

THE EFFECTS OF USING AN INQUIRY-APPROACH THROUGH THE 5 E  
LESSON FORMAT ON MIDDLE SCHOOL EARTH AND SPACE SCIENCE  
STUDENTS

by

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

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY  
Bozeman, Montana

June 2011

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June 2011

## DEDICATIONS AND ACKNOWLEDGEMENTS

I would like to thank Professor John Graves (my Major Project Advisor), for all his guidance and hard work, as well as my other committee member, Suzanna Carrithers-Swallow (my Science Reader), and Peggy Taylor (my Academic Advisor). In addition, I would like to thank all my classmates who have helped me through this project. Finally, I would like to thank my friends and family who've had to put up with my complaining.

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## ABSTRACT

In this investigation an inquiry-based instructional approach called the 5 E Learning Cycle was implemented with the purpose of improving students' learning in science and improving students' ability to understand and apply inquiry. The effects of this 5 E Learning Cycle on 8th grade Earth and Space Science students were studied in a small public middle school. Additionally, this project looked at the effects of the 5 E Learning Cycle on teacher instruction. Instructional lessons were planned and presented using the 5 E Learning Cycle while pre-, mid-, and post- formal and summative assessments were collected to show its effects on students and the teacher. Through these assessments, science learning of the state standards increased, while the ability to understand and apply inquiry got better at first, but then showed a decrease in getting better. The teacher's role in the classroom changed, as did the way she planned and presented each lesson and guided the class. Promoting inquiry in the classroom increased.



## INTRODUCTION AND BACKGROUND

### Classroom Environment and Project Setting

Hana School is a K-12 school serving approximately 348 students along 50 miles of rugged coastline from Keanae to Kaupo on Maui, Hawaii (Hana School Status and Improvement Report, 2008-2009). A series of communities along this stretch on the eastern side of Maui is what is known as the Hana District. Hana town is a geographically isolated, rural, agricultural community with three main employers, and has a population of about 1,855 residents. The Hana School Status and Improvement Report showed that between 75%-80% of the student population are of Hawaiian or Part-Hawaiian ancestry. The school setting was described as Hawaiian (4%), Part-Hawaiian (80%), Filipino (1%), Japanese (1%), Chinese (1%), Hispanic (2%), Samoan (1%), White (7%), Indo- Chinese (1%), Portuguese (1%), and other (1%).

Many students speak a pidgin dialect at home and in the community, which presents a challenge when students are required to use standard English at school. Pidgin, a creole language based in part on English, originated as a form of communication used between English speaking residents and non-English speaking immigrants in Hawaii. It is the primary language of most people in Hawaii.

Hana's percentage of special education students enrolled at the school is larger than the national or state average (The Academic and Financial Plan, 2010-11). Of the 348 students, 53 (15.2%) are special education students with individualized education programs (Student Population Data, 2009). Hana School is in its fourth year of a four-day instructional week schedule (The Hana School Status and Improvement Report,

2008). Friday mornings are being used for tutoring targeted students, staff development and professional learning communities. Hana School's 300 server-based computers allow the school to focus on the use of technology that will assist students with integrated project-based learning activities. Parents are semi-involved with the school because they want to know the status of their child's progress and foster open-communication with the teacher. On the other hand, there are some parents that do not support the teacher and do not want to know or hear about their child's status and quite often, the effort of communication seems to be a waste of time. A Western Association of Schools and Colleges awarded Hana School a 6-year accreditation from March 2006 to 2012.

The Hawaii State Assessment (HSA) is a yearly performance assessment that scores student proficiency in reading and math Hawaii State Content and Performance Standards (HCPS). In middle school, the eighth grade was the only grade tested. Student performance was assessed three times, once in January, once in March, and once in April. The highest of the three scores was used as data by the state. Hana school's HSA Scores for the 2009-2010 School Year showed that of the 30 students, 60% were proficient in 7th grade reading and 40% were not proficient. In math, their 7th grade HSA scores revealed that 33% were proficient and 67% were not. This year, 2010-2011, 62% meet proficiency in 8th grade reading and 38% did not. Therefore, there was a 2 % increase in reading proficiency for these students from 7th to 8th grade. In 8th grade math, 45% of the students were proficient and 55% were not. Resulting in a 12% increase in math proficiency from last year (7th grade) to this year (8th grade).

The Academic and Financial Plan (2010-11) stated Hana School did not make Adequate Yearly Progress (AYP) on the Spring 2009 Hawaii State Assessment (HSA). Out of 13 NCLB performance targets, Hana School met 9.

Currently, I am teaching physical science (6th grade), life science (7th grade), and earth and space science (8th grade) at Hana School in Hana, Maui, Hawaii. In Hawaii teachers teach the Hawaii Content and Performance Standards (HCPS) III. The HCPS III identifies what students need to know and should be able to do in science at each grade level. Additionally, these standards serve as a guidepost in creating lessons and activities for students. Scientific Inquiry and Science Technology and Society are two standards taught every quarter. To include Scientific Inquiry into daily benchmark lessons, I implemented the 5 E Learning Cycle, an inquiry-based approach to lesson planning, teaching and learning. Therefore, this project centered around the implementation of the 5 E Learning Cycle and its effects on students and the teacher. This project allowed me to inquire into my own teaching methods and reflect on my teaching practices.

The main focus question was: *What are the effects of using the 5 E Learning Cycle, an inquiry-based approach in lesson formatting, on 8th grade middle school students?* The sub-questions included the following:

- What are the effects of the 5 E Learning Cycle-approach on students' ability to learn science?
- What are the effects of using the 5 E Learning Cycle-approach on students' understanding and application of inquiry?
- What are the effects of using the 5 E Learning Cycle-approach on my science instruction?

## CONCEPTUAL FRAMEWORK

The Learning Cycle-approach teaches thinking and problem solving and increases students' ability to relate what they learn to new problems that come up later (Lawson, 1995). The Learning Cycle-approach is an inquiry-based teaching model which can be useful to teachers in designing curriculum materials and instructional strategies in science (Abraham, 1997). The model was derived from constructivist ideas of the nature of science, and the developmental theory of Jean Piaget (Piaget, 1970). "Constructivism is a dynamic and interactive model of how humans learn" (Bybee, 1997, p. 176). Constructivism states that learners construct knowledge through learning experiences. According to constructivist philosophy, meaning is continually being negotiated by means of assimilation and accommodation in the minds of thinking beings (Llewellyn, 2007). Language plays an important role in learning.

The Learning Cycle is one of the most familiar and effective models for science instruction. It was originally proposed in the early 1960's by Atkin and Karplus (1962). The model was later used as the instructional basis for the Science Curriculum Improvement Study (SCIS) program, by Karplus and Thier (1967). It was further documented by Lawson, Abraham, and Renner (1989); Barman and Kotar (1989); Beisenherz and Dantonio (1996); Marek and Cavallo (1997); Bybee (1997); Abraham (1997); and Colburn and Clough (1997).

In the 60's Atkin and Karplus (1962) performed experiments in order to look at the role of discovery in teaching. They used the stages of *exploration*, *invention*, and *discovery*. They found that in the development of a concept, it is useful to distinguish the original introduction of a new concept, which can be called *invention*, from the

subsequent verification or extension of the concept's usefulness, which can be called *discovery* (Atkin & Karplus 1962).

The Learning Cycle approach was first fully described and used to help students learn science in 1967 by Karplus and Thier in the *Science Curriculum Improvement Study*. The learning cycle was based on three phases of instruction: 1) *exploration*, which provides students with experiences to investigate science phenomena; 2) *concept introduction*, which allows students to build ideas through interaction with peers, texts, and teachers, and 3) *concept application*, which asks students to use these science ideas to solve new problems (Karplus & Thier, 1967). This teaching and learning cycle alternates between hands-on and minds-on activities, both which are necessary for learning science (Brown & Abell, 2006). Since Karplus and Thier introduced the learning cycle, many variations have been invented. However, every new version retains the “essence of the original learning cycle, exploration before concept introduction.” (Abell & Brown, p.2).

Most of the research supporting the Learning Cycle approach is discussed in detail in Lawson, Abraham and Renner (1989). Research supports the conclusion that the Learning Cycle-approach can result in greater achievement in science, better retention of concepts, improved attitudes toward science and science learning, improved reasoning ability, and superior process skills than would be the case with traditional instructional approaches (see for example: Abraham & Renner, 1986; Ivins, 1986; McComas III, 1992; Raghbir, 1979; Renner, Abraham & Birnie, 1985). This is especially true with intermediate level students where instructional activities have a high level of intellectual demand (Lott, 1983).

The BSCS model is a direct descendant of the Atkin and Karplus learning cycle proposed in the early 1960s and used in the *Science Curriculum Improvement Study* (SCIS) (Bybee, R.W., Taylor, J.A., Gardner, A., Scotter, P.V., Powell, J.C., Westbrook, A., Landes, N. (2006). Origins of the BSCS 5 E Instructional Model, which is just like the 5 E Learning Cycle, can be traced to the philosophy and psychology of the early 20th century and Johann Herbart (Bybee et al.). His psychology of learning can be synthesized into an instructional model that begins with students' current knowledge and their new ideas that relate to the current knowledge. The connections between prior knowledge and new ideas slowly form concepts. According to Herbart, the best pedagogy allows students to discover relationships among their experiences. The next step involves direct instruction where the teacher explains ideas that the student could not be expected to discover. Finally, the teacher provides opportunities for the student to demonstrate their understanding. The phases of this instructional model includes, preparation, presentation, generalization, and application (Herbart, 1901). In the 1930's an instructional model based on John Dewey's "complete act of thought" philosophy gained popularity (Bybee et al., 2006). The instructional model phases includes: sense a perplexing situation, clarify the problem, formulate a hypothesis, test the hypothesis, revise tests, and act on solutions (Bybee et al., 2006).

Llewellyn (2007) said, "When teachers apply Piaget's stages of cognitive development and the ideas about how children progress from concrete to formal operations, they realize the importance of introducing a concept by first providing concrete, motivational experiences before introducing new concepts of information." (p. 134). The 5 E Learning Cycle implemented in this project consists of these five stages.

Llewellyn (2007) stated that the five stages of the Learning Cycle allows students to move from concrete experiences, to the development of understanding, to the application of principles. In the first stage, called the *engagement* stage, the teacher sets the stage for learning by stating the purpose of the lesson, the topic of the lesson, the expectations for learning by introducing an essential question, and explaining what the students should know and be able to do by the end of the lesson or unit. Also, this stage is designed to get the students' attention and focus by using an attention-grabbing, demonstration and discrepant event. This stage allows the teacher time to assess prior knowledge and misconceptions, and have students share their prior experience about the topic.

The second stage, called the *exploration* stage, gets the students engaged in inquiry. Students explore, raise questions, create statements to test, and work without instruction from the teacher. At this time, students collect evidence and data, record and organize information, share observations, and work in cooperative groups. The exploration stage of the 5 E Learning Cycle, is hands-on learning, and at times, responsibility roles are assigned to individual students working in groups or students choose their own roles. Roles include, group manager, material collector, recorder, and reader.

The third stage also known as the *explanation* phase or the concept development stage is based on the evidence the students collected and the newly developed concepts are assimilated into the cognitive structure of the students. In this stage students may work to assimilate or accommodate new information as they make sense of their understanding, and they may construct new meaning from their experience. In this stage, the teacher takes on the teacher-directed mode and facilitates data and evidence

processing strategies for the information collected during the exploration stage. This is the time for teacher-led instruction and the time when information is discussed. The teacher explains scientific concepts associated with the exploration by providing a common language for the class to use. During this stage, the teacher introduces details, vocabulary terms, and definitions to the lessons. This is accomplished by using guided instruction, short lectures, audiovisual resources, online sources, and computer software programs. Here the teacher uses the students' prior knowledge to explain concepts and address misconceptions (Llewellyn, 2007).

The fourth stage of the Learning Cycle, called the *elaboration* or *extension* stage, the teacher helps reinforce the concepts by extending and applying the evidence to new real-world situations outside the classroom. This stage is also used as an opportunity to investigate questions that were generated in the exploration stage and an opportunity to engage in an open-ended inquiry.

The fifth and final stage of the Learning Cycle is the *evaluation* stage. In this stage the teacher brings closure to the lesson or unit by helping the students summarize the relationships among the variables studied in the lesson, posing higher-order and critical thinking questions that support students in evaluating and making judgments about their work. Concept maps may be used in this stage to illustrate concepts just studied and learned. During the evaluation stage, the teacher provides a means for students to assess their learning and make connections from prior knowledge to new knowledge. Assessment examples include, constructive response questions, rubrics, monitoring charts, concept maps, and student self-assessments (Llewellyn, 2007).

## METHODOLOGY

The 5 E Learning Cycle was implemented at Hana School to 15- 8th grade middle school Earth and space science students. 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 treatment consisted of using the 5 E Learning Cycle lesson plan-approach to guide science instruction for four months. During this time, qualitative and quantitative sources of data were collected, analyzed, and compared in the early stages of implementation (January) , mid-way through (March), and at the end (May).

Six 5 E Learning Cycles were implemented consisting of three units, Forces that Shape the Earth (January), Forces of the Universe (March), and The Universe (April-May) and six benchmarks, two benchmarks per unit. Each Hawaii Content and Performance Standard (HCPS) benchmark was taught using the 5 E Learning Cycle. Data were collected at different stages of the 5 E Learning Cycle to assess learning, inquiry and instruction.

The Constructive Response Questions were used to assess students' understanding of science content, investigation protocols, and process skills (Appendix A). This one-question assessment was created from the HCPS and utilized the HCPS Constructive Response Rubric for scoring purposes (HCPS III database, 2005). The Constructive Response Questions were long-response questions and used by students to explain, compare, interpret, summarize, apply, examine, and develop science. The responses were examined from the perspective of students' application, analysis, and synthesis in the writings. The Constructive Response Question assessment was

administered at the end of each 5 E Learning Cycle lesson. The Constructive Response Questions were analyzed pre, mid, and post-treatment and class average scores were compared for changes at each level of proficiency as the treatment continued. In addition, Constructive Responses were used as data to support the identified themes. These data helped determine the effectiveness of the 5 E Learning Cycle continuously throughout the study of science learning.

This Constructive Response Rubric provided assistance in describing the performance of students at various standards or levels of proficiency (Appendix B). On the rubric, Constructive Responses fell into one of five categories: a no score response, a novice response, a partially proficient response, a proficient response, and an advanced response. A response that made generalizations and used description were advanced responses and a response that just used description was proficient. A response that *identified* a change and its effects was a partially proficient response and a response that *recognized* a change and its effect was novice. Finally, a *no score* response meant that the question was incorrect, incomplete and/or exhibited many flaws.

The Hawaii State Assessment (HSA) in science is a comprehensive assessment of the prior year's learning and the current year. HSA Scores were used to assess students' understanding of science content, investigation protocols, and skills process (Aloha HSA, 2011). This 50-item electronic assessment was created from the HCPS, was mandatory, and was scored instantly and automatically upon completion. The HSA was administered pre, mid, and post-treatment. The HSA was not timed and was taken and scored electronically. The class average scores were then compared for changes as the treatment continued.

The Science Inquiry Monitoring Chart (Llewellyn, 2007, p.149) was used by the teacher to pinpoint what students are expected to do during the course of a scientific inquiry (Appendix C). Llewellyn (2007) stated, “The chart enables the teacher to identify and monitor skills used by students as they investigate solutions to their questions” (p. 147). The teacher observed the class using 35 predetermined behaviors broken into eight stages. The eight stages included; exploring, stating a question, identifying a statement to test, designing a procedure, carrying out a plan, collecting evidence, describing relationships between variables, and communicating results. Under each stage were listed behaviors and included, *makes observations, states an investigation question, makes a statement to test, arranges steps in sequential order, identifies manipulated variables, gathers data, draws conclusions, analyzes results, makes eye contact with the audience* (Llewellyn). The teacher moved about the room and observed individual behaviors, carefully observing all students equitably. These behaviors were recorded on the Science Inquiry Monitoring Chart. A letter grade was assigned to each behavior (ranging from A-F), an A meaning “excellent” through an F meaning “Failing.” Lastly, as the teacher made simple observations and informal anecdotal comments using an Inquiry Monitoring Anecdotal Record form (Appendix C). Guidelines included; *record observations in writing, note typical as well as atypical behaviors, document the date, time and stage of the lesson*. The Inquiry Monitoring Anecdotal Record comments were collected, scored and analyzed before the treatment, mid-way through the treatment, and post-treatment. The Science Inquiry Monitoring Chart was analyzed for changes in group averages as the treatment continued. The Inquiry Anecdotal was utilized as data to

support the identified data themes. This assessment helped determine the effectiveness of the 5 E Learning Cycle on my students understanding and application of inquiry.

The Inquiry Lab Report Plan was used to assess students' understanding and application of inquiry (Appendix C). This 10 item planning document/lab report utilized the Lab Report Rubric for scoring purposes (Appendix D). This Inquiry Lab Report Plan, administered during the Exploration stage of the 5 E Learning Cycle, provided students with directions on how to go about planning and conducting an investigation. Pre-treatment, mid-treatment, and post-treatment Inquiry Lab Report Plans were collected and analyzed. The Lab Report Rubric placed a 4-point-sliding value for each of the 10 sections. Each section was assigned anywhere between 0 to four points, depending on mastery of the section. Four points was *excellent*, three points was *satisfactory*, two points was *needs improvement*, one point was *deficient*, and zero points meant *no score*. For example, a hypothesis that was considered to be worth 4 points and excellent related to the question, was experimentally testable, and included a manipulated and/or responding variable. Whereas, a 1 point-deficient hypothesis did not relate to the question and was not testable. The data was analyzed for changes in group averages as the treatment continued. In addition, entries were used as data to support the identified data themes.

The Inquiry Self-Evaluation Form was used to assess students' understanding and application of inquiry (Appendix D). This 14 item self-evaluation form allowed the students to determine reflection on inquiry and to evaluate their behaviors, such as; *I made accurate observation, I did my share of the group work, I used many sources for information for this lab and I shared what I learned with others in the class.* This

assessment provided a window into students' perceptions of how well they did and provided an opportunity to reflect on how they can improve their performance. The Inquiry Self-Evaluation Form was given at the end of each 5 E Learning Cycle lesson. In addition, it was collected and analyzed pre, mid and post-treatment. The Inquiry Self-Evaluation Form was scored by assigning each response to a point system. For example, *Rarely* was assigned zero points, *Sometimes* was assigned 1 point, *Often* was assigned 2 points, and *Almost Always* was assigned 3 points. The data was analyzed and compared for changes in the class average scores as the treatment continued.

The Inquiry Self-Assessment Questionnaire was used to assess students' understanding and application of inquiry (Appendix F). This assessment provided a means to collect feedback about how individual students perceive their abilities, attitudes, and performances. The Inquiry-Self-Assessment Questionnaire was administered at the end of each 5 E Learning Cycle and was collected and analyzed pre, mid, and post-treatment. This seven-question questionnaire allowed students to gain an understanding of their level of competency of inquiry through a self-assessment. Questions included, *What was investigated? Was the hypothesis supported by the data? What were the major findings? and What are some possible applications of the experiment?* The Inquiry Self-Assessment Questionnaire was scored using a seven-point scoring scale, one point for each question answered correctly. The data was analyzed for changes in group averages as the treatment continued. In addition, correct responses for each individual question from pre-, mid-, and post-assessments were averaged at the end of the project to determine areas of strengths and weaknesses in students' understanding and application of inquiry.

The Lesson Plan Write-Up (Template) was used to assess the teachers understanding and application of the 5 E Learning Cycle and inquiry (Appendix G). Pre-, mid- and post-5 E Learning Cycle Lesson Plan Write Up's were analyzed and compared for changes in the various sections of the plan. Science instruction and planning followed the Lesson Plan Write-Up (Template). This plan allowed an easy-to-follow 5 E Learning Cycle inquiry-approach to teach the Hawaii Content and Performance Standards (HCPS). In addition, it provided a place to reflect on four questions about the 5 E Learning Cycle-inquiry-approach.

A Concept Map and a Concept Map Checklist and Self-Scoring Rubric were used to assess teacher instruction and student learning (Appendix H). Students' Concept Maps were collected and analyzed pre-, mid-, and post-treatment and were scored using the Concept Map Checklist and Self-Scoring Rubric by the teacher at the end of each 5 E Learning Cycle. Class average scores were compared for changes in the pre, mid, and post-treatment. Concept Maps allowed students to figure out meaning, organize ideas, and become more effective learners. Concept Maps were used to assess students' understanding of a specific topic, such as HCPS benchmark. Concept Maps were used by students prior to a 5 E Learning Cycle lesson to assess what they know (using one color pencil) and at the end of each 5 E Learning Cycle to connect prior knowledge to new knowledge gained (in another colored pencil). The two-colored pencils made it easy to distinguish between the prior knowledge and the new knowledge gained.

The Concept Map Checklist and Self-Scoring Rubric (Pre-Test) and (Post Test) were also used by the students to assess the affect of the instruction and students' learning (Appendix H). This five item, self-scoring rubric, was created so students could

reflect and evaluate their learning. The Concept Map Checklist and Self-Scoring Rubric contained five components on which students scored their Concept Web. Each component was worth two points each for a total of ten possible points. A sliding scale of half a point to one point to one and a half points was used. The five components included the following: place the main idea at the center of the page, organize the words or concepts from most general to most specific, use a linking word (verb, preposition, or short phrase) to connect and illustrate the relationships and linkages from one idea to another, use crossing links to make connections between words in different areas of the map, and add to the map as new knowledge is constructed (Llewellyn, 2007). The data was analyzed for changes in group averages as the treatment continued. Also, class average scores were compared for changes in the beginning of the 5 E Learning Cycle and at the end of the same 5 E Learning Cycle to see if students felt they learned more. The Concept Map and The Concept Map Checklist and Rubric were scored, analyzed and compared pre-, mid-, and post-treatment.

Reflections were used to assess the effect of the 5 E Learning Cycle-lesson plan approach on teacher instruction and learning. Reflections were written by the teacher throughout and at the end of each 5 E Learning Cycle. They were written in part six of the Lesson Plan Write-Up (Template) (Appendix G). It included four questions about reflection. Most of the time, Reflections were completed at the end of each 5 E Learning Cycle lesson. Questions included, *Did I follow the 5 E model and complete all the steps? Any ideas or suggestion? Am I moving my students from teacher-dependent to more independent experiences?* and *Am I providing for student-initiated inquiries as the year goes on?* This four-question reflection was analyzed and compared pre-, mid-, and post-

treatment and answers were analyzed for common and uncommon themes that presented itself. The Data Triangulation Matrix displays the study questions and the data collecting instruments used to collect the data to answer the research questions (Table 1).

Table 1  
*Triangulation Matrix and Corresponding Appendices (X)*

Research Question	Data Source 1	Data Source 2	Data Source 3
What are the affects of using a 5 E approach on students' ability to learn science?	Concept Maps (H)	Constructive Response Questions (A) and Rubric (B)	HSA Scores
What are the affects of using a 5 E approach on students' understanding and application of inquiry?	Science Inquiry Monitoring Chart (C)	Inquiry Lab Report Plan and Rubric (D)	Inquiry Self-Evaluation Form (E) and Inquiry Self-Assessment Questionnaire (F)
How will the 5E Learning Cycle effect my science instruction?	Lesson Plan Write-Up (Template) (G)	Concept Map and Concept Map Checklist and Rubric (H)	Reflections (G)

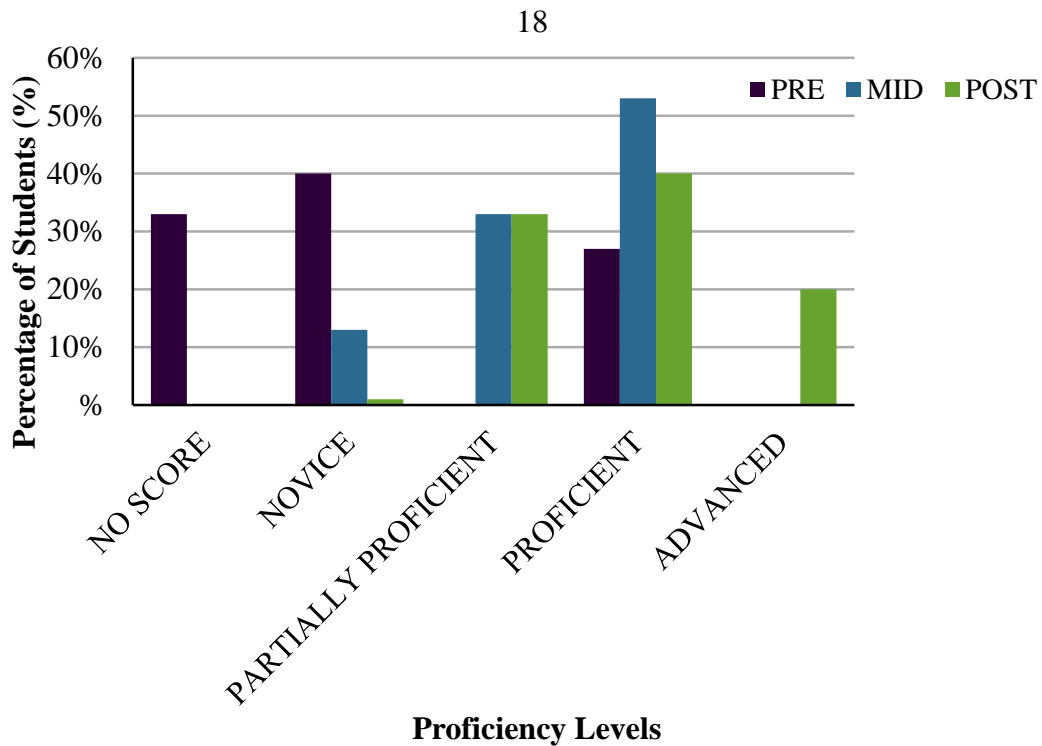
## DATA AND ANALYSIS

A Constructive Response Question was used to assess learning or levels of academic achievement at the end of each 5 E Learning Cycle. The pre- Constructive Response Question asked students to explain the relationship between density and convection currents and the ocean and atmosphere and the class scored an overall average of 62% (N=15). The mid- Constructive Response Question asked students to explain the relationship between an object's mass and the gravitational force it exerts on other objects. The class scored an overall average of 75%. Finally, the post- Constructive Response Question asked students to compare the characteristics and movement patterns of the planets in our solar system and the class scored an average of 77% (Table 2).

Table 2  
*Student Constructive Response Question Level's for pre-, mid-, and post-treatment (N=15).*

<b>LEVELS</b>	<b>Pre-test</b>	<b>Mid-Test</b>	<b>Post-Test</b>	<b>Percent Change From Pre- to Post-test</b>
No Score	33%	0%	0%	-33%
Novice	40%	13%	1%	-39%
Partially Proficient	0%	33%	33%	+33%
Proficient	27%	53%	40%	+13%
Advanced	0%	0%	20%	+20%

Pre-assessment indicated that 33 % of the students did not score and 40% wrote a novice response. As a result, over 70% of the class was not able to answer a Constructive Response Question after the first 5 E Learning Cycle. Only 27% of the students were



proficient at writing a Constructive Response Question. After implementation of the post-assessment, 5 E Learning Cycle, there were no *No Score* responses and only one student (.07%) wrote a *Novice* response. Thirty-three percent of the students wrote *Partially Proficient* responses and 20% wrote *Advanced* responses. As a result, 60 % of the class wrote *Proficient* and *Advanced* responses (Figure 1).

*Figure 1.* Student Constructive Response Question Levels, pre-, mid-, and post treatment, ( $N = 15$ ).

Analysis of students' work from pre to post-assessment showed that students went from simply recognizing and defining concepts or processes to analyzing and explaining the concepts or processes. For example, many of the students' pre-assessment responses were five to ten sentences, very vague, simple, general, and incorrect. One student wrote, "The relationship between density and convection currents in the ocean and atmosphere

is controlled by temperature and salt,” but was not able to explain how the salt and temperature create a current, or how it affects the ocean and atmosphere. Another student wrote, “Convection currents are made up of temperature differences. The water closest to the equator is the hottest and the water closest to the poles is colder. The warm water spreads to the poles the cold water takes over and spreads.” This student that wrote a *Novice* response did not explain convection currents, and did not mention density or the atmosphere. Students were able to identify what created a current, but could not explain how salt and temperature created a current or how it affects the ocean and atmosphere.

Post-assessment data showed improvement at explaining, interpreting, and summarizing the HCPS. Students compared the characteristics and movement patterns of the planets in the solar system rather than just recognizing or defining characteristics and patterns. Many responses were over ten sentences, some even two pages long with many details and labeled diagrams. The same student who scored a *Novice* response on the pre-assessment wrote a *Proficient* response, “All planets move in an ellipse, they all have a gravitational force on each other. The four outer planets are gas and have big rings. The inner planets are rocky and smaller.” Students’ applied, analyzed, and synthesized the information in their writings correctly. For example, “Outer planets have larger ellipses than the inner planets and therefore it takes longer for them to orbit the sun. The planets move faster when they are closer to the sun because of gravity.”

HSA Scores used to assess students' understanding of science content, investigation protocols, and skills process in 8th grade Earth and Space science, revealed a class average score of 273 points in the pre- HSA, 285 points in the mid-HSA, and 291 points in the post- HSA (Figure 2).

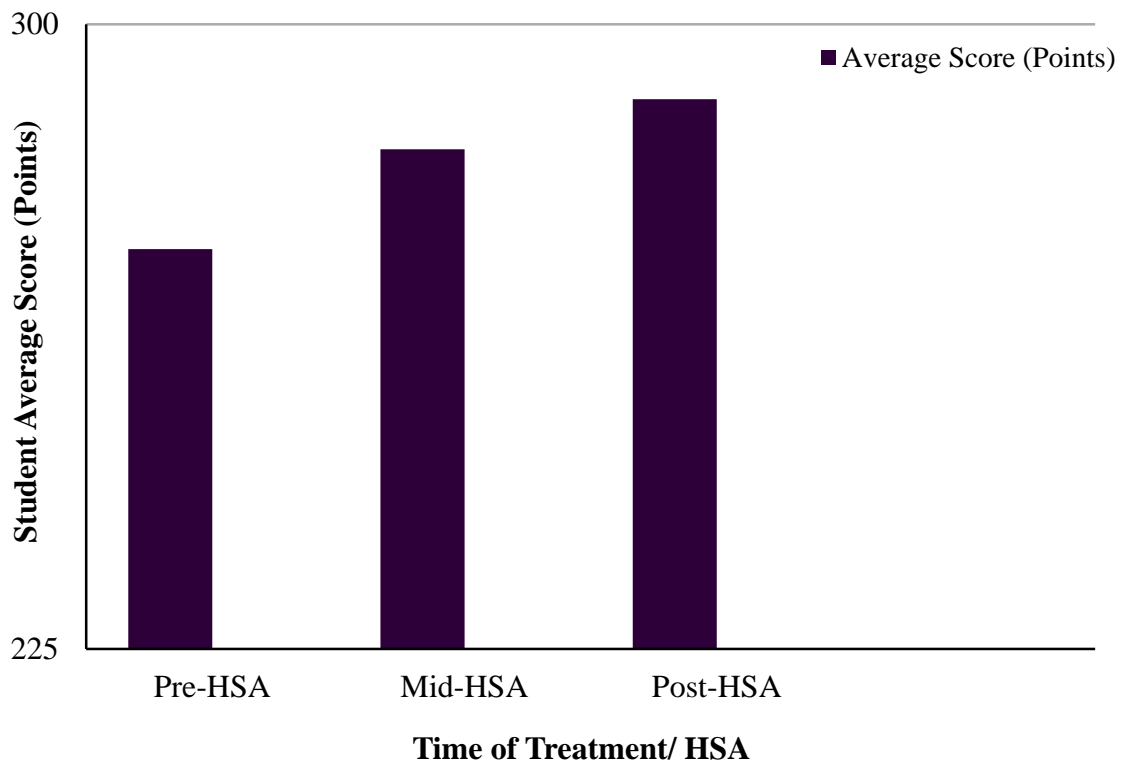


Figure 2. Student Average HSA Scores (Points), ( $N = 15$ ).

The class's average score on the HSA during the pre-treatment was 55%, the mid-treatment was 57%, and post-treatment was 58% (Figure 3).

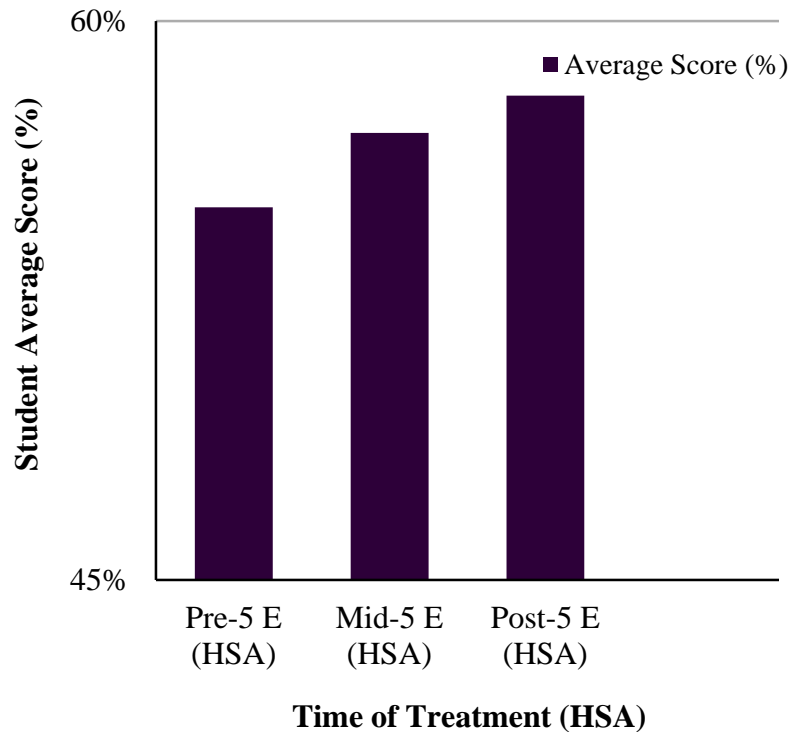


Figure 3. Student Average HSA Scores (Percentage) for pre-, mid-, and post- treatment, (N = 15).

The pre-HSA reported no students (0%) *exceeded proficiency*, one student (.07%) that *met proficiency*, ten students (67%) that *approached proficiency*, and four students (27%) that were *well-below proficiency*. The mid-HSA revealed one student (.07%) *exceeded proficiency*, three students (20%) *met proficiency*, nine students (60%) *approached proficiency*, and two (13%) were *well-below proficiency*. Post-HSA reported the same one student (.07%) that *exceeded proficiency*, four students (27%) that *met proficiency*, eight students (53%) *approached proficiency*, and two students (13%) *well-below proficiency* (Table 3). The same student who *exceeded proficiency* in the mid-HSA with a score of 356 points increased her score to 359 points in the post-HSA. There were two students who *met proficiency* in the mid-HSA, but did not meet in the post-HSA. Three students who had not *met proficiency* in the mid-HSA ended up *meeting*

*proficiency* in the post-HSA. There was one student who *met proficiency* in both the mid- and post-HSA. Combining mid- and post-HSA data revealed that in the beginning of the treatment, one student *met proficiency* and by mid-/post- treatment there were seven students that *met proficiency* (Table 3).

Table 3  
*Student HSA Scores and Levels of Proficiency pre-, mid-, and post- treatment (N= 15).*

<b>Proficiency Level</b>	<b>Pre-HSA # of students</b>	<b>Pre-HSA % of class</b>	<b>Mid-HSA # of students</b>	<b>Mid-HSA % of class</b>	<b>Post-HSA # of Students</b>	<b>Post-HSA % of class</b>
Well-Below (100-261)	4	27%	2	13%	2	13%
Approached (262-299)	10	67%	9	60%	8	53%
Met (300-342)	1	0.07%	3	20%	4	27%
Exceeded (343-500)	0	0%	1	0.07%	1	0.07%

By the end of the treatment seven students *met* and *exceeded* proficiency compared to the one student that *met* proficiency during the pre-treatment.

The Science Inquiry Monitoring Chart, used to monitor inquiry, showed an increase in understanding and application of inquiry stages and behaviors as the treatment continued. The pre-Science Inquiry Monitoring Chart average group score was 16%, the mid-assessment was 32% and the post-Science Inquiry Monitoring Chart group score was

54%. Overall, there was a 38% increase in student inquiry behaviors during an investigation from pre- to post-treatment (Figure 4).

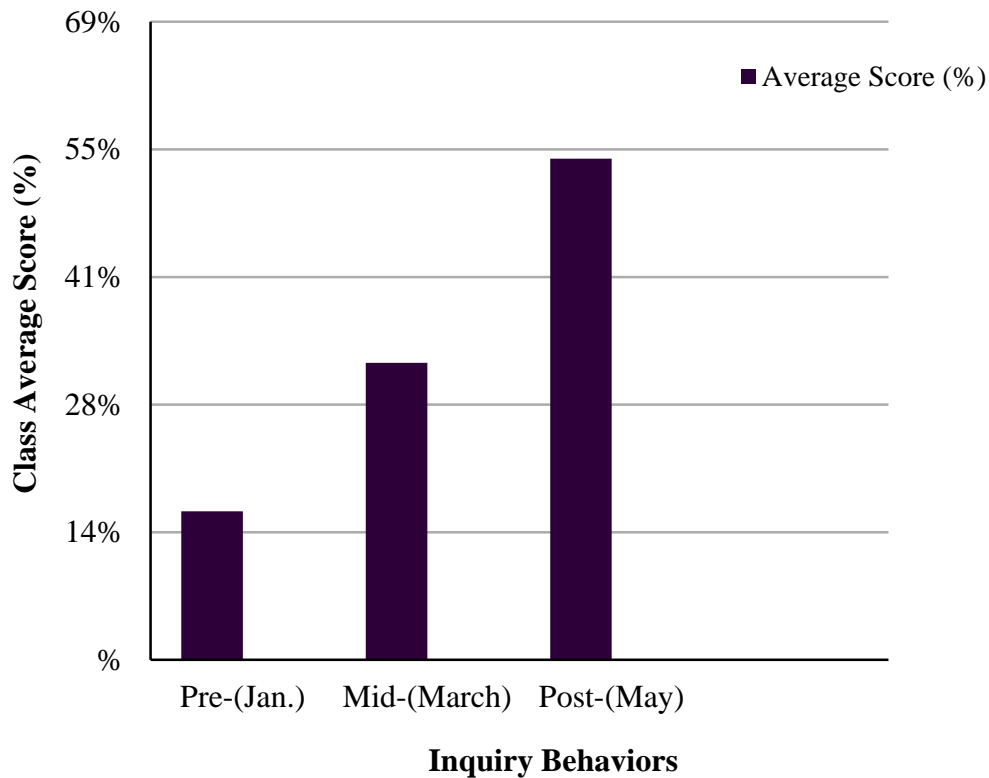


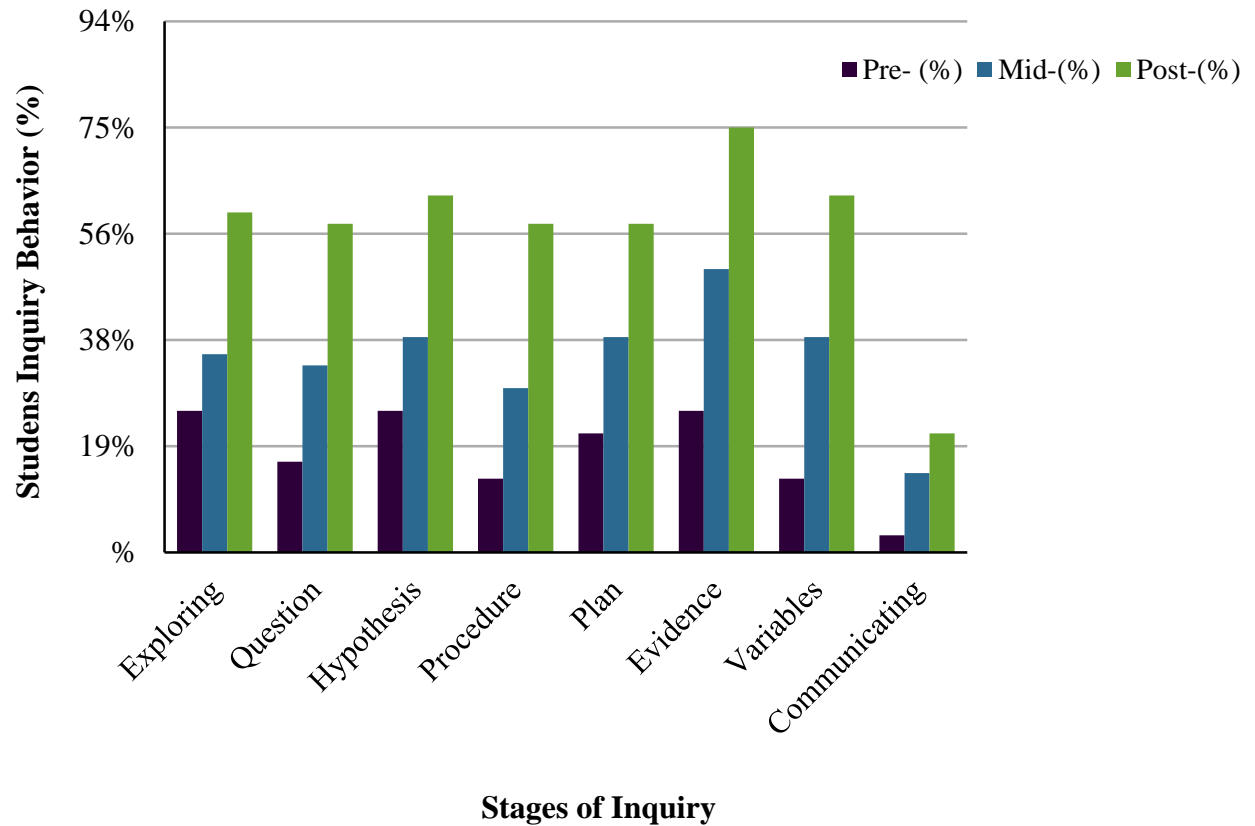
Figure 4. Group Average Scores- The class percentage of inquiry behaviors, ( $N = 15$ ).

Although students scored below 60% in four of the eight stages of the Science Inquiry Monitoring Chart, overall, there was improvement from pre-, mid-, to post-assessment in each of the eight stages (Figure 5). Inquiry behaviors increased as the treatment continued. For example, stating a question increased from 16 % to 58%, designing a procedure increased from 13% to 58%, carrying out a plan increased from 21% to 58%, and communicating results, the lowest score, increased from 3% to 21%. As a result, inquiry behaviors that improved included *sorting and revising questions*,

*stating an investigation question, arranging steps in sequential order, identifying manipulated and responding variables, obtaining supplies and materials, sharing and respecting ideas with group members, and reflecting on the investigation.* Behaviors that were not observed or observed very little included; *preparing a trifold poster, making a contribution to the presentation, answering questions from the audience, speaking clearly, and making eye contact with the audience.*

The Science Inquiry Monitoring Chart revealed that in the post-assessment, students were below average in exploring (60%), identifying a statement to test (63%), and describing relationships between variables (63%), but these behaviors improved from the beginning of the treatment to the end. These specific behaviors included; *recording observations, taking careful notes, drawing sketches and illustrations, recording “what if” questions, making a statement to test, and drawing conclusions and analyzing results.*

Finally, students were average at the stage of collecting evidence (75%). Students started with an average group score of 25%, increased to 50% in the mid-assessment, and finally increasing to 75% in the post- assessment. As the treatment continued students *gathered data, made accurate measurements, organized data in tables and charts and plotted the data in tables and graphs* better and more frequently (Figure 5).

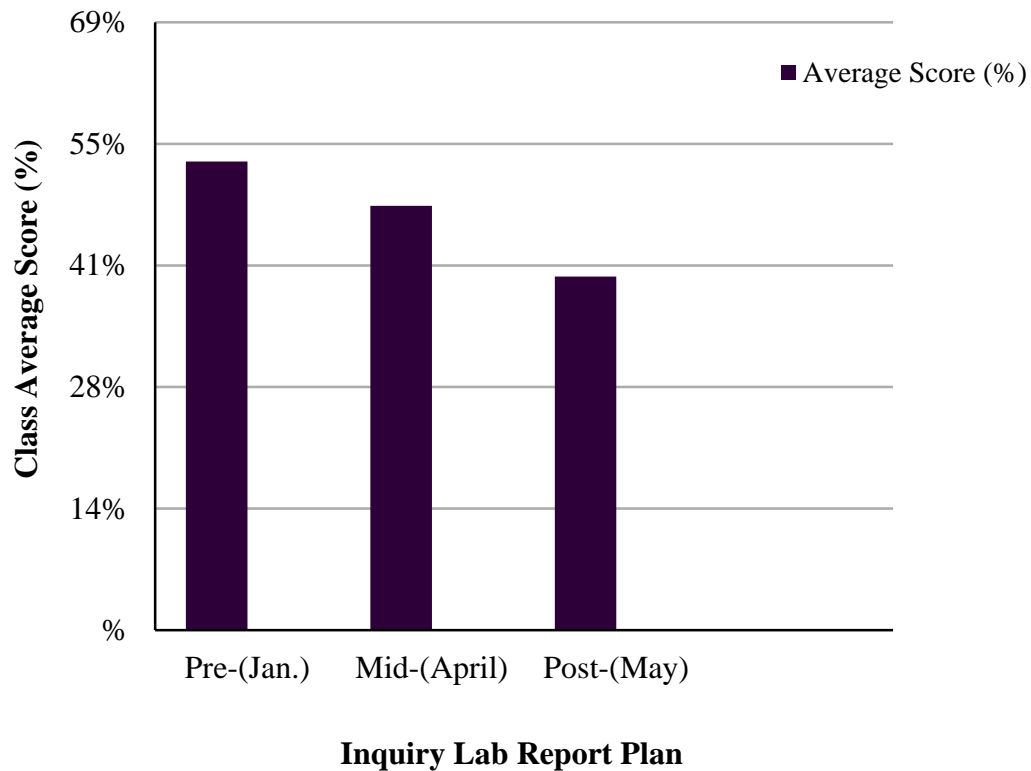


*Figure 5.* Percentage of student inquiry behavior represented in the 8 stages, pre-, mid- and post- treatment, ( $N = 15$ ).

The Science Inquiry Monitoring Chart was analyzed for changes in group averages as the treatment continued and for each of the eight stages of inquiry, students' average scores of inquiry behaviors increased from pre-, to mid- to post- treatment, showing an increase in application and understanding of inquiry.

The Inquiry Lab Report Plan and Rubric was used to assess students' understanding and application of inquiry and they revealed a decrease in students understanding and application of inquiry as the treatment continued. Group scores

averaged 53% in the pre-assessment, 48% in the mid-assessment, and 40% in the post-assessment (Figure 6).

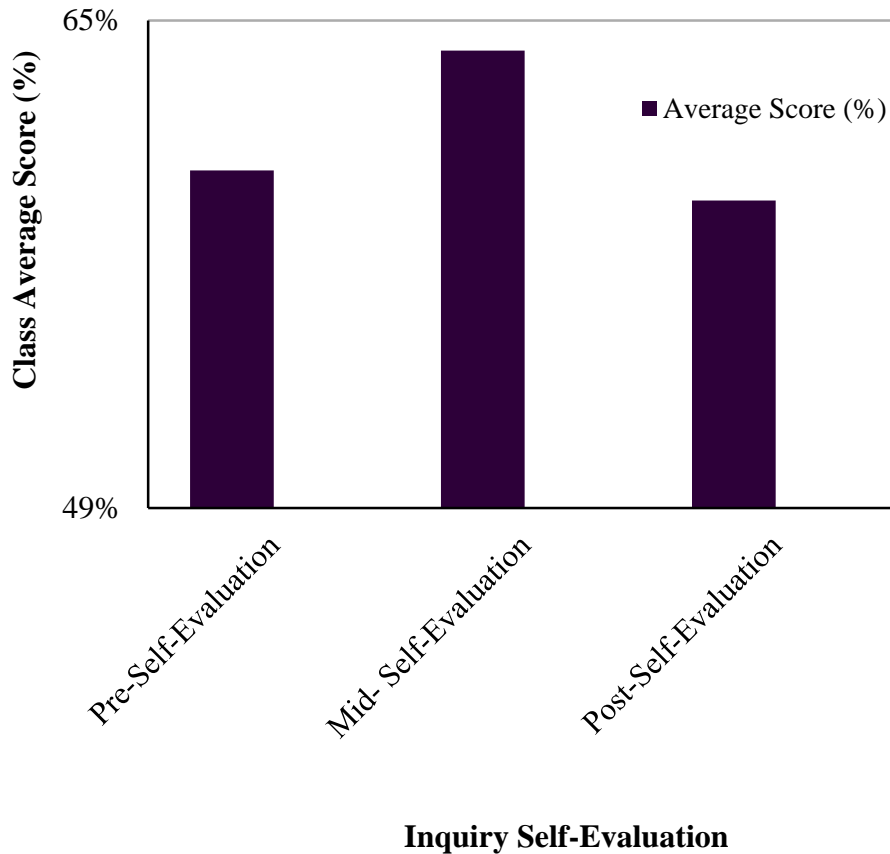


*Figure 6.* Students Inquiry Lab Report Plans Average Scores from pre-, mid- and post-assessments, ( $N = 15$ ).

The data was analyzed for changes in group averages as the treatment continued and group averages decreased. Data was skewed a bit due to the fact that pre-treatment Inquiry Lab Reports were a bit guided by the teacher or teacher-initiated inquiry because students were completely lost on where to begin the plan. Mid- and post-assessments

were not guided by the teacher but rather student-initiated, where the students played the role of the investigator throughout the entire investigation. Student entries that were used as data to support the identified data themes showed that students did improve slightly in understanding and application of inquiry. For example, students improved at creating investigation questions, creating a hypothesis, listing materials, writing a procedure, determining variables, creating data tables and charts, analyzing and interpreting data, and drawing conclusions. A group of students in the mid-assessment came up with the investigation question of, “I wonder how long it will take for a clown to come back up with different masses?” and were not able to make a prediction, but concluded that the timing of each clown standing up was very close. Students in this group collected data that revealed that the more mass they added to the clown, the amount of time it took to stand up was the same or even less. This showed that students were not able to see a relationship between mass and gravity and were not able to control variables that needed to be controlled. Other mid-assessment questions included, “I wonder if gravity can help me pick up a ball without using my fingers?” “I wonder if I spin a bucket, will gravity keep the water in it?” “Do parachutes slow down the gravitational pull of earth?” Post-assessment revealed questions, such as, “Does the planets distance from the sun affect its orbit?” “What causes the colors of Mars?” “I wonder if the distance a planet is away from the sun affects how long the orbit will be?” “I wonder what the affect would be if the moon was bigger then the sun?” “I wonder if I can make a clay model of the earth and moon and show it’s faces?” These students created hypotheses and planned the procedure using materials that were more detailed.

The Inquiry Self-Evaluation Form was used to assess students' understanding and application of inquiry. The Form showed an increase then a decrease in students' understanding and application of inquiry. Group average scores first increased from 60%



in the pre-test to 64% in the mid-test, but then decreased from mid-treatment (64%) to post-treatment (58%) (Figure 7).

*Figure 7.* Class Inquiry Self-Evaluation Form average score ( $N = 15$ ).

The Inquiry Self-Assessment Questionnaire was used to assess students' understanding and application of inquiry and to provide a means to collect feedback

about how individual students perceive their abilities, attitudes, and performances. The Inquiry Self-Assessment Questionnaire revealed a similar trend to the Inquiry Self-Evaluation Form. Average group scores increased from pre- to mid-assessments (66% to 72%), then decreased from mid- to post-assessments (72% to 65%)(N=15). At the end of this project, each correct question on the Inquiry Self-Assessment Questionnaire from pre-, mid- to post assessment was averaged to study areas in need of improvement. Eighty-two percent of the students were able to describe the problem statement or recall something that was investigated during the 5 E Learning Cycle. Eighty percent agreed that their hypothesis was supported by their data. Seventy-three percent compared their finding to others in the class. Sixty-nine percent of the students were able to identify the major finding of an investigation presented during the 5 E Learning Cycle and 64% percent of the students were able to make recommendations for further study or for improving the experiment. Forty percent of the students were able offer explanations for their findings. Finally, 31% of the students at the end of this project were able to identify some possible applications of the experiment.

The data was analyzed and compared for changes in the class average scores as the treatment continued and this showed that scores increased from pre- to mid-assessment but then decreased from mid- to post-assessment. In addition, correct responses for each individual question from pre-, mid-, and post-assessments were averaged upon completion of this project to determine areas of strengths and weaknesses in students' understanding and application of inquiry. Students were able to describe what was investigated (82%), determine whether the hypothesis was supported by their data (80%), and were able to describe how their findings compared with other researchers

(73%) because these scores averaged above 70%. These were considered the students strengths in understanding and applying inquiry. Students weaknesses at the end of this project included identifying their major finding (69%), providing recommendations for further study (64%), listing possible explanations they can offer for their findings (40%), and finally, giving some possible applications of the experiment (31%). These were considered students' weaknesses in understanding and application of inquiry because the correct responses averaged 69% or less.

Data from the Reflections section of the Lesson Plan Write-Up revealed steps of the 5 E Learning Cycle-plan that were not implemented and skipped over due to time constraints. Steps of the 5 E Learning Cycle Lesson Plan Write-Up that were either not done often or at all included; making a Concept Web from what the entire class knows (not done), allowing students enough time to write questions to investigate and sorting them to see if they can be answered in an investigation (not done), providing students more time in the library or internet researching (needs improvement), and providing students the opportunity to communicate their results (not done). All of this may have affected the Science Inquiry Monitoring Chart results or inquiry behaviors by not giving the students the time to practice and learn about sorting and revising their questions, Concept Webs, and sharing and communication. For example, if I would have made a Concept Web from what the entire class knows, this would have taught students to make contributions to presentation, speak clearly, reflect on what they know, use appropriate terminology, share and respect ideas with other group members, and make constructive contributions to the group. If I allowed students enough time to write questions to investigate and then we sorted them to see if they can be answered in an investigation,

students would have been better at this and stating an investigation question, making a statement to test, and identifying variables. Providing students the opportunity to communicate their results would have taught and allowed students to assume responsibility for a group role, make constructive contributions to a group, prepare trifold posters, make contributions to presentation, make eye contact with the audience, speak clearly, answer questions from the audience, and reflect on investigations. All were Inquiry behaviors that were thought by the students and I to be below average as revealed in the Science Inquiry Monitoring Chart and the Inquiry Self-Evaluation Form. In addition, reflections revealed that inquiry data maybe skewed due to guided inquiry in the first 5 E learning cycle and more independent inquiry in the mid- and post-cycle's.

Pre-, mid- and post-5 E Learning Cycle Lesson Plan Write Up's were analyzed and compared for changes and what worked and what did not work in the various sections of the plan. All sections of the plan were kept the same throughout the treatment to keep instruction consistent and controlled, although certain parts of a section were not done. These sections that were not done may have had an affect on students understanding and application of inquiry. What worked for me was having a plan to follow that followed an inquiry-approach from day to day and using alternative, authentic inquiry-based assessment or evaluation strategies that were meaningful, interesting to perform, and relevant to the learner. These assessments allowed me to probe student's understanding in ways that I had never done before in my classroom. They emphasized the process used to obtain an answer or a product. The assessments used in the Lesson Plan Write Up provided students opportunities for self-reflection and self-evaluation.

The Concept Web and Concept Web Self-Scoring Checklist and Rubric worked for me, as it allowed students to self-reflect and self-evaluate themselves and provided information about student learning of the concepts presented during the 5 E Learning Cycle. Concept Web's allowed students to display their learning and was not too complex for students to undertake individually or even in a group.

The Reflection section on the Lesson Plan Write-Up allowed me to reflect on my own practice throughout each 5 E Learning Cycle and at the end of each Cycle to determine how I am doing, what needs to be changed or improved and what is working and what's not. What did not work for me very well was the Inquiry Lab Report Plans that my students were to complete. These took a lot of time, more time than I was able to provide in a week, and were not of good quality that I would have liked them to be. I felt they were the most important component of the 5 E Learning Cycle because they allowed students to practice being a scientist. Students struggled with the Inquiry Lab Report Plans and I was not able to provide much time or guidance, due to time constraints. Another aspect of the Lesson Plan Write Up that did not work was the part where students were to communicate result of their investigation by holding a conference. This would have been very worthwhile but time did not allow for it.

In addition, reflections revealed that students moved from teacher-dependent to more independent experiences. There were more opportunities for student-initiated inquiries as the year went on. Lack of materials, time, and resources; such as computers and books made it difficult for students to research topics. Students needed time to carry out plans and investigations. Research played a vital role in helping students facilitate the designing process. The Inquiry Lab Report Plan required a lot of time to carry out

and prepare. The Lab Report Rubric was changed mid-way through the treatment. The old Lab Report Rubric was used by students in the pre-assessment only. The new Lab Report Rubric was not used by the student in the mid- and post- assessments but should have. Inquiry Lab Reports may have been better if students used the new Lab Report Rubric to assist them in the planning and completing of the Inquiry Lab Report. The Lesson Plan Write-Up (Template) allowed me to use an inquiry-approach to teach science. I feel it was very effective in guiding me through my job as a science instructor trying to use an inquiry-approach.

Students' Concepts Maps were assessed by the instructor using the Concept Map Checklist and Self-Scoring Rubric to assess the affect of instruction using the 5 E Learning Cycle-approach. Concept Maps revealed slight student improvement in figuring out meaning, organizing ideas, and becoming more effective learners and some improvement in students' understanding of a specific topic. The groups average score for the pre-assessment was 52%, mid- average was 65%, and the post- average was 62% (N=15). Concept Maps improved and then got worse. Students increased their Concept Map scores by 13% from the pre-assessment to the mid-assessment, but then dropped 3% from the mid- to post-assessment. The data was analyzed for changes in group averages as the treatment continued. As a result, my instruction using the 5 E Learning Cycle approach for pre- to post- did improve students learning and understanding of a topic. On the other hand, my instruction was not was affective using this approach from mid- to post- as students Concept Map scores decreased 3 %.

Students assessed their Concept Maps using the Concept Map Checklist and Self-Scoring Rubric. At the beginning of each 5 E Learning Cycle students assessed

themselves on what they knew and how well they created their maps (pre-test). At the end of each 5 E Learning Cycle students assessed themselves on the new knowledge gained and how well they added to their maps (post-test). Student Concept Maps, as scored by them, steadily increased from pre-, mid-, to post-treatment and scores increased from each pre-test to each post-test of each of the 5 E Learning Cycle lessons. Students felt their Concept Maps showed improvement in placing the main ideas at the center, organizing concepts from general to most specific, using linking words to connect relationships and ideas, using crossing links to make connections between words in different areas of the map and adding new knowledge to the maps (Figure 8). Class average scores were compared for changes in the beginning of the 5 E Learning Cycle and at the end of the same 5 E Learning Cycle and from pre- (Jan.) to mid- (March) to post- (May) treatment. The Concept Map Checklist and Self-Scoring Rubric scores, scored by the students, were analyzed to see if students felt they learned or understood a specific topic, figured out meaning, organized ideas, and became more effective learners. Scores increased from pre-, mid-, to post-treatment and increased from each 5 E Learning Cycle pre-test to each 5 E Learning Cycle post-test, therefore students' felt that the 5 E Learning Cycle did improve their learning and over time they did get better as organizing their ideas, becoming more effective learners.

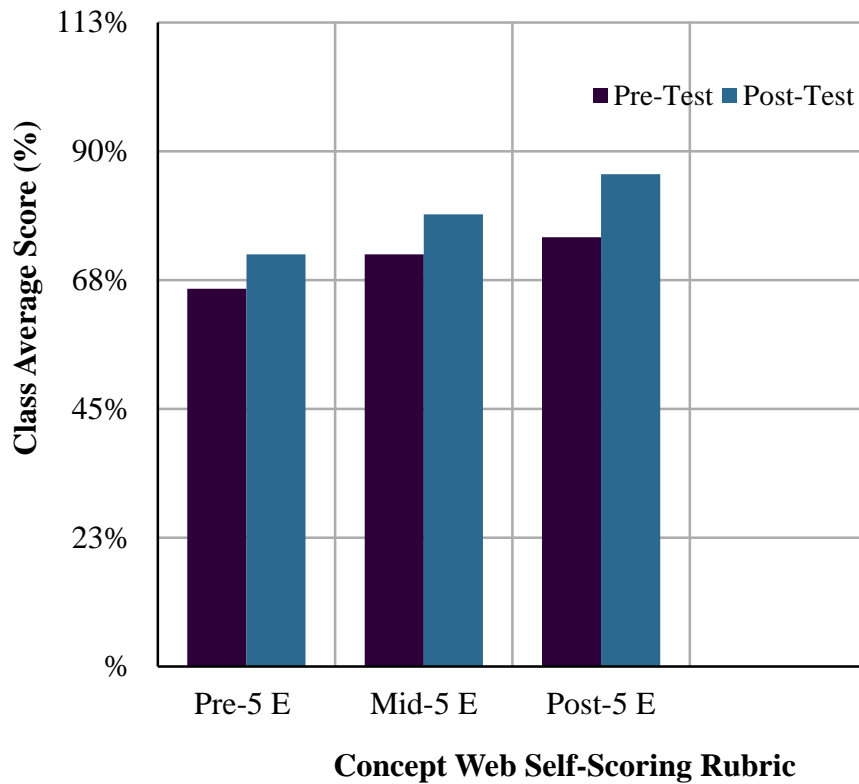


Figure 8. Student Self-Evaluated Concept Web (Average Scores), ( $N = 15$ ).

#### INTERPRETATION AND CONCLUSION

Constructive Response Questions responses, HSA scores, the Science Inquiry Monitoring Chart and the students' Concept Map Self-Scoring Checklist and Rubric revealed the learning that results from the 5 E Learning Cycle-approach to science

instruction. Renner, Abraham, and Birnie (1988) found greater achievement and retention when concepts were introduced after experiences. First, Constructive Response Questions showed students moving towards levels of increasing academic achievement. Gerber, Cavallo, and Marek (2001) found that students taught via a learning cycle scored higher on a test of scientific reasoning. Second, HSA scores revealed an increase in learning of concepts, science content, investigation protocols, and process skills. Average HSA Scores increased 12 points from the pre- to the mid-assessment and increased 6 points from mid- to the post-assessment (Figure 2). There was an increase of 18 points on the HSA from pre- to post-treatment. There was a 46% increase in students *meeting proficiency* on the HSA from the beginning of the treatment to the end of treatment. Proficiency in 8th grade Earth and Space Science increased as a result of science instruction following the 5 E Learning Cycle.

Third, the Science Inquiry Monitoring Chart showed that students were getting better at what the NRC (1996) describes as inquiry. This is, students were seen making more “observations, posing questions, examining books, and other sources of information to see what is already known, planning investigations, using tools to gather, analyze, and interpret data, proposing answers, explanations, and communicating the results” (p. 23) as the treatment continued. As a teacher, the Science Inquiry Monitoring Chart forced me to take the role as a facilitator of learning, therefore promoting inquiry (Llewellyn, 2007). Students were guided into making observations, brainstorming possible solutions, making statements to test, identifying variables, carrying out a plan, collecting evidence, describing relationships between variables, and communicating results a lot more than before the treatment.

Forth, the Concept Map and Self-Scoring Rubric, as assessed by students, showed that students felt they were learning and inquiring into their own learning more. Additionally, students' felt they were getting better at figuring out meaning, connecting prior knowledge to new knowledge gained, illustrating relationships from one idea to another, and organizing ideas about specific topics. From the teacher's perspective, students Concept Maps reflected improved good thinking and creation and use of meaning.

One thing that shocked me was that students understanding and application of inquiry decreased as evident from their Inquiry Lab Report Plan's. Pre-treatment average scores were highest because I guided my students through the process of planning. Mid-treatment scores were lower than pre-scores because I did not guide them and they were on their own in completing the Inquiry Lab Report Plans. Post-treatment average scores were the lowest of all because students were not motivated, over school, and just wanted to turn in the assignment, producing poorer quality work. When I noticed that students were zipping through the post-treatment assessment and turning in poor quality work, I asked a few to redo and go over what they handed in. Many students refused to put any more effort or time into their work and they expressed that they are done. As their teacher, I knew by looking at their post-Inquiry Lab Report work that many of them were capable of producing better work. I sternly believe that the post-scores were the lowest due to the fact that students were just not putting effort into their lab reports. Perhaps allowing students to have completed their post-Inquiry Lab Reports in early April rather than Mid-May would have shown an improvement in my students' understanding and application of inquiry. Student's scores dropped dramatically as the treatment continued,

but according to Flick and Lederman (2006), students will best learn science if they learn using the processes that scientists follow. So, although scores decreased, the Inquiry Lab Report Plan allowed for students to learn and practice the processes scientists use. Hester (1994) stated that inquiry involves “critical thinking processes such as methods of diagnosis, speculation, and hypothesis testing.” (pp.116-117). The Inquiry Lab Report Plan in the Exploring phase of the 5 E Learning Cycle gave students the opportunity to confront problems and generate and test ideas for themselves. The emphasis was on “Ways of examining and explaining information (events, facts, situations, behaviors, etc.).” (Hester,1994, p.116-117). These Inquiry Lab Report results made me realize that this learning and instructional approach is needed. Therefore, next year I will continue using the Inquiry Lab Report Plans and provide more guidance.

On top of being shocked, I noticed three similar trends, which lead me to a hypothesis. The Inquiry Self-Evaluation Form, the Inquiry Self-Assessment Questionnaire and the students Concept Maps (as assessed by the teacher) showed an increase in students’ understanding and application of inquiry from January to March but then showed a decrease from March to May. My one reason for this is students lack of motivation to produce quality work decreased in May. I advise teachers not to assess students in May if they want valid results. The decrease in students understanding of inquiry from March to May, as evident through these assessments, should have not happened. Students understanding and application of inquiry should have increased from March to May. Which brings me to the question, “What are the effects of the time of year on students ability to produce good quality work?” My guess is that students get lazy toward the end of the school year and the quality of work declines, hence, the

results. Students exhibited improvement in inquiry-behaviors throughout the treatment as evident from the data collected from the Science Inquiry Monitoring Chart, but students did not apply it well in the Inquiry Lab Reports (pre- to post), the Inquiry Self-Evaluation From (mid- to post), and the Inquiry-Self Assessment Questionnaire (mid- to post-). Perhaps with more time students would show more improvement in understanding and application of inquiry. The 5 E Learning Cycle-inquiry approach to teaching and learning improves students' understanding and application of inquiry but it takes time, a lot of coaching, modeling, practice, with no assessment taking place in May (the end of the school year when field trips and parties are being planned).

The 5 E Learning Cycle instructional approach had dramatic affects on my instruction. First, I will never teach science the same way again. Starting a lesson by engaging the students, allowing them time to explore the concept, explaining the concept or allowing them to explain, extending the lesson to allow for application of the concept, and finally evaluating them or letting them evaluate themselves proved to be worthwhile. The Lesson Plan Write-Up that was used as an inquiry-approach guide and a place for notes and reflection proved to be indispensable and valuable. More practice time on certain steps of the plan will improve inquiry understanding and application.

My research could have been better in many ways. First, spending some quality time on certain parts of the 5 E Learning Cycle would have increased my students' ability to apply and understand inquiry. Also, not having waited until May to collect my last round of data would have helped my evidence in showing that the 5 E Learning Cycle does improve understanding and application of inquiry.

## VALUE

This project has given me the opportunity to explore the connections between how children learn and teaching science using an inquiry-approach through the 5 E Learning Cycle. Constructivism and how the constructivist principles relate provide the philosophical foundation for scientific-inquiry (Lewellyn, 2007, p. xiv). Using an inquiry-approach through the 5 E Learning Cycle format to teach science content improved students' understanding and application of inquiry. In addition, students' learning or academic achievement of science increased. Students understanding and application of inquiry and learning of science increased with each 5 E Learning Cycle implemented.

The experience of implementing and conducting this project has led to four significant changes in my approach to teaching science. The first area is in planning and implementing of a lesson using an inquiry-approach. Through the process of planning and teaching following the 5 E Learning Cycle lesson-plan approach, I transitioned from not knowing how to format an inquiry lesson to knowing how format an inquiry lesson. With each cycle, I was able to reflect on the process of teaching and learning. I learned the meaning and purpose of each stage in the 5 E Learning Cycle. Cognitive scientists tell us that students need to relate new ideas to their experiences and place new ideas into a framework for understanding (Bransford, Brown, & Cocking, 2001). This means exploring events before explaining them is important for learning. Researchers have found that students and the teacher benefit when all phases of the learning cycle are present. I see the purpose of the Exploration phase before the Explanation phase and the need for an Extension or Elaborate phase. The more experiences a student has with a

concept the more they will learn, and providing students with these experiences allows for more learning. The introduction of terms after investigations helps students connect new concepts with prior experiences. I was able to modify my instruction to meet my students' needs at each stage of the cycle, by guiding inquiry investigations. Each stage of the 5 E Learning Cycle played a vital role in student learning and understanding of science and inquiry and really allows the students to become independent inquirers about the world. This approach to learning allows students to think and act in ways associated with inquiry.

The second area of change in my teaching is that I have expanded my repertoire of research-based instructional strategies and assessments and found the importance of these strategies and assessments in improving student learning and inquiry. I will continue to assess inquiry and learning through Concept Webs, Inquiry Lab Reports and Rubrics, Constructive Responses, Multiple Choice Questions, questionnaires, surveys, self-evaluations, and presentations. I have gotten better and feel more comfortable at implementing the 5 E Learning Cycle and will continue to use it to guide my instruction and student learning. In addition, the students have gotten better at using these various assessments for learning. Next year, I will spend more time in the Explore stage and Explain stages of the 5 E Learning Cycle.

The third area and most important area of change is my increased awareness of the relationship of how students learn and scientific inquiry. Constructivism lays the foundation for understanding and implementing inquiry.-based learning. This project allowed students to construct knowledge based on their past experience, reflect on their learning, share questions and points of view, and create meaning from an experience.

Students used their senses, were engaged, took part in dialogue, discussion, and communication with peers, and interacted and manipulated materials. All of which allows students to do scientific processes and gather knowledge about the processes. Similarly, the use of the 5 E Learning Cycle can clarify students' thought processes and correct their misconceptions. When students explore a new concept through an exploration, their new experiences cause them reevaluate their past experiences. This produces disequilibrium in the student, and s/he needs to accommodate the concept to reach equilibration. The 5 E Learning Cycle allows students to accommodate the concept. In the *Elaboration* or *Extension* phase, students gain familiarity with the introduced concept and either assimilate or accommodate the new concept into their schemata.

Finally a fourth area of change in my instruction is how I view myself in the classroom. Being a teacher is just like being a researcher. We are always observing and collecting evidence and data from our students in the form of assessments to better guide our planning, instruction, and improve student learning. The 5 E Learning Cycle approach has allowed me to view myself as a facilitator of learning, teaching students how to learn and providing students with opportunities to learn. Also, just because students are engaged in inquiry does not mean they are implicitly learning about scientific inquiry and the nature of science. To promote a deeper understanding, I must follow-up an investigation with explicit “coaching” explanations and scaffolding discussions about the questions, the procedure, and evaluating and debating the evidence and claims from an investigation. In addition, practicing, learning, teaching, applying and understanding inquiry takes time and with enough practice and time, application and

understanding of inquiry will improve. I plan to begin inquiry-based instruction using the 5 E Learning Cycle process early on, gathering data through observation and assessments, and providing explicit coaching and scaffolding in the needed areas.

During the coming school year, my professional goal will focus on planning, implementing, and refining lessons using the 5 E Learning Cycle inquiry-approach, building on inquiry research-based instructional strategies and assessments, and encouraging an atmosphere of a scientific inquiry-based classroom. I will implement my professional goal by doing the following:

- I will begin addressing the stages of the 5 E Learning Cycle that need improvement in both areas of teaching and student achievement.
- I will start coaching the students through the areas in which they have trouble understanding within the first couple of weeks of school.
- I will use assessments to monitor and evaluate students understanding on content and inquiry and to guide my coaching and instruction.
- I will emphasize and spend time on parts of the 5 E Learning Cycle that were overlooked in the past due to time constraints.
- I will modify the 5 E Learning Cycle to accommodate time constraints and my students learning needs.

As I come to know inquiry better and how to provide inquiry-based instruction and learning in my classroom using the 5 E Learning Cycle, I can improve on timing or the time span spent on one cycle. I will coach students in sorting questions to see if they can be answered in an investigation, identifying variables, having students refer to the Inquiry

Lab Report Rubric, spending more time on research from the library and Internet, and students communicate results of their investigation by holding a conference.

It is important for me to assess inquiry in the science classroom because if they are inquiring they are learning. Children are “theory builders” (Llewellyn, 2007, p. 79), and the 5 E Learning Cycle compliments this theory. The 5 E Learning Cycle allowed students to build on what they know and understand and develop their own theories. With that in mind, my final goal is to create an inquiry- centered classroom. The study presented here revealed that the 5 E Learning Cycle instructional approach slightly improved students' understanding and application of inquiry and greatly improved learning. The study suggests the use of the 5E learning cycle as method of instruction. However, successful implementation requires that teachers are aware of students' prior knowledge and their misconceptions and direct the lesson accordingly. Finally, this project has showed that the 5 E Learning Cycle-approach does improve science learning and increases students understanding and application of inquiry.

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APPENDICES

APPENDIX A

CONSTRUCTIVE RESPONSE QUESTIONS AND RUBRIC

**HCPS CONSTRUCTIVE RESPONSE BENCHMARK QUESTIONS****Quarter 2**

NAME: \_\_\_\_\_ CLASS: \_\_\_\_\_ DATE: \_\_\_\_\_

Directions: Answer the following HCPS Constructive Response Questions.  
HCPS Constructive Response Benchmark Questions

**8.1.1 Scientific Inquiry**

1. *Determine the link(s) between evidence and the conclusion(s) of an investigation*

**8.1.2 Scientific Inquiry**

2. *Communicate the significant components of the experimental design and results of a scientific investigation*

**8.2.1 Science, Technology, and Society**

3. *Describe significant relationships among society, science, and technology and how one impacts the other*

**8.2.2 Unifying Concepts and Themes**

4. *Describe how scale and mathematical models can be used to support and explain scientific data*

**8.5.1 Biological Evolution**

5. *Describe how changes in the physical environment affect the survival of organisms*

**8.6.1 Waves**

6. *Explain the relationship between the color of light and wavelength within the electromagnetic spectrum*

**8.6.3 Waves**

7. *Identify the characteristics and properties of mechanical and electromagnetic waves*

**8.8.3 Earth in the Solar System**

8. *Describe how the Earth's motions and tilt on its axis affect the seasons and weather patterns*

**8.8.4 Forces that Shape the Earth**

9. *Explain how the sun is the major source of energy influencing climate and weather on Earth*

**8.8.6 Forces that Shape the Earth**

10. *Explain the relationship between density and convection currents in the ocean and atmosphere*

**8.8.7 Forces that Shape the Earth**

11. *Describe the physical characteristics of oceans*

**HCPS CONSTRUCTIVE RESPONSE BENCHMARK QUESTIONS**

**Quarter 3**

NAME: \_\_\_\_\_ CLASS: \_\_\_\_\_ DATE: \_\_\_\_\_

Directions: Answer the following HCPS Constructive Response Questions

HCPS Constructive Response Benchmark Questions

**8.1.1 Scientific Inquiry**

1. *Determine the link(s) between evidence and the conclusion(s) of an investigation*

**8.1.2 Scientific Inquiry**

2. *Communicate the significant components of the experimental design and results of a scientific investigation*

**8.7.1 Forces of the Universe**

5. *Explain that every object has mass and therefore exerts a gravitational force on other objects*

**8.8.9 The Universe**

6. *Explain the predictable motions of the Earth and moon*

**8.8.12 The Universe**

7. *Describe the role of gravitational force in the motions of planetary systems*

**HCPS CONSTRUCTIVE RESPONSE BENCHMARK QUESTIONS**

**Quarter 4**

NAME: \_\_\_\_\_ CLASS: \_\_\_\_\_ DATE: \_\_\_\_\_

Directions: Answer the following HCPS Constructive Response Questions

**8.8.1 Scientific Inquiry**

1. *Determine the link(s) between evidence and the conclusion(s) of an investigation*

**8.8.2 Scientific Inquiry**

2. *Communicate the significant components of the experimental design and results of a scientific investigation*

**8.8.8 The Universe**

8. *Describe the composition of objects in the galaxy*

**8.8.9 The Universe**

9. *Explain the predictable motions of the Earth and moon*

**8.8.10 The Universe**

10. Compare the characteristics and movement patterns of the planets in our solar system

**8.8.11 The Universe**

11. Describe the major components of the universe

**8.8.12 The Universe**

12. *Describe the role of gravitational force in the motions of planetary systems*

APPENDIX B

CONSTRUCTIVE RESPONSE RUBRIC

**8th Grade Constructive Response Scoring Rubric (SAMPLE):****Topic:** Waves**Benchmark:** SC.8.6.1 Explain the relationship between the color of light and wavelength within the electromagnetic spectrum**Sample Performance Assessment (SPA):** The student: Diagrams and explains the small band of visible light within the larger electromagnetic spectrum.**Rubric****Advanced**

Generalize and explain the relationship between the color of light and wavelength within the electromagnetic spectrum

**Proficient**

Explain the relationship between the color of light and the wavelength within the electromagnetic spectrum

**Partially Proficient**

Identify the relationship between the color of light and the wavelength within the electromagnetic spectrum

**Novice**

Recognize that there is a relationship between the color of light and the wavelength within the electromagnetic spectrum

\*Hawaii Content and Performance Standards III Database contains Sample Performance Assessment and Rubrics (2005), Hawaii State Department of Education. Retrieved from <http://165.248.30.40/hcpsv3/>

APPENDIX C

SCIENCE INQUIRY MONITORING CHART





Stage/Behavior	1	2	3	4	5	6	7	8
Makes contribution to presentation								
Uses appropriate terminology								
Makes eye contact with audience								
Speaks clearly								
Answers questions from audience								
Reflects on investigation								

\*Llewellyn, 2007, p.149

INQUIRY MONITORING ANECDOTAL RECORD  
**INQUIRY MONITORING ANECDOTAL RECORD**

**Document the date:** \_\_\_\_\_ **time:** \_\_\_\_\_, and  
**stage of the lesson:** \_\_\_\_\_

**Observe and monitor all students equitably (use class list  
grading sheet):** \_\_\_\_\_

**Made multiple observations to ensure reliability:** \_\_\_\_\_

**Observe often and regularly (use class list):** \_\_\_\_\_

**Record *observations* in writing:**

**Note typical as well as atypical behaviors:**

APPENDIX D

INQUIRY LAB REPORT PLAN AND RUBRIC

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

### **Inquiry Lab Report Plan**

Plan:

1. Generate a science-benchmark related question or problem to be solved.
2. Brainstorm possible solutions
3. Formulate a statement to investigate
4. Design an action plan and carry out the procedures of the investigation
5. Gather and record evidence and data through observation and instrumentation
6. Draw appropriate conclusions and explanations from the evidence
7. Connect the explanations to previously held knowledge
8. Communicate the conclusions and explanations with others

**Title:****Benchmarks):****Science Concept (s):****Problem Statement (My Question is...), or (I wonder....) (What if...):****My potential hypothesis (es) is....or (I predict...):****Research: Attach research. List all references under RESOURCES below.****The materials:**

- |    |     |
|----|-----|
| 1. | 7.  |
| 2. | 8.  |
| 3. | 9.  |
| 4. | 10. |
| 5. | 11. |
| 6. | 12. |

**The procedure (the steps to follow...):**

- 1.
- 2.
- 3.
- 4.
- 5.

- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.
- 13.

**Number of Trials:**

**Control Test:**

**Variables:**

**The manipulated (independent) (cause) (what are you changing?) variable is:**

**The responding (dependent) (effect) (what is responding to that change?) variable is:**

**The controlled variables are (the variables held constant...):**

**Data:**

**Data (Tables, Graphs, Charts), and (the observations I made are...): Space provided on back or please attach..**

**Data Analysis and Interpretation (the pattern or the relationships I found are...):**

**Conclusions (the answer to my question is...) and (my hypothesis was...) (I learned...)  
( I can apply this to the real world...):**

**Resources: (Bibliography, Interviews, etc.) (three minimum)**

### Inquiry Lab Report Rubric

	Excellent 4 pts.	Satisfactory 3 pts.	Needs Improvement 2 pts.	Deficient 1 pts.
Question or Problem Statement	Question is clearly identified, referenced to benchmark and testable	Question is clearly identified and testable	Question identified, but not clearly stated and not testable	Question identified does not make sense, not testable
Hypothesis	Statement <b>related</b> to question and <b>experimentally testable</b> includes a <b>manipulated variable and/or responding variable</b>	Statement <b>semi-related</b> to the question and <b>experimentally testable</b>	Statement <b>semi-related</b> to the question and <b>not experimentally testable</b>	Statement <b>not related</b> to the question and <b>not testable</b>

	<b>Excellent 4 pts.</b>	<b>Satisfactory 3 pts.</b>	<b>Needs Improvement 2 pts.</b>	<b>Deficient 1 pts.</b>
Materials	All material needed to conduct lab is listed along with quantity	Most material needed	Some materials needed no quantity	Very few materials listed
Procedure	Procedure <b>clearly step-by-step logical format, easy to follow, design addresses hypothesis and question</b>	Procedure is <b>written clearly</b> in a <b>logical format</b>	Procedure is <b>not written clearly, semi-logical formate</b>	Procedure is <b>not clear, not logical and incomplete</b>
Identification of Variables	Identified all <b>three</b> variables properly	Identified <b>two</b> variables	Identified <b>one</b> variable	An attempt to identify variables was made
Control	Three or more properly identified	Two identified	One identified	None identified but attempt was made

	<b>Excellent 4 pts.</b>	<b>Satisfactory 3 pts.</b>	<b>Needs Improvement 2 pts.</b>	<b>Deficient 1 pts.</b>
Measurement and Observational Data	Professional looking and accurate representation, easily readable and appropriate labels, data, format, and diagrams. Easy to interpret and neatly recoded.  Observations are clearly stated  Replicable trials used	Accurate representation, readable and appropriate data, labels, format, and diagrams.  Observations are stated	Semi-accurate representation, semi-readable and semi-appropriate labels, format, and diagrams.  Observations stated	An unorganized, sloppy representation, not readable and inappropriate or missing labels, format, and diagrams.  Few observations stated
Data Analysis and Interpretation	The analysis was done correctly, trends are noted, enough data was taken to establish conclusion, Summarized results, figures, graphs, tables are provided, labeled axes and units, related to question and hypothesis,	Analysis somewhat lacking in insight, enough data though additional data would have been more powerful.	Analysis lacking in insight, not enough data was gathered to establish trends or analysis does not follow data	Analysis poor, not enough data, inaccurate analysis

	<b>Excellent 4 pts.</b>	<b>Satisfactory 3 pts.</b>	<b>Needs Improvement 2 pts.</b>	<b>Deficient 1 pts.</b>
Conclusions	1. Describes highlights of what can be concluded from experimental results (data), 2. answers question, 3. explains how hypothesis is accepted or rejected 4. applied to the real world, 5. any short comings, 6. future investigations, 7. science concepts learned, 8. data errors and sources of experimental error,	Two of the "Excellent" qualities are not meet	Three of the "Excellent" qualities are not meet	Four or more of the "Excellent" qualities are not meet

	<b>Excellent 4 pts.</b>	<b>Satisfactory 3 pts.</b>	<b>Needs Improvement 2 pts.</b>	<b>Deficient 1 pts.</b>
Presentation	Covered all 9 major components of the lab report, great eye contact, easy to understand, voice was projected, well-spoken, use of visual aids	7 major components presented, good eye contact, understandable,	5 components presented, poor eye contact and not very easy to understand	Less than 5 components presented, difficult to understand

Total possible points: 40

#### Grading Scale:

100% - 90% = A

89% - 80% = B

79% - 70% = C

69% - 60% = D

59% - 50% = F

APPENDIX E

INQUIRY SELF-EVALUATION FORM

## Inquiry Self-Evaluation Form

Name: \_\_\_\_\_

**Shade in the circle that BEST describes your experience**

	<b>Almos t Alway s</b>	<b>Often</b>	<b>Some- times</b>	<b>Rarel y</b>
I handled the material properly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I made accurate observations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I made accurate drawings.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I followed the procedure on my inquiry plan.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I participated in the group discussions productively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I listened to other members of my group and respected their ideas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I did my share of the group work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I used my journal to record my observations and measurements.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I used the supplies and materials appropriately.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I used many sources to collect information for this lab.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I shared what I learned with others in my class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I shared responsibility during the presentation of our work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I made good eye-contact during the presentation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I projected my voice during the presentation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*Llewellyn, 2007

APPENDIX F

INQUIRY SELF-ASSESSMENT QUESTIONNAIRE

### **Inquiry Self Assessment**

Please answer the following questions the best you can.

1. What was investigated? (Describe the problem statement)
2. What was your hypothesis and explain how it was supported by the data?
3. What were the major findings?
4. How did your findings compare with other researchers?
5. What possible explanations can you offer for your findings?
6. What recommendations do you have for further study and for improving the experiment?
7. What are some possible applications of the experiment?

APPENDIX G

LESSON PLAN WRITE-UP (TEMPLATE)

**LESSON PLAN WRITE-UP    Date:\_\_\_\_\_**

**1. Title:**

**2. Grade Level and Objectives:**

**3. Background Information: (for teacher)(science content being taught):**

**4. List of Materials and Vocabulary:**

**5. Detailed Lesson Plan:**

**Engage:**

1. Introduce concept/objective to be learned and Vocabulary
2. Assess prior knowledge (KWL). Students fill in the K and W sections of their table individually
3. Students share what they know (Thank, Pair, Share or TAG) (TAG, T-Tell Something you like, A-Ask a Question, G-Give A Suggestion)
4. Student makes individual **Concept Map** and uses the “**Concept Map Checklist and Rubric**” (**Pre-Test**) (**Appendix E**) to score themselves. Then, I make concept map from what the entire class knows using the same “**Concept Map Checklist and Rubric**” we score ourselves.
5. Students observe a video and record observations in their science journals using the “**Reflection Journal Entires**” (**Appendix A**). Then, fill in the “L” section of their KWL Table
6. Students are asked to write questions to investigate, in “I wonder” and What if” questions
7. Sort questions to see if they can be answered in an investigation
8. Students research information in the library and on the Internet (google, classzone, NASA, Discovery Education, NOAA)

**Exploration:**

9. Students Plan an investigation using the “**Inquiry Lab Report Plan**” and “**Lab Report Rubric**” (**Appendix J & K**).
10. Students gather data, organize their evidence on a chart or graph, look for patterns and relationships, and draw conclusions

**Explanation:**

11. Provide information through direct instruction or class discussion on the topic being studied
12. Students communicate results of their investigations by holding a “Earth’s Weather and Seasons (fill in)” Conference

**Elaboration or Extension:**

Lab Activity in groups.

Teacher fills in the “**Science Inquiry Monitoring Chart**” (Lewellyn, 2007, pg. 149)

**Evaluation:**

Assess students through **Concept Map and Concept Map Checklist and Rubric (Post-Test) (Appendix E)**, the textbook’s multiple-choice questions and **Multiple Choice Questions Grading Scale (Appendix G)**, **Constructive Response Questions (Appendix H)** and **Constructive Response Rubric, Inquiry Self-Assessment Questionnaire (Appendix F)**, **Inquiry Self-Evaluation Form (Appendix L)**, and **Interview Questions (Appendix I)**.

Home learning: **HCPS Benchmark & Big Ideas Prompts (Appendix B)**, **Writing Rubric (Appendix C)**, and **Peer Review Writing Log (Appendix D)**, **Reflection Journal Entries (Appendix A)**.

**6. Curricular Integration:**

Math, Reading, Language Arts, Writing, Technology, Engineering, and Art.

**7. Modifications:** Include a statement specifically addressing how you will modify the lesson for students with diverse needs, such as ADD, ADHD, Learning Disabled, AG, and ESL. **Metacognitive strategies, students plan, monitor, and evaluate their science learning of concepts by using:** a. Advance organizers (What’s the question and the purpose for this experiment?) b. Selective Attention (What information requires my close attention?) c. Organizing planning (What steps do I need to design or follow?) d. Self-Monitoring (Is my plan working?) e. Self-assessment (How well did I solve the problem?) **Cognitive Strategies, students interact with the information to be learned, changing or reorganizing it either mentally or physically by:** a. Elaborating prior knowledge (What do I already know about this problem?) b. Resourcing (What information can I find about the topic or problem?) c. Taking notes, organizing data (How will I record and organize my data, observations, and questions?) d. Using images and models (How will I communicate my understanding of the concept through illustrations or models?)

**8. Sources:** *Sciencesaurus*, Harcourt’s *SciTech: Science* (state adopted textbook), Discovery Education, NOAA

**9. Reflection:**

Did I follow the 5 E model and complete all steps?

Any ideas or suggestions?

Am I moving my students from teacher-dependent to more independent experiences?

Am I providing opportunities for student-initiated inquiries as the year goes on?

APPENDIX H

CONCEPT MAP CHECKLIST AND RUBRIC

Name: \_\_\_\_\_ Date: \_\_\_\_\_  
 BENCHMARK: \_\_\_\_\_

### Concept Map Checklist and Rubric (Pre-Test)

Directions:

Make a Concept Web on the back of this paper using the words in the “Vocabulary Word Box.” Then, score yourself on how well you did in each of the five components.

Rate yourself using the following rubric. 0 points = failed

1 points = good

2 points = great.

As you look at your concept web, ask yourself:

HOW WELL DID I.....

1. Place the main idea at the center of the page. \_\_\_\_\_(2 pts.)
2. Organize the words or concepts from most general to most specific. \_\_\_\_\_(2 pts.)
3. Use a linking word (verb, preposition, or short phrase) to connect and illustrate the relationships and linkages from one idea to another. \_\_\_\_\_(2 pts.)
4. Use crossing links to make connections between words in different areas of the map. \_\_\_\_\_(2 pts.)
5. Add to the map as new knowledge is constructed. \_\_\_\_\_(2 pts.)

Total Points: \_\_\_\_\_(10 possible points)

### Concept Map Checklist and Rubric (Post-Test)

Directions:

Make a Concept Web on the back of this paper using the words in the “Vocabulary Word Box.” Then, score yourself on how well you did in each of the five components.

Rate yourself using the following rubric. 0 points = failed

1 points = good

2 points = great.

As you look at your concept web, ask yourself:

HOW WELL DID I.....

1. Place the main idea at the center of the page. \_\_\_\_\_(2 pts.)
2. Organize the words or concepts from most general to most specific. \_\_\_\_\_(2 pts.)
3. Use a linking word (verb, preposition, or short phrase) to connect and illustrate the relationships and linkages from one idea to another. \_\_\_\_\_(2 pts.)
4. Use crossing links to make connections between words in different areas of the map. \_\_\_\_\_(2 pts.)
5. Add to the map as new knowledge is constructed. \_\_\_\_\_(2 pts.)

Total Points: \_\_\_\_\_(10 possible points)

**Concept Web Rubric**

0 points = failed

1 points = good

2 points = great.

HOW WELL DID YOU.....

1. Place the main idea at the center of the page. \_\_\_\_\_(2 pts.)
  2. Organize the words or concepts from most general to most specific. \_\_\_\_\_(2 pts.)
  3. Use a linking word (verb, preposition, or short phrase) to connect and illustrate the relationships and linkages from one idea to another. \_\_\_\_\_(2 pts.)
  4. Use crossing links to make connections between words in different areas of the map. \_\_\_\_\_(2 pts.)
  5. Add to the map as new knowledge is constructed. \_\_\_\_\_(2 pts.)
- Total Points: \_\_\_\_\_(10 possible points)

10= 100%=A

9= 90%=A

8=80%=B

7=70%=C

6=60%=D

5=50%=F

APPENDIX I

INFORMED CONSENT FORM FOR STUDENTS IN THE STUDY

### **Informed Consent Form for Students in the Study**

The purpose of this research project entitled "The Effects of using an Inquiry approach through the 5 E Lesson Format on Middle School Earth and Space Science students," is to examine one of the most familiar and effective models for science instruction and its effects on students understanding and application of inquiry, student learning, and teacher instruction.

For this project, students will be asked to complete pre-, mid- and post- multiple choice questions, constructive responses, interviews, monitoring charts, lab reports, self-evaluations, journal writing entries, concept maps, surveys and questionnaires. All of these data collection instruments fall within the area of common classroom assessment practices.

My study will research one focus question and three sub-questions. The main question is, "What are the affects of using an inquiry approach through the 5 E lesson format on middle school earth and space science students?" Subquestion 1: What are the affects of using a 5 E approach on students' understanding and application of inquiry?" "What are the affects of using a 5 E approach on students' ability to learn science? How will the 5E Learning Cycle effect my science instruction?"

Identification of all students involved will be kept strictly confidential. Most of the students involved in the research will remain unidentified in any way, and their levels of environmental interaction will be assessed and noted. Six students will be selected for interviews randomly. Nowhere in any report or listing will students' last name or any other identifying information be listed.

There are no foreseeable risks or ill effects from participating in this study. All treatment and data collection falls within what is considered normal classroom instructional practice. Furthermore, participation in the study can in no way affect grades for this or any course, nor can it affect academic or personal standing in any fashion whatsoever.

There are several benefits to be expected from participation in this study. First, an increase in your child's science learning. Second, an increase in students understanding and application of inquiry and problem solving. Third, this study allows me, as a science teacher, to improve and grow in my professional career a teacher of science. Finally, this study is allowing me, as a student of Montana State University, to complete my final Capstone Project. This required project must be completed in order to fulfill the requirements needed for a Masters of Science in Science Education from Montana State University.

Participation in this study is voluntary, and students are free to withdraw consent and to discontinue participation in this study at any time without prejudice from the investigator.

Please feel free to ask any questions of Ms. Margaret Magonigle (8th grade science teacher) via e-mail, phone, or in person before signing the Informed Consent form and beginning the study, and at any time during the study.

Student Signature \_\_\_\_\_

Parent signature: \_\_\_\_\_

Date: \_\_\_\_\_

This project was approved by: \_\_\_\_\_

Mr. Richard Paul, Principal of Hana School

**Simplified Letter attached to the Informed Consent Form for Students in the Study**

December 4, 2010

Hello Parent and/or guardian,

I am currently working on my Master of Science in Science Education from Montana State University. Of course this is an online program. I will be graduating in the Summer of 2011, but I need your help so that I can.

In order to complete this program and earn my degree, I need to implement a project in my classroom. Therefore, the attached letter simply asks for your permission to allow your child, as a student involved in the educational process, to participate. By doing so, you will be allowing your child to take part in an important role in educational research to improve student learning and classroom instruction.

Please help make my project a success by allowing your child to participate and signing on the bottom of the next page. Thank you for your support.

Sincerely,

Margaret Magonigle  
Middle School Science Teacher