (us), animals, and life itself.” These types of quotes were found throughout the surveys and helped reiterate how awesome and engaging biology really is.

While making a more concise effort to monitor my students’ work and teaching strategies for over three months, I also found out several things about myself. The main thing I noticed was how much joy I felt when my students were able to engage in the educational process and have lively discussions with their peers about the deeper meaning of different vocabulary words and scientific concepts. Since many of these activities elicit this type of behavior I found the extra vocabulary units to be both beneficial to my students but also to me as they provided those engagement opportunities. As I stated earlier in this paper, I have always taught vocabulary units in my regular curriculum but this experience showed me that I need to do a better job selecting which types of activities and how frequently we conduct them. Being on a four-day week I believe that trying to incorporate one visual explicit vocabulary unit per week would both benefit myself and my students.

Another important eye opener for me was the importance of getting and reviewing student feedback about both my instructional style and the activities that we are conducting in class. Reading my students’ individual thoughts and seeing their surveys showed me that what I am perceiving in class is not always what the students are feeling. This realization will help me keep better tabs on students’ thoughts as this will increase engagement and hopefully academic success.

As I mentioned before, the two groups of students who appeared to feel that they benefited the most and who I believe benefitted the most are the Native American
students and particularly the ELL students. With this in mind, I think it is important for other teachers in my school and on the Flathead Reservation to utilize visual explicit vocabulary instruction across all curriculums. When given the opportunity to present vocabulary, focusing on a small number of words, in small group settings, and with a visual component seems to be the best strategy for our demographic.

I plan to reflect on this entire process as I continue on my journey of educating. With aspirations to look at the effectiveness of student portfolio based websites, scientific journaling, and standards based grades, I will continue to implement visual explicit vocabulary instruction in my classroom and utilize the AR process.
REFERENCES CITED


APPENDICES
APPENDIX A

VOCABULARY WORDS
Unit 1: Cell Division
1. Mitosis
2. Cancer
3. Cytokinesis
4. Tumor
5. Interphase
6. Meiosis
7. S Phase
8. G2
9. Chromosome
10. Anaphase
11. Diploid
12. Zygote
13. Homologous Chromosomes
14. Cell Cycle
15. Prophase
16. Chromatid
17. Metaphase
18. Chromatin
19. Telophase
20. Gamete
21. Haploid
22. G1

Unit 2: Protein Synthesis
1. DNA
2. Nucleotide
3. Purine
4. Pyrimidines
5. Nitrogenous Base
6. Double Helix
7. Ribosomal RNA
8. Transfer RNA
9. Messenger RNA
10. RNA
11. DNA Polymerase
12. Okazaki Fragments
13. DNA Helicase
14. Protein Synthesis
15. Transcription
16. Translation
17. Anticodon
18. Codon

Unit 3: Genetics
1. Genetics
2. Allele
3. Homozygous
4. Heterozygous
5. Monohybrid
6. Dihybrid
7. Recessive
8. Dominant
9. Genes
10. Codominance
11. Incomplete Dominance
12. Law of Segregation
13. Law of Independent Assortment
14. Genotype
15. Phenotype
16. Punnett Squares
17. Sex-Linked Genes
18. Carriers
19. Hybrid
20. True-Breeding
APPENDIX B

EXPLICIT VOCABULARY TOOLS
List-Group-Label

Materials:

1. Sticky Notes
2. Markers
3. Large Post-It Paper

Procedure:

1. Generate the list of words to be used.
2. Put each word on a sticky note
3. Have small groups manipulate the sticky notes to sort the words into categories and come up with labels for those categories (Have them manipulate their sticky notes on a large piece of poster paper so the entire map is moveable once they’re finished.)
4. Stop the action to have groups either share out a few labels they’ve come up with, or have groups quickly circulate around the room, seeing what other groups have been doing with their categorizing and labeling.
5. Return to original small groups and complete categorizing and labeling.
6. Now have the students show relationships between the categories by putting the content/concept that ties the sticky notes together in the middle linking the categories and words, show interrelationships between them.
7. Have small groups present their thinking to the large group – post final maps.

Adapted from Scholastic Teaching Resources Teaching Reading: A Complete Resource for Grades 4 and Up
Compare/Contrast Related Words

Three Words:

_______________________  _____________________  _____________________

List the points all three words have in common.

Next to each word write its unique or different qualities.

1. ______________________

2. ______________________

3. ______________________

Adapted from Scholastic Teaching Resources Teaching Reading: A Complete Resource for Grades 4 and Up
Interactive Word Walls

Overview and Rationale: Interactive Word Wall is a routine that involves students in developing academic vocabulary and describing relationships among the key concepts and technical terms relevant to the topic under study. The purposes of an interactive word wall are to develop students’ academic vocabulary on an ongoing basis and to give students an opportunity to represent and revise their conceptual understandings as they participate in inquiry and other kinds of knowledge building experiences. The complexity of academic vocabulary requires multiple opportunities for students to make sense of key concepts and to come to understand how key concepts relate to one another. Individually, or in small groups, students interact with the chosen academic vocabulary (on file cards or post-it notes) and arrange the words in relation to one another. Students use arrows to represent how one term might lead to another. Interacting with vocabulary in this manner allows students to articulate their developing knowledge of concepts, reveal their misconceptions, socially construct more sophisticated understandings, and track growth in their understanding.

Steps in the Process:

- Choose the vocabulary words that are integral to understanding the big concepts that will be studied in the curriculum unit and write them on file cards or post-it notes for each student or each group of students.
- Model for students how you might begin to arrange the cards and think-aloud as you do so. There are a variety of methods the teacher can use to help students grapple with definitions and meanings. For example, the teacher could define three key terms and then model a possible way to categorize other words under those three big terms.
- Have students work in small groups or individually to arrange cards with the vocabulary words on them to show their current understanding of meanings and relationships.
- Have students present their word walls to each other and note differences and similarities.
- Give students an opportunity to rearrange their word walls given what they’ve learned from how other students have arranged theirs.
- Have all students make a copy of their word walls in their notebooks.
- Give students multiple opportunities to rearrange their word walls as more vocabulary words are encountered and as students build background knowledge through reading and inquiry experiences.
- Have students assess how changes in their word walls, over time reflect changes in their understanding of key concepts and their relationships.
Possible Sentences

These words come from _______________________________________________.
Work by ourself, with a partner or your small group and predict how you think these words might be used in the text.

Word List:

Possible Sentences:
Write sentences using two or more of these words that you might find in the text.

1.

2.

3.

4.

5.

6.

7.

8.

Modifying Predictions:
After reading and coding the text, mark each of your sentences above as true, false, or unknown. Return to each sentence, modify and rewrite below so that the content is accurate.

1.

2.

3.

4.

5.

6.
Vocabulary Inferences

<table>
<thead>
<tr>
<th>Word</th>
<th>Inference: What I think it means</th>
<th>Clues: Why I think so</th>
<th>Real Definition</th>
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</tbody>
</table>
Word Map

Directions:

1. Place the word or phrase in a circle on the middle of your piece of paper.

2. In a circle directly above the word describe, “What is it?”

3. In a circle directly below the word describe, “What is it like?”

4. In a circle to the left of the word provide several examples.

5. In a circle to the right of the word provide several non-examples.

6. At the bottom of the paper write a sentence that shows you understand its meaning.

Modified from Scholastic Teaching Resources: Teaching Reading: A Complete Resource for Grades 4 and up.
Frayer Model

**Overview and Rationale:** The purpose of the Frayer Model are to help students develop in-depth understanding of key concepts important to the topic they are studying and to make it easier for students to access those concepts in a variety of texts and situations. This graphic organizer helps students do more than memorize a key concept or term by asking students to think about the identified concept in terms of the definition, characteristics, examples, and non-examples. Definitions are, of course, critical to understanding a concept. Identifying key characteristics gives students concrete facts to hold on to in relation to the concept. Examples help students quickly access the concept and to see the concept as a category and not just as one “thing.” Non-examples help students to see what the concept is not, further establishing how the key concept names a category. As Rick Wormelli (*Differentiation*, 2007) reminds us, “Frequent and intense experience examining the characteristics of related and unrelated terms makes for powerful long-term memory retention.” The “Frayer Model” becomes an instructional practice when used in the sequences described below.

**Steps in the Process:**
- **Introduce the Frayer Model (if students have never used this kind of graphic organizer before):** Explain the purposes of the Frayer Model (to deepen understanding of key concepts and to make it easier to remember and use the concept accurately).
- **Co-construct an Exemplar:** After explaining the purpose of the graphic organizer and briefly defining each aspect (definition, characteristics, examples, non-examples), have the whole class help you fill in the graphic organizer using a key term that would be familiar to students.
- **Assign key terms to individual students, pairs, or small groups:** Have students work on their Frayer Model in whatever size grouping is most appropriate to your purpose. Collaborating, as always, helps to engage students, keeps them focused, and uses social construction to help develop understanding. Have resources available for students to use.
- **Present and Defend:** Have students present their Frayer Models to the whole class in whatever grouping they constructed them. Oral presentations guarantee accountability and gives students and opportunity to test their reasoning and accuracy before the whole class. Request that everyone in the group play a part in the presentation (this is easy to do as long as the group size is no bigger than four students, as each student can present one part of the Frayer Model).
- **Time to Revise:** If necessary, give students a chance to revise their Frayer Models to ensure accuracy and usefulness.
- **Make Copies and Distribute:** Students will now have a Frayer Model of all relevant key terms for the topic under study.
APPENDIX C

DATA COLLECTION TOOLS
Student Engagement Survey

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

1 = strongly agree  2 = agree  3 = disagree  4 = strongly disagree

I enjoy biology.

1 2 3 4

What is your favorite thing about biology?

I am motivated to do my best in biology.

1 2 3 4

I always try my best in biology.

1 2 3 4

I think it is important to get good grades in biology.

1 2 3 4

I think the activities we do in biology help me learn.

1 2 3 4

I enjoy the vocabulary activities (i.e. Frayer models, compare and contrast, etc...) we do in class.

1 2 3 4

I am confused in biology.

1 2 3 4

I get good grades in biology.
I do biology work at home.

I always keep a notebook of what is going on in biology class.

I always use my notes to prepare for quizzes and tests.

I think biology is difficult

What do you think is the most difficult part of biology?

I do not like any part of biology.

I actively participate in biology class each day.

I am more motivated to work when I am in a group.

I like school.

I like being challenged in school.
I want to get good grades in school.

1 2 3 4

**Student Pre-Test Survey**

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

1. What grade do you think you will receive on this test?
A  B  C  D  F

2. How long did you study for this test?
Less than an hour  1-2 hours  2-3 hours  More than 3 hours  I didn’t study

3. I feel prepared for this test.
Strongly Agree  Agree  Disagree  Strongly Disagree

4. I feel like the activities we did in class helped prepare me for this test.
Strongly Agree  Agree  Disagree  Strongly Disagree

5. I feel like the vocabulary activities we did in class prepared me for the test.
Strongly Agree  Agree  Disagree  Strongly Disagree

6. I feel like my teacher helped prepare me for this test.
Strongly Agree  Agree  Disagree  Strongly Disagree

7. What vocabulary activity do you think prepared you the most for this test?
Compare & Contrast  Word Maps  Possible Sentences  List Group Label

8. Why do you think this activity was the most helpful?
9. What vocabulary activity did you enjoy the most?

Compare & Contrast  Word Maps  Possible Sentences  List Group Label

10. Why did you enjoy this activity?

11. What vocabulary activity do you think was the least helpful in preparing you for this test?

Compare & Contrast  Word Maps  Possible Sentences  List Group Label

12. Why do you think this activity was the least helpful?

13. What vocabulary activity did you dislike the most?

Compare & Contrast  Word Maps  Possible Sentences  List Group Label

14. Why did you dislike the activity?
On-Task Observation Tally Sheet

Date (include day of the week): ___________________

Activity: __________________________

Observations

<table>
<thead>
<tr>
<th>Time</th>
<th>Students</th>
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<tr>
<td></td>
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</tr>
<tr>
<td>1:05</td>
<td>N1</td>
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<tr>
<td>1:10</td>
<td>N2</td>
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<td>1:25</td>
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<td>1:30</td>
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</table>

On Task: listening  
Off Task: passive

On Task: writing  
Off Task: working on another subject

On Task: speaking  
Off Task: listening to others

On Task: reading  
Off Task: disturbing others (i.e. talking)

On Task: hands on activity  
Off Task: playing (i.e. electronics)

Adapted from Student Observation Engagement Tool. Available at: http://www.schooltransformation.com/resources/
APPENDIX D

IRB EXEMPTION LETTER
MEMORANDUM

TO: William Stockton and Walt Woolbaugh
FROM: Mark Quinn
DATE: November 5, 2015
RE: “The Effects of Explicit Vocabulary Instruction on Vocabulary Acquisition and Student Motivation”

The above research, described in your submission of November 5, 2015, 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 E

KNOWLEDGE RATING ASSESSMENT
Unit 1 Cell Division

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<th>Don’t Know it</th>
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## Unit 2 Protein Synthesis

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## Unit 3 Genetics

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APPENDIX F

EXTRA FIGURES
Figure 1. The percentage of responses from the first student engagement survey by category for the question, What do you think is the most difficult part of biology? (N=30).

Figure 2. The percentage of responses from the second student engagement survey by category for the question, What do you think is the most difficult part of biology? (N=31).
Figure 3. The percentage of responses from the third student engagement survey by category for the question, What do you think is the most difficult part of biology? (N=31).