INQUIRY IN THE FIRST GRADE SCIENCE CLASSROOM

by

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ABSTRACT

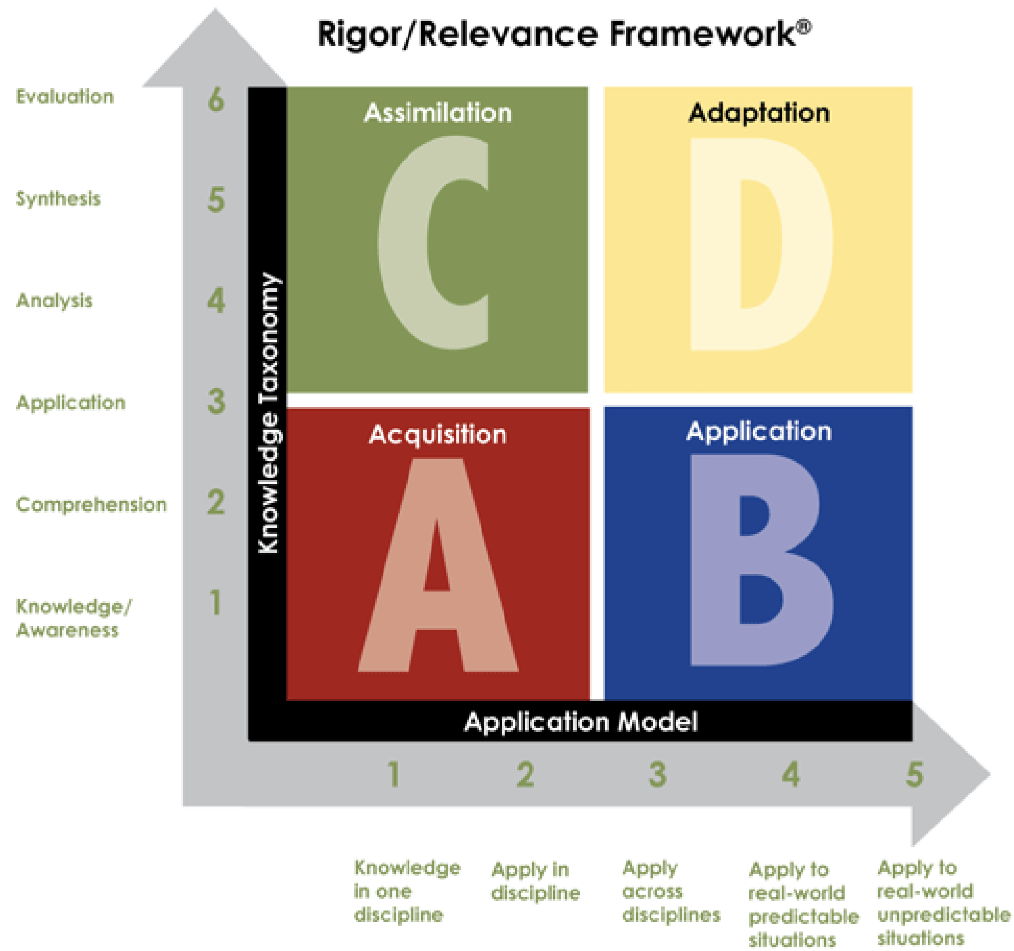
Given the varying degrees of reading literacy in the first grade classroom, the traditional teaching approach of text and lecture does not meet the needs of all students. This capstone project looks at the effect of inquiry-based instruction (hands-on learning) on students' abilities to communicate and collaborate while measuring student engagement. Students of all reading levels were actively engaged in designing and carrying out investigations. Student communication was measured through a variety of mediums. Student collaboration took place in partner, small group and whole group activities. By allowing first grade students to "do" science rather than read about science, they were able to capitalize on their natural curiosity and thereby learn vital science skills while developing a working knowledge base. Inquiry-based instruction provided a positive learning environment for students of all reading levels. Struggling readers benefited from inquiry-based instruction because the students did not have to rely on reading skill and were able to be successful in the science classroom. Conversely, by not being able to read the answer, on grade level readers experienced a learning disequilibrium and had to rely on less used skills during inquiry-based instruction. It was refreshing to see a different set of student successes.

INTRODUCTION

Rossiter Elementary School is located in the North Valley of Helena Montana. With a population of roughly 500 students K-5, Rossiter Elementary School is the largest of eleven elementary schools in the Helena School District. The school is comprised of students from diverse socioeconomic backgrounds though majority of the students come from middle-income families. My first grade section has 21 students, most classified as white with Native American students comprising only three percent of the classroom population. Eighteen percent of my students qualify for free or reduced lunches. Given that I am my students' primary instructor, I am very familiar with their literacy levels and have come to understand that the traditional textbook and lecture approach to teaching science provides certain difficulties for young students. In my six years as a first grade teacher, I have seen degrees of literacy vary from fourth grade reading levels to difficulty in identifying letter names and sounds. The first grade students who read well enough to extrapolate information from text thrive in a traditional setting and teaching from a textbook is tailored to their learning style. However, even at the young age of six years old, these conventionally labeled "bright" students are accustomed to reading the information, finding the answer, and considering the task complete. It is my experience that these students are uncomfortable when asked to apply the information they have read. They verbalize a learning preference by asking me to just tell them the answer rather than exhibit a willingness to discover the answer on their own. The ease with which a science basal textbook lends itself to supplying information to the efficient first grade reader is poignantly shadowed by the challenge of teaching the intensive/strategic reader from the same textbook. The intensive/strategic reader is still learning to read and therefore is actively engaged in making words from letters rather than in drawing meaning from these words. Teaching from a science basal textbook becomes just another lesson in reading literacy and the focus is not on science content.

Enhancing science instruction with inquiry levels the playing field by allowing students who do not learn best through the typical text and lecture approach to develop a stronger science knowledge base. Pairing inquiry-based instruction with traditional text and lecture instruction may create a symbiotic relationship between reading literacy and science literacy. By incorporating science text into science lessons after the inquiry process has occurred, I hope to use my students' science literacy to increase their interest in science literature. Pearson (2010) writes, "When science literacy is conceptualized as a form of inquiry, reading and writing activities can be used to advance scientific inquiry, rather than substitute for it" (p.459). Capitalizing on the strengths of my students is a key factor for their success. It is my hope that if my students have a strong hands-on experience to draw from, the science literature will be more meaningful.

The state of Montana recently adopted a Common Core Standards based curriculum. At the heart of the adoption is Dagget's Rigor/Relevancy Framework rubric as developed by the International Center for Leadership in Education (Figure 1). With this adoption comes an increased focus on student learning. The goal behind the adoption of the common core standards is to move students from Quadrant A where students acquire information to Quadrant D where students adapt their working knowledge to fit the needs of the problem or situation. Given the literacy challenges presented in a first grade classroom, inquiry-based instruction appears to be a capital means of not only covering all quadrants of the Rigor/Relevancy Framework but also allowing students to spend a good majority of their time in the higher ordered quadrants of Application (Quadrant B), Assimilation (Quadrant C) and Adaptation (Quadrant D).



A	B	C	D
Students gather and store bits of knowledge and information. Students are primarily expected to remember or understand this knowledge.	Students use acquired knowledge to solve problems, design solutions, and complete work. The highest level of application is to apply knowledge to new and unpredictable situations.	Students extend and refine their acquired knowledge to be able to use that knowledge automatically and routinely to analyze and solve problems and create solutions.	Students have the competence to think in complex ways and to apply their knowledge and skills. Even when confronted with perplexing unknowns, students are able to use extensive knowledge and skill to create solutions and take action that further develops their skills and knowledge.

Figure 1. Rigor/relevance framework (adapted from the International Center for Leadership in Education. 2012).

Given the fact that most first graders are still learning to read, it follows that the majority of first grade students are not yet prone to pulling information out of text

(Quadrant A). However, first graders are innately able to investigate and discover. Their level of text comprehension does not match their scientific abilities. The primary focus of this research study is to investigate the impact inquiry-based science instruction has on helping students to become 21st century learners. My subsequent questions are:

- Does inquiry-based science instruction affect student engagement?
- Does inquiry-based science instruction foster collaboration between students?
- Does inquiry-based science instruction aid students in developing Essential Science Skills like observing, communicating and investigating?

CONCEPTUAL FRAMEWORK

With the advent of technology and the 21st Century, our educational focus has shifted from acquisition of information to utilization and adaptation of information. Rote memorization has become outdated. Information is now readily accessed through the internet. Educators are becoming more focused on what students do with the information they acquire. Inquiry-based science instruction is gaining attention as a positive way to allow students to assimilate information while they process, adapt, and evaluate what is happening in the science setting (National Research Council 2012). Inquiry-based science instruction is rooted on the Constructivist theory that we build knowledge through using our five senses. As the idea of inquiry-based science instruction has continued to evolve, two distinct camps have emerged regarding its importance. On one hand, there is the group that states that there is no benefit to inquiry-based instruction (Kirschner, Sweller, & Clark, 2006). Kirschner describes inquiry-based instruction as unstructured and ineffective. It is clear to Kirschner that hands on experience without sense making instruction is not an effective means of instructional delivery. However, in responding to the claims that inquiry-based instruction is futile, proponents hold firm that with the proper scaffolding and guidance, hands on learning (inquiry-based instruction) has a significant positive impact on student learning (Hmelo-Silver, Golan Duncan, & Chin, 2007).

As the idea of inquiry-based science instruction has continued to evolve, the importance of coupling hands-on experience with direct instruction also known as sense-making has become evident (Butts, 1993). There are those who would argue that activity based instruction places too much stress on science process at the expense of content learning (Bredderman, 1983). However, as Bredderman explains, standardized content tests do not support this fear and in fact, "… they have found that the activity-based methods produced greater science content learning" (1993, p. 506). More recently, Chang (2010) also found that inquiry-based instruction has a positive impact on content learning. He explored the impact inquiry-based instruction has on student motivation. Chang divided students of varying IQ's into two groups. One of the groups received traditional direct instruction and the other received problem solving based instruction in an Earth Science unit. Pre and post assessments were administered to both groups to record student progress. Chang also administered student surveys to assess motivation and learning preference. Chang found that students "taught by the problem-solving based instructional model did experience a significant conceptual change (as opposed to)… students who were taught by the traditional-lecture type teaching method" (p. 380). However, Chang reported in his study that students expressed frustration with the problem solving based method of instruction and admitted being more comfortable with traditional methods of instruction, and viewing it as a more efficient means of scoring well on standardized tests. Chang's study group was comprised of Taiwanese ninth grade students whose focus was on the upcoming national placement exams. Clearly, the focus of these ninth grade students was to get the information they needed in order to be successful on a placement exam rather than build a strong science base. Conceptual changes were not as essential to the students who had a stake in placement standings.

One of the most challenging aspects inquiry-based instruction poses is to allow the students to discover answers on their own. Traditionally speaking, students tend to look at the teacher as a fount of information and have come to realize that the answer will be provided in time through no effort of their own. With the focus on instruction, the teacher is viewed as the source of information whose job it is to mete out information in digestible bits. In inquiry-based instruction, teachers must refrain from doling out the expected answer so that students may learn by doing. The focus becomes on learning. Furtak (2005) describes a study of three teachers and their interactions with students during an inquiry-based science unit. Each of the three teachers wanted his or her students to arrive at the answers without being spoon-fed the information. All three teachers taught middle school science but had limited degrees of exposure to implementing the inquiry process in the science classroom. In all three cases, it became clear that the students simply went through the motions of the science lab while fully expecting the teacher to provide the answers in the end thereby placing the emphasis on instruction.

One benefit of inquiry-based instruction is that it has student driven learning at its center. Student motivation plays a key factor in content learning. Inquiry-based instruction uses natural curiosity to engage students in active learning (National Research Council, 2012). Allowing students to take on the role of scientific investigator leads them along the path to becoming 21st century learners. Student engagement, motivation and learning style come into play when evaluating the effectiveness of inquiry-based instruction (Pintrich, 1993). According to Pintrich, there are defined indicators of motivation. Pintrich claims that "three aspects of an individual's behavior -choice of a task, level of engagement or activity in the task, and willingness to persist at the task- are the three traditional behavioral indicators of motivation" (p. 3). Inquiry-based instruction has engagement at its core. Students have choice of task. The focus is on learning.

With the clarification that inquiry-based instruction does not have to be a free for all as supposed by opponents, comes the need to look at the role of guided instruction. Children are curious by nature. Coupling this natural-born instinct for discovery with science content allows students to build on background knowledge. Guiding students by using the 5 E's learning cycle has proven an effective way to enhance science content learning (Bybee & Landes 1988). The following descriptions clarify the five phases of the learning cycle (Bybee & Landes, 1988; Bybee et al., 2006; Stamp & O'Brien, 2005).

- Engagement (E1): The teacher engages the students in a new learning concept.
- Exploration (E2): The teacher provides common activities designed to allow students to explore questions and possibilities pertinent to the new learning concept.
- Explanation (E3): The students demonstrate their understanding of the new learning concept. The teacher guides students to a deeper understanding of the new learning concept.

- Elaboration (E4): The teacher challenges students so that they develop deeper understanding and skills.
- Evaluation (E5): The teacher evaluates the students' progress toward the new learning concept and the students learn to assess their understanding and abilities.

The five phases give the exposure needed in order to move students along to becoming 21st century learners.

In conclusion, traditional textbook and lecture instruction places a greater emphasis on instruction, whereas inquiry-based instruction places more emphasis on learning. Throughout the years, inquiry-based instruction has been examined as an alternative to traditional teacher driven instruction in educational history. With the recent trend in education to shift focus to the application of knowledge, inquiry-based instruction merits further exploration.

METHODOLOGY

My capstone project centered on two Helena School District #1 critical competencies required for first grade science students: Magnets and Characteristics of Living Things. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained. The participants in this research study were the students in my own first grade class, made up of thirteen boys and eight girls of varied reading abilities ranging from a girl who reads at Kindergarten level to a boy who reads at third grade level. The unit on magnets occurred the first three weeks of February 2013 and the unit on living vs. nonliving things occurred the first two weeks of March 2013. During the unit on magnets, the students worked in small groups to design and carry out their own investigations. I focused on the impact inquiry-based science instruction had on the students' ability to demonstrate Essential Science Skills as defined by Montana OPI. The unit specifically relied on the first four of the five E's of the inquiry learning cycle: Engage, Explore, Explain and Elaborate. During the unit on living versus nonliving things, the students also worked in small groups and focused on the Essential Science Skills of observation, collection of data, classifying and collaboration. This unit included all of the five E's of the inquiry learning cycle with particular emphasis placed on the fifth E: Evaluate.

While the Properties and Characteristics of Magnets unit focused on the outcome of students' designing an investigation, the first four E's of the inquiry learning cycle were heavily utilized. I began the Engage portion of the learning cycle by using two donut magnets and a pencil. I put the pencil through the center of both magnets and positioned the magnets with the south pole of one magnet facing the south pole of the other so that the magnets repelled each other. The top donut magnet seemed to float in air around the pencil and above the bottom magnet. I did not tell my students that the donuts were magnets and I challenged them to explain how they thought I was able to cause the top circle to hover. Students recorded their explanations in their science journals. Students communicated their ideas in a class discussion during which I supplied the scientific terminology and content (Explain). I then guided students in using content vocabulary: magnet, attract, strength, poles, repel, magnetic force, and magnetize. For the Explore portion of the learning cycle, students were given the opportunity for hands-on free exploration of various magnets including bar, donut, circle and horseshoe magnets. Students demonstrated the outcome that surprised them the most to the rest of the class. As a class, we developed and recorded scientific questions about magnets. I then guided students in determining whether each question could be investigated within the confines of the classroom. When all that remained on the list were questions that could be investigated within our classroom, students were asked to pick three questions they would like to explore and write them down in their science journal, listing their top pick first. I then collected their journals and divided students into small groups based on the questions they picked. Each small group was charged with designing an investigation to answer its assigned scientific question about magnets. Before allowing students to break into the investigation portion of the science unit, I told each student that he or she would be responsible for sharing with the rest of the class at least one thing that no one else in the group already shared. I assured the class that they could collaborate so that each group member would have something to share. After ample investigation time, students reconvened as a whole class. Each group presented its question, investigation, data, and explanation. To conclude each presentation, the groups elaborated by using the prompt, "Now that we have answered this question, we wonder…" and "We think that…" After all groups shared, students recorded their investigations in their science journals in which I had written the question pertaining to their small group.

I monitored student engagement and collaboration throughout the unit by making and recording observations based on an engagement scale (Appendix A) and on a collaboration scale (Appendix B). I tracked and recorded science content vocabulary during small group share on a vocabulary content sheet (Appendix C). I used a content vocabulary assessment probe as a whole group record of vocabulary understanding

(Appendix D). I handed out the vocabulary assessment probe and asked students to fill in the missing content vocabulary. I also used student journals to aid in assessing their science content learning.

The focus of the Living vs. Nonliving unit was on the Essential Science Skills of observation, data collection, classifying and collaboration. Unlike the unit on magnets, the fifth E (Evaluate) of the inquiry learning cycle came into play during this second unit. Students began this unit with a pre assessment in order to give me baseline information. I then guided the students in constructing a data table with eight different sections for recording observations. I placed eight observation stations at various locations around the room and each station had one object for observation. The eight objects included: 1) a glass of water, 2) a carrot, 3) toy car capable of movement, 4) a habitat with two crickets, 5) a houseplant, 6) a fish, 7) a puppet, and 8) a rock. I broke students into small groups of two or three. I placed one group of students at each of the eight observation stations and gave them five minutes to make their observations about the object/living thing on display and record their findings on the data table before moving on to the next station. Students recorded observations in writing or through pictures. After completing observations at all eight stations students were given ten minutes to individually classify each of the things they saw into living or non-living using their data table as reference before we discussed their classifications as a class. Students offered their answers about how they classified each thing and had to explain their choice. When students disagreed with each other about the classification of a particular object, they explained their reasoning. Through guided instruction, students created their own set of rules to determine whether the object fell under the category of living or nonliving. According to our first grade Harcourt Inc. (2005) science basal textbook the criteria for determining if something is living are: 1) Does it need food, water, and air? and 2) Does it grow and change? (p. A14). The unit on Characteristics of Living versus Nonliving concluded with a classroom read aloud of the relevant chapter (lesson 2) in the classroom science basal textbooks.

I reviewed the student science journals and data tables to assess students' observation and data collection skills. Assessment of student engagement took place through classroom observation and was recorded in the engagement scale chart (Appendix A). I also used an adapted rubric for NGSS Science and Engineering Practices K-2 (Appendix E). I specifically looked at four students to assess with the adapted NGSS Science and Engineering Practice K-2 rubric. I selected one student from each of the reading categories as ascertained by the AIMS/WEB reading fluency test, which is administered by the Helena School District. The categories are Intensive, Strategic, Benchmark, and High Benchmark.

The data from both units was collected according to the Triangulation Matrix found in Table 1.

Table 1
Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
Primary Question: 1. What impact does inquiry-based science instruction have on helping students to become 21st century learners?	Engagement Scale	Content Vocabulary Assessment and Probe	Adapted NGSS Rubric
Secondary Questions: 2. Does inquiry-based science instruction impact student engagement?	Engagement Scale	Adapted NGSS Rubric	Student Science Journals
3. Does inquiry-based instruction foster collaboration between students?	Engagement Scale	Collaboration Scale	Adapted NGSS Rubric
4. Does inquiry-based instruction aid students in developing Essential Science Skills like observing, communicating, and investigating?	Content Vocabulary Assessment	Adapted NGSS Rubric	Student Science Journals

DATA AND ANALYSIS

The analysis of the engagement scale for the magnet unit resulted in a score indicating active engagement of all but one first grade student. Out of twenty total students who were present that day, the scores ran from one student scoring 1 (distracted/off task) to fourteen students scoring a 5 (actively engaged and demonstrating enthusiasm). Five students scored a 3 which indicated that they were engaged and on task. The class average (86\20) was 4.3, which indicated marked engagement. The majority of first graders were actively engaged in the hands on portion of the magnet unit. Collaboration assessment revealed results similar to those of the engagement scale assessment. On the collaboration scaled assessment, two students showed no evidence of collaboration. Eight students scored a 3 which indicated a willingness to express ideas. Ten students scored a 5 which indicated a willingness to show ideas and listen to what others had to say. The class average for collaboration was 3.8. The results indicate that inquiry-based instruction fosters student collaboration. Students successfully collaborated to design and carry out scientific investigations.

The content vocabulary assessment sheet indicated use of content vocabulary in small group presentations where appropriate. All twenty students used the content vocabulary word “magnet” in the small group presentations. However, the use of content vocabulary varied depending on the small group presentation. In the small group presenting on the effect water has on a magnet, three out of four students used the content vocabulary word “attract” whereas none used the word strength. One student used “poles” and “repel”. No student in that group talked about “magnetic force” or “magnetize.” In the small group presentation about what magnets are attracted to, all four students used content vocabulary “magnets” and “attract” but none talked about “strength” “poles” “repel” “magnetic force” or “magnetize”. The small group presentation on possible uses of magnets in our daily living again had all four students using the word magnets. Two of the four used “attract” and “strength”. One of the four used “poles” and none used the other content vocabulary words for the unit on magnets. The small group presentation on magnetic force had similar results with all four students using “magnets”. Three of the four used “attract” and one used “strength”. No other content vocabulary was used in this small group presentation. The final small group investigated magnetic poles and again, all four students used the word “magnets”. In this group, two students used “attract” “repel” and “magnetize”. One student used “poles” and no student used “strength” or “magnetic force”. The results indicated appropriate communication in the first grade science classroom. Break down of content vocabulary usage by word is shown in Figure 2.

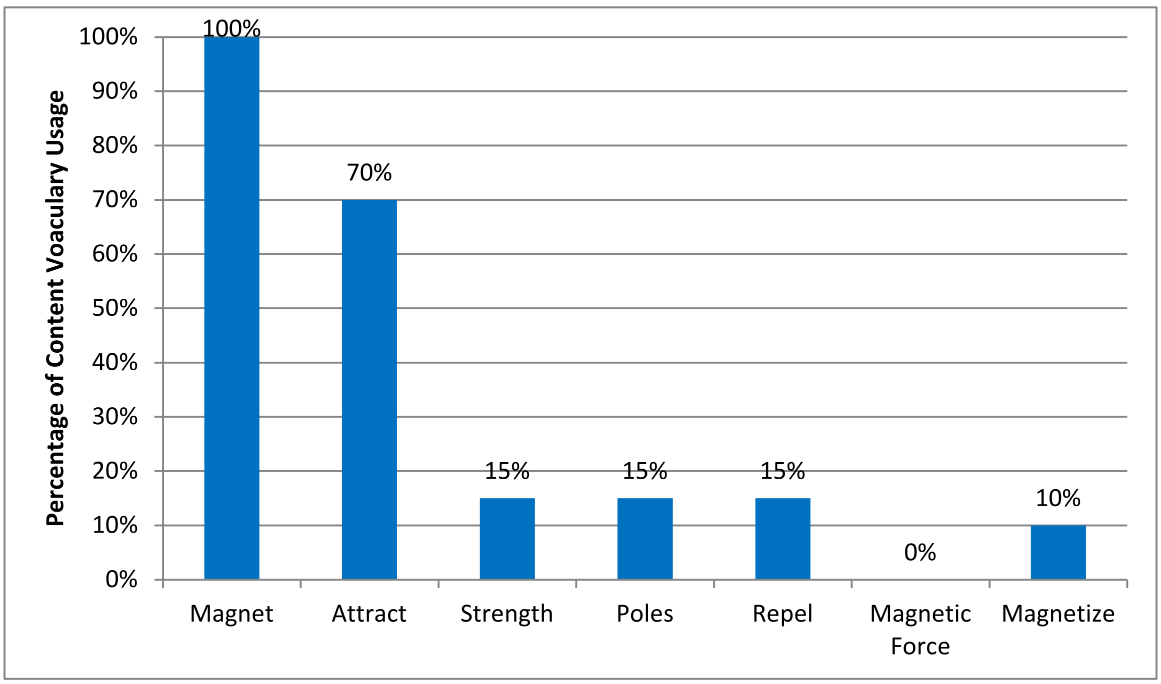


Figure 2. Content vocabulary usage in small group presentations, (*N*=20).

Because of the content specific aspect of small group investigation and presentation, I administered an additional content vocabulary probe. Eighteen students turned in the vocabulary assessment probe. The vocabulary assessment probe consisted of fill in the blank content vocabulary definitions. Eight students correctly identified the content vocabulary word “magnet.” Ten students correctly identified “attract” and “strength.” Five students correctly identified the definition for “poles.” All eighteen students correctly identified the definition for “repel.” “Magnetic force” was correctly identified by nine students and seven students were able to correctly define “magnetize.” The data for the assessment probe is illustrated below in Figure 3.

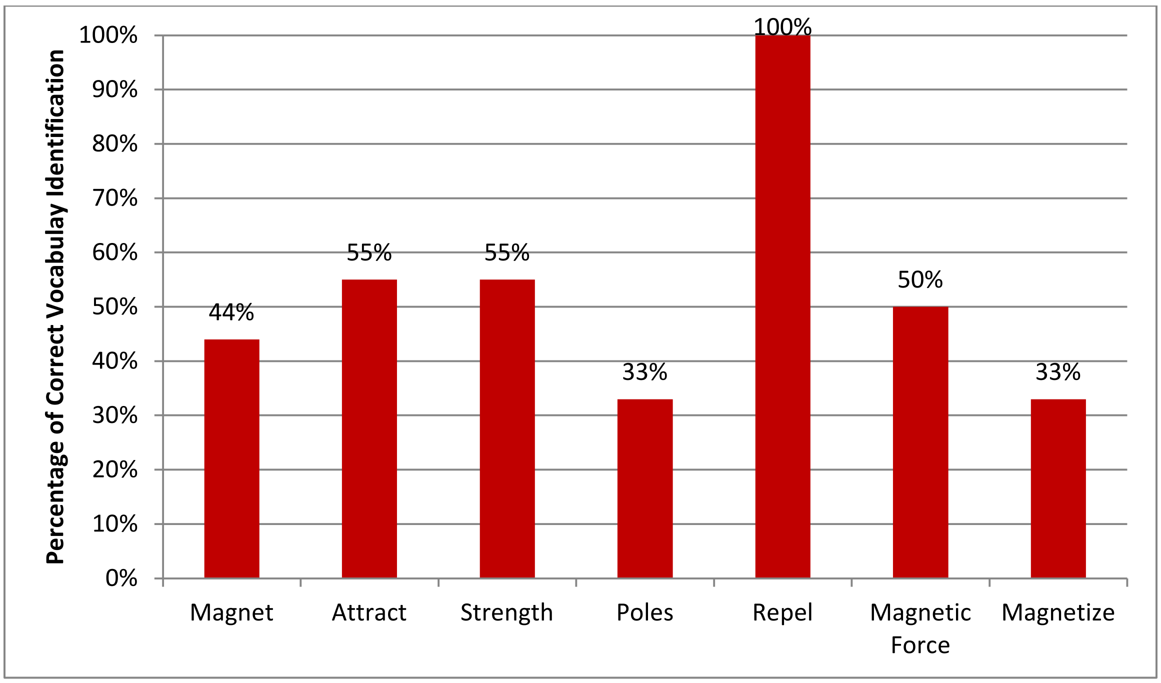


Figure 3. Content vocabulary identification on assessment probe, (*N*=18).

In a culminating activity for the unit on magnets, students were guided in the construction of a magnet journal. Seventeen students turned in a journal for assessment. The journals consisted of content vocabulary, reflections on learning about magnets and the opportunity to show creative writing. Of the seventeen students, ten correctly defined the word “magnet”. Nine correctly defined “attract”. “Strength,” “poles,” and “repel” were correctly identified by fourteen students. Fifteen students correctly defined "magnetic force" and thirteen correctly defined "magnetize". The results indicate that inquiry-based instruction fosters communication and correct usage of content vocabulary by students. The graphic illustration of the data gathered from the science journals is found below in Figure 4.

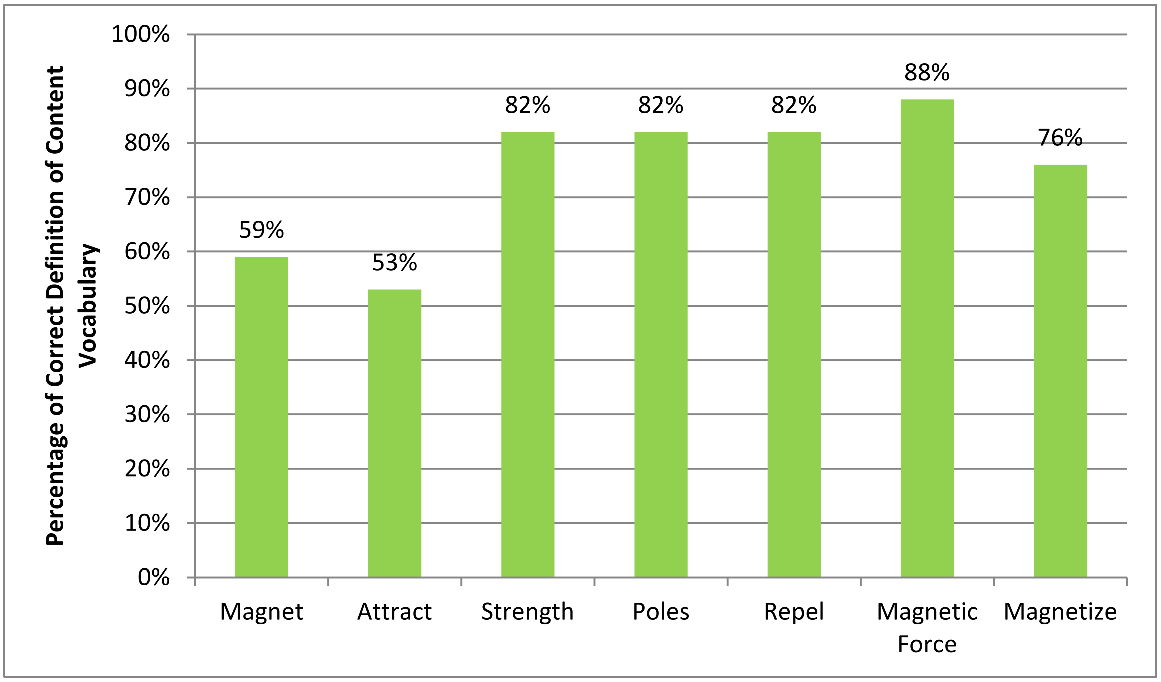


Figure 4. Content vocabulary by definition in science journals, (*N*=17).

The findings for the unit on magnets show different strengths and vocabulary usage for different activities. It is interesting to note that all students used the word magnet when presenting their chosen investigation but the word magnet was not correctly identified by all students in the assessment probe. The fact that the most content vocabulary was used correctly in science journals, the final student driven activity, shows that many approaches must be used by teachers to assess mastery. The culmination of content vocabulary usage is summarized in Figure 5.

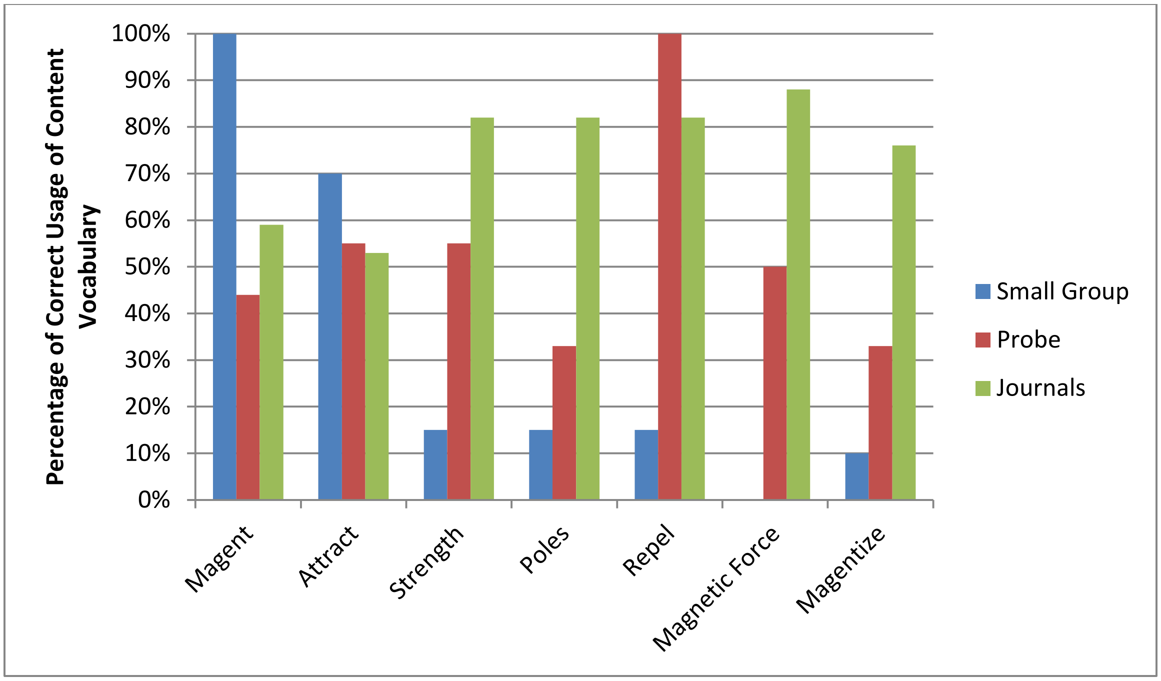


Figure 5. Cumulative content vocabulary information, (N=17)

In the second treatment unit on Living versus Nonliving, the pre unit assessment probe revealed an average score of 83% of correct categorization of objects by students into the categories of living or nonliving. Of the twenty-one students, eighteen turned in the pre unit assessment probe. Four of the eighteen (22%) correctly categorized four of the six items on the probe. Nine students (50%) correctly categorized five of the six items. Five students (27.8%) correctly categorized all six items. Three objects (pencil, cat, and car) were correctly identified by all eighteen students whereas only seven correctly identified the apple as living. The summary of data by item is shown in Figure 6.

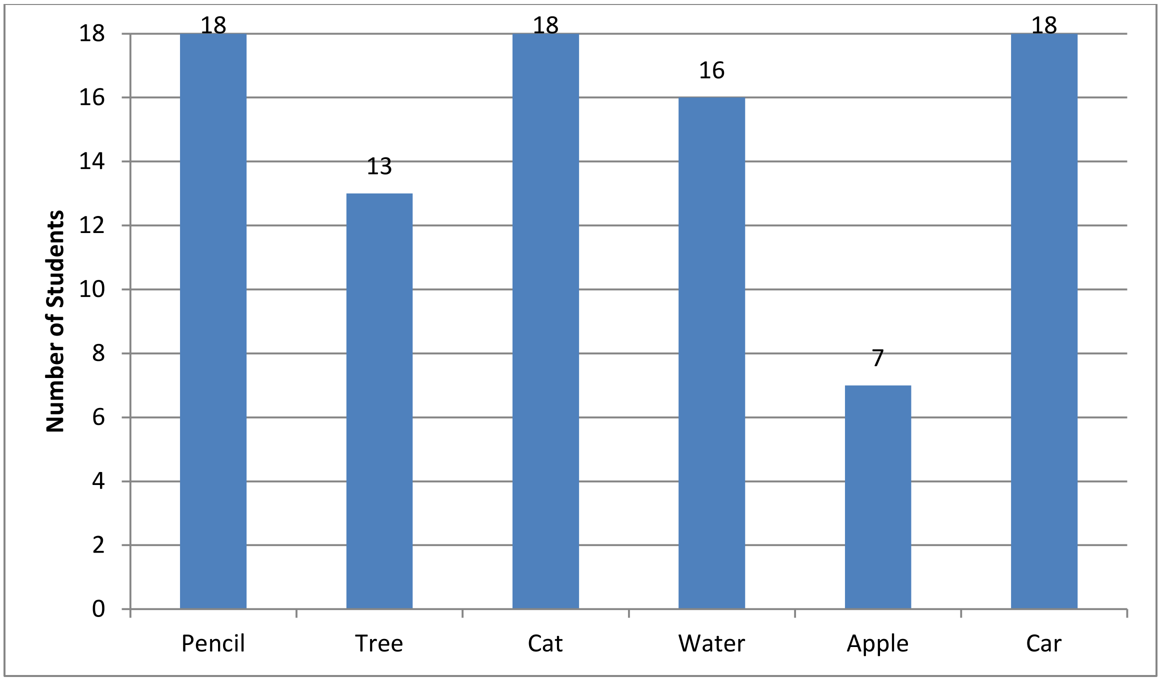


Figure 6. Pre unit assessment probe, (*N*=18).

The overall class score for engagement was 4.7. Eighteen out of twenty-one students (86%) scored a five on the engagement scale with only three (14%) scoring a three. The students demonstrated enthusiasm and eagerness. Again, the results indicate that inquiry-based instruction has a positive effect on student engagement.

In using the NGSS rubric, I specifically looked at four students. I selected one student from each of the reading categories as ascertained by the AIMS/WEB reading fluency test, which is administered by the Helena School District. The categories are Intensive, Strategic, Benchmark, and High Benchmark. At the last AIMS/WEB reading assessment, the selected Intensive reader's score indicated that she read at the level of a kindergartener after nine months of instruction. The strategic reader read at a first grade level after three months of instruction. The Benchmark reader read at a first grade level after eight months of instruction and the High Benchmark student read at a third grade level after one month of instruction. Of the four students assessed with the NGSS rubric, one hundred percent scored a five on the engagement scale. The reading level of the students did not come into play in the hands-on portion of the instruction. The collective score for collaboration was 3.75 with three of the four students scoring exemplary on collaboration and one scoring proficient. The intensive reader scored proficient. The strategic, benchmark and high benchmark readers all scored exemplary. Collectively, the four students scored a 2.75 on the observation portion on the NGSS rubric. The intensive reader began her recording of observations during the construction of the data table. With prompting, she was able to wait until we had begun the actual observation portion of the process. Her observations were based on scientific fact. The strategic reader scored a proficient. His observations for each observation station were general and broad. The benchmark reader scored exemplary on the NGSS rubric for observation. The benchmark student provided observations that were rich in detail and based on scientific facts. The high benchmark student struggled with providing scientific evidence in his observations. His descriptions included opinion rather than fact. He therefore scored a two on the NGSS rubric for observation. The results indicate that inquiry-based instruction aids in developing the Essential Science Skill of observing.

True to the AIMS/WEB guidelines, the intensive reader was unable to read the grade level text. When she and I read the text together, she was able to make sense of the text with prompting. During the reading portion, she was off task and distracted. When asked to draw conclusions from the text, she used her hands-on experience and was comfortable distinguishing living from nonliving. This was evident from her referencing the classroom objects rather than the textbook examples. The strategic reader was able to read the text with prompting. He was able to make sense of the text with prompting. The strategic reader was off task during the reading portion but he could come back on task with prompting. He was able to draw conclusions from the text and his hands-on experience. The benchmark reader was proficient at reading the grade level text. He was able to make sense of the text. He was on task during the reading portion of the unit. The benchmark reader was able to draw conclusions from the text and his hands-on experience. The high benchmark reader scored exemplary in both reading and understanding the text. He was on task during the reading portion of the unit. The high benchmark reader was able to draw conclusions from the text and his hands on experience but he still had difficulty distinguishing his opinion and fact. A summary of the data appears below in Figure 7.

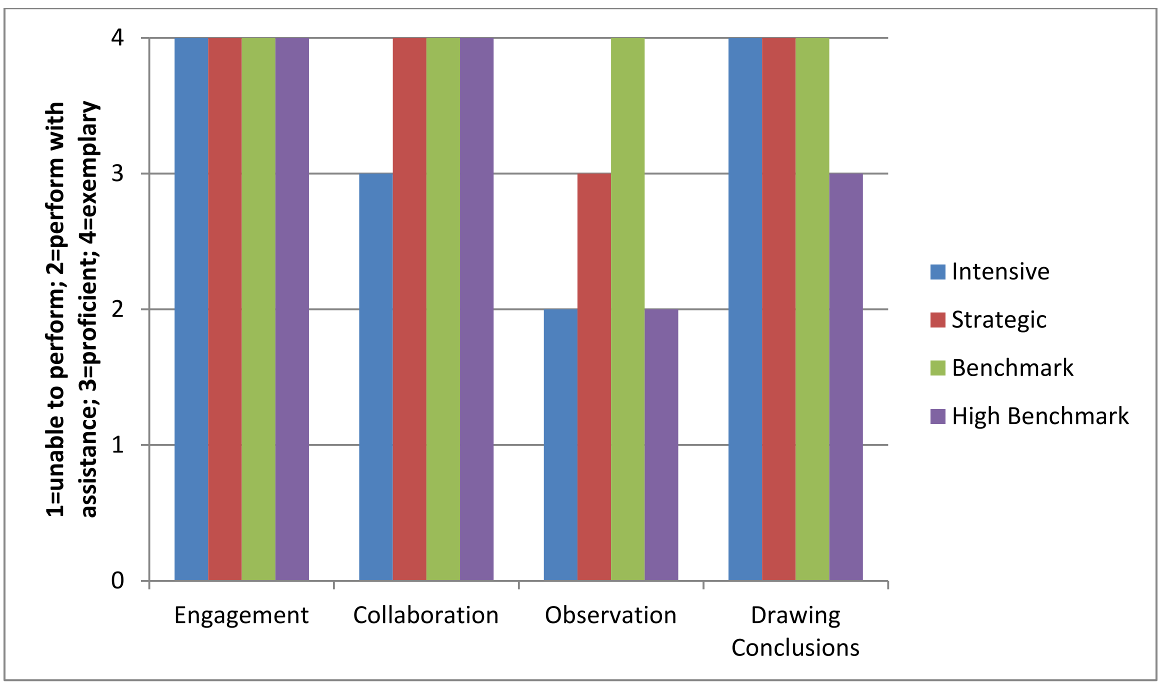


Figure 7. NGSS rubric data, (*N*=4).

The same assessment probe was set after completion of the unit on Living versus Nonliving. The same eighteen students were assessed post unit as were assessed pre unit. Sixteen of the eighteen students (89%) correctly categorized all six objects on the assessment probe. The other two of the eighteen (11%) correctly categorized five of the six items. The class average for correctly categorizing the objects was 98%. The data indicated that inquiry- based instruction is an effective approach in guiding students in becoming 21st century learners. The data for correct categorization by item is summarized in Figure 8.

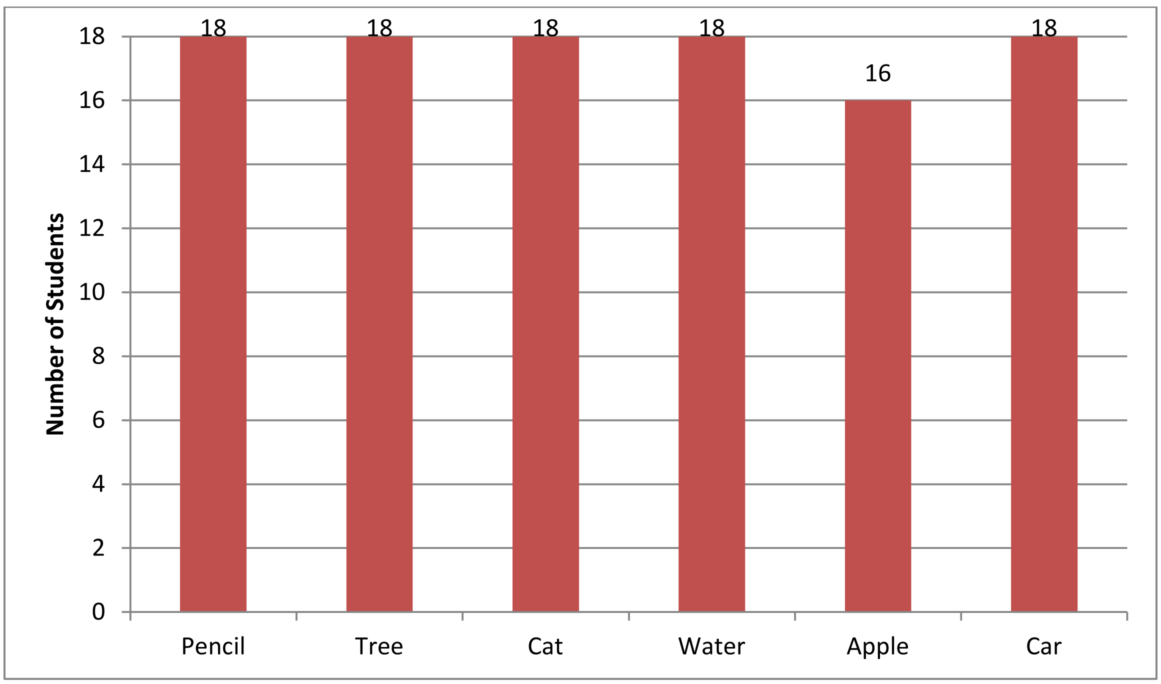


Figure 8. Post unit assessment probe, (*N*=18).

Side by side comparisons of the pre and post unit assessment probes appear below in Figure 9.

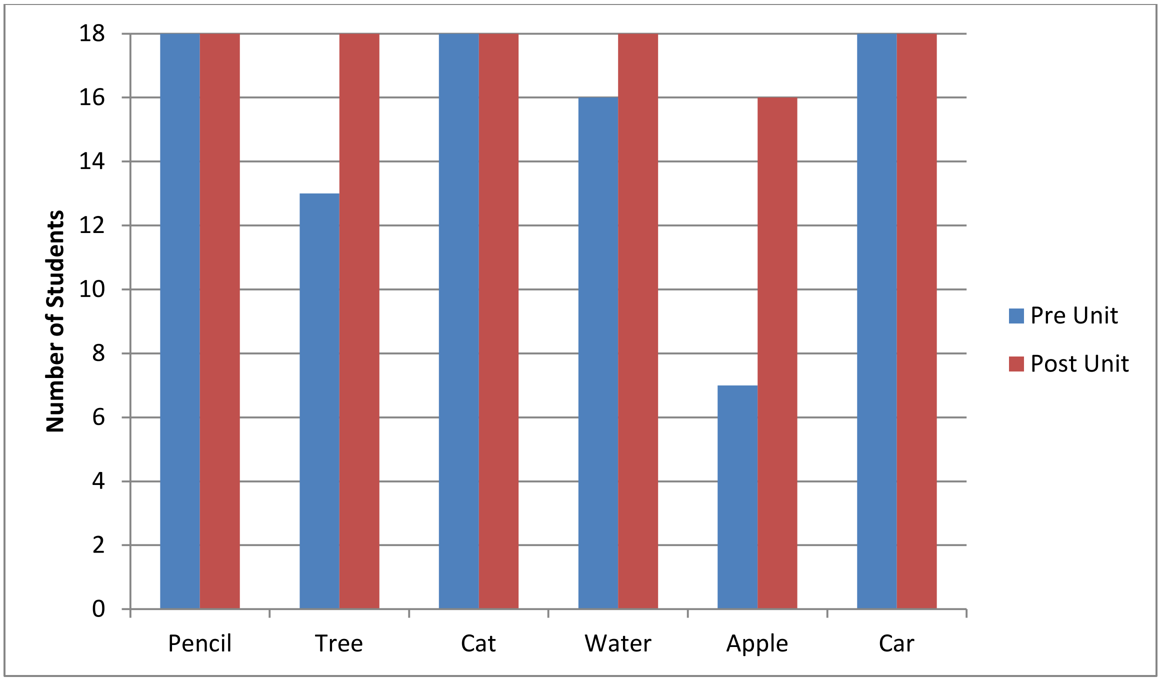


Figure 9. Pre and post unit data, (*N*=18).

INTERPRETATION AND CONCLUSION

This action based research project provides evidence that inquiry-based instruction has a positive impact on the learning of students of all reading levels. The opportunity to have hands-on experience with magnets was an effective method of allowing students to gain firsthand knowledge about magnets and their properties. Students were able to successfully design investigations and carry them out. Students effectively collaborated and communicated throughout the unit on magnets. During the hands-on portion of the units on magnets, students were engaged and on task. Specific content vocabulary was used correctly during small group presentations. Student magnet journals showed that students had gained a broad knowledge base throughout the unit on magnets. Initially, when students were exposed to magnetic repulsion, they deemed that wind was the force keeping the magnets apart. By the end of the unit, students had working knowledge of magnets and their properties.

Likewise, on the second treatment unit of living versus non-living, the students showed remarkable growth in their knowledge of what distinguishes something that is living from something that is nonliving. The apple was the item that caused the most discussion as to its being living or nonliving. I believe that because students could not observe the apple growing, it was not as meaningful to them. Given more time and exposure to the plant cycle, I am confident that students could correctly categorize an apple as living. In this unit, students were able to hone their observation skills in a way that would not have taken place through the traditional text and lecture approach to teaching. Students were actively engaged throughout the unit and all collaborated. This level of engagement and collaboration does not take place in the typical text and lecture session in the first grade classroom.

In conclusion, inquiry-based instruction provided my first grade students the opportunity to hone 21st century learner skills regardless of their literacy level. In fact, it proved beneficial to my intensive and strategic learners in that they did not have to rely on their reading prowess in order to gain scientific knowledge. Inquiry-based instruction also proved to be beneficial to the benchmark and high benchmark readers in my class. These students were required to rely on something other than their reading skill to acquire information and build a knowledge base. It was refreshing to see students step up to the challenge and excel in building science knowledge through inquiry-based instruction.

VALUE

I found the action based research project implemented for this capstone process to have a positive impact on my teaching. My students are naturally curious and using that curiosity to foster learning provided a positive and engaging learning environment. First grade students often are stuck in the doldrums of the typical text and lecture approach to doling out information. By allowing them to discover through hands-on learning, their experience became more meaningful. My intensive and strategic readers could use their brainpower to build a stronger science knowledge base rather than use the majority of their brainpower to decipher words. Benchmark and high benchmark students developed skills in learning science that did not have basis limited to their proficiency in reading. Inquiry-based instruction is a more effective way to deliver science information to a group of six and seven year olds than asking them to take out their basal science books and read about science.

Another important aspect of using inquiry-based instruction is the improved student attitude I encountered while teaching these two units. It was inspiring to observe my students' enthusiasm while they collaborated and learned. I do not often see such enthusiasm when my students are reading from a textbook. Generally speaking, doing is better than reading in the mind of my typical first grade student.

Because the use of inquiry-based instruction was so successful in the two-selected science Critical Competencies, I have begun to look for ways to add an inquiry aspect to the other science units. Some units lend themselves nicely to the use of inquiry-based instruction. I am particularly looking forward to instructing the unit on the plant cycle. I realize that not all science units lend themselves as easily to inquiry-based instruction. I have yet to be successful in finding an inquiry-based component for the unit on space and planets but continue to seek ideas. I have also looked into inquiry-based instruction in other curricular areas. I find math to be the easiest subject in which to use inquiry. My ultimate goal is to figure out how to make a spelling lesson interesting through the use on inquiry based instruction. I will continue to use inquiry-based instruction where appropriate in order to enhance student learning.

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APPENDICES

APPENDIX A

ENGAGEMENT SCALE

ENGAGEMENT SCALE

Student	Engagement*	Comments
AA		
BD		
CD		
AE		
AH		
JH		
MH		
KH		
CJ		
DL		
JL		
CL		
MM		
PMW		
JM		
CN		
RS		
RAS		
RJS		
KS		
LW		

Key: 1=Distracted/Off Task, 3=Engaged/On Task, 5=Actively Engaged/Demonstrates Enthusiasm (verbally/physically)

APPENDIX B

COLLABORATION SCALE

Collaboration Scale

Student	Collaboration*	Comments
AA		
BD		
CD		
AE		
AH		
JH		
MH		
KH		
CJ		
DL		
JL		
CL		
MM		
PMW		
JM		
CN		
RS		
RAS		
RJS		
KS		
LW		

Key: 1=no collaboration, 3=expresses ideas, 5=expresses ideas/listens to peers' ideas

APPENDIX C

CONTENT VOCABULARY ASSESSMENT FOR SMALL GROUP PRESENTATION

CONTENT VOCABULARY ASSESSMENT

Science Vocabulary	Student One	Student Two	Student Three	Comments
Magnet				
Attract				
Strength				
Poles				
Repel				
Magnetic Force				
Magnetize				

Key: X indicates use of vocabulary in small group oral report

APPENDIX D

CONTENT VOCABULARY ASSESSMENT PROBE

magnet poles attract repel strength magnetic force magnetize

____ is how strong something is.

____ means to push away.

The places where the pulling force of a magnet is strongest are called the ______________________________________.

______________________________________means to pull something.

______________________________________ is the pulling force of a magnet.

A _____________________________________is a piece of iron that pulls things made of iron.

Giving magnetic force to something a magnet attracts is called

____.

APPENDIX E

ADAPTED NGSS SCIENCE & ENGINEERING PRACTICES GRADES K-2 DRAFT

Adapted

****DRAFT** NGSS Science & Engineering Practices Grades k-2 **DRAFT****

1 = unable to perform; 2 = perform with assistance; 3 = proficient; 4 = exemplary

Practice / Indicator	1	2	3	4	NOTES
Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.					
Ask questions about observations of the natural and designed world.					
Modeling in K–2 builds on prior experiences and progresses to include identifying, using, and developing models that represent concrete events or design solutions.					
Compare models to identify common features and differences.					
Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. *Planning and carrying out investigations may include elements of all of the other practices.*					
Carry out investigations collaboratively.					
Make observations and/or measurements to collect data which can be used to make comparisons.					
Identify questions and make predictions based on prior experiences.					
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.					
Use and share pictures, drawings, and/or writings of observations where appropriate.					
Use observations to note patterns and/or relationships in order to answer scientific questions and solve problems.					
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence or ideas in constructing explanations and designing solutions.					
Use information from observations to construct explanations about investigations.					
Distinguish between opinions and evidence.					
Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world.					

Distinguish arguments that are supported by evidence from those that are not.					
Listen actively to others' arguments and ask questions for clarification.					
Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.					
Read and comprehend grade appropriate texts and/or use other reliable media to acquire scientific and/or technical information.					
Critique and communicate information or design ideas with others in oral and/or written forms using models, drawings, writing, or numbers.					
Record observations, thoughts, and ideas.					