INCREASING STUDENT SUCCESS AND PARTICIPATION IN SCIENCE USING PLACE-BASED EDUCATION

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

July 2012

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In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

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July 2012

ACKNOWLEDGEMENTS

I am grateful for the continuous support and encouragement that was given by my husband, son, daughter, family, Dr. Beth Covitt, LeAnne Yenny, and Dr. John Graves. Without it, this amazing accomplishment could not have been achieved. Thank you all, for the support and guidance you gave to me while completing this lifelong achievement.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This research project was initiated to determine if using place-based educational strategies had increased students' understanding and attitude while studying specific science topics. During the nine-week study, I used a variety of place-based educational approaches to teach students about ecosystems, biomes (large scale ecosystems), and weather and climate. I applied several qualitative and quantitative data collection instruments during the treatment period. Quantifiable data collected showed evidence that growth in conceptual understanding and students' ability to transfer and apply knowledge of place to areas of greater geographic distance had occurred. Qualitative statements revealed a positive increase in students' attitude and interest towards science lessons during the implementation of place-based methods. As a result of this study, it was concluded that the use of place-based educational strategies while teaching specific science themes does enhance students' understanding and attitude toward the learning of science concepts.

INTRODUCTION AND BACKGROUND

I teach 5th grade at Florence-Carlton School District 15-6. Florence-Carlton is a single school district that includes grades K-12. The school is located in Florence, Montana, a small rural community south of Missoula. The surrounding Bitterroot Valley is well noted for its abundant wildlife, fishing, and recreational opportunities. The area has been economically challenged over the past ten years due to a downturn in the housing and logging industries. These industries have historically been a main source of employment and income for people living in the community. The current student enrollment is 820, which is considerably lower than in previous years. The majority of the student population is Caucasian, with less than 5% representing minorities (L. Warila, personal communication, November 30, 2011). The elementary school has an active and involved parent association that supports both teachers and students in the educational process. All staff members are dedicated to providing a safe, caring, and dynamic learning environment.

This is my fourth year teaching fifth grade at Florence-Carlton Elementary. In addition to teaching reading, writing, and math to the students enrolled in my classroom, I am responsible for teaching science to all three fifth grade classes. The student population at this grade level is roughly 20 students per classroom. There is an equal proportion of males to females, with 23% of students requiring additional academic support services for below grade level performance (D. Schroder, personal communication, November 2, 2011). The students in my class are respectful and have a strong desire to learn.

This study was conducted in my three fifth grade science classes during the third quarter of the 2011-2012 school year. The reason I chose to do this study was to determine if incorporating place-based education (PBE) would have an impact on students' learning. Place-based education is simply using our place, where we live, as the framework for learning. PBE engages and exposes students to local landscapes, cultures, heritage, and experiences. It uses these components to teach science and other subjects across the curriculum.

Formative assessment responses and teacher observation indicated that most of my students initially lacked the ability to conceptually bridge what happened in their local community to the world around them. During the study, I used place-based education methods to teach students about ecosystems, biomes (large scale ecosystems), and weather and climate. My focus question for this study was, does incorporating place-based education strategies while teaching specific science concepts improve students' understanding and attitudes toward science? In addition, I studied a second question, does incorporating place-based educational strategies while teaching specific science concepts improve teacher attitude?

CONCEPTUAL FRAMEWORK

When place-based education and real-world problems are effectively incorporated into the curriculum, student understanding and engagement are increased. According to Woodhouse (2000), place-based education is a fairly new term. Progressive educators have promoted the concept for over a century. Place-based education (PBE) is basically using our place, i.e., where we live, as a back drop for learning.

Place-based education usually includes conventional outdoor education and experiential methodologies as were advocated by John Dewey in the early 1900s. Dewey (1915) strongly believed that an investigational approach to student learning should be tied to the local environment. Dewey (1915) stated that, “Experience [outside the school] has its geographical aspect, its artistic and its literary, its scientific and its historical sides. All studies arise from the aspects of the one earth and the one life lived upon it” (p. 91). This idea targets one of the key benefits in the use of PBE. The knowledge we gain as an individual results from the direct experience of understanding the things around us. Place-based pedagogy usually includes using conventional outdoor educational practices as advocated by John Dewey to help students connect with their particular corner of the world. Dewey advocated a process of exploration, engagement, and critical reflection when learning about the local environment. The focus is specific to the ecology, geography, sociology, politics and other dynamics of that place. The famous seventeenth-century philosopher, Comenius, was first to define one of the core principles of place-based education. He stressed the importance of gaining knowledge of those things we are closest to first, then those of further distance (Woodhouse, 2001).

Place-based education helps students learn to care for the world by understanding where they live. Place-based education links students to their local community and environment while connecting the chain to the teaching of science, mathematics, social studies, writing, reading, and other subjects across the curriculum. Hence the term *place-based* or *place-conscious education*, a positioned method that cuts a wide swath encompassing experiential learning in and about local or regionally authentic natural and social settings. The practice also merges cross-cultural and multidisciplinary

understanding of place-related knowledge and pedagogy and the inclusion of a community or service learning component (Gruenewald, 2003a, 2003b; Gruenewald & Smith, 2008; Smith, 2002; Sobel, 2004; Woodhouse & Knapp, 2000).

Schools involved in place-based education believe that it intentionally influences awareness of teachers and students and encourages local ecological and cultural ownership (Lim & Calabrese Barton, 2006; Semken, 2005). Place-based teaching promotes local ecological and cultural sustainability, rather than the global spirit of competitiveness and resource exploitation (Sobel, 2004).

The value of place-based education has been recognized as an important educational method by the National Science Teachers Association (NSTA, 2003). NSTA supports this component of environmental education as a way to instill environmental literacy in our country's students. Student knowledge of environmental concepts helps them establish a foundation for their future understandings and actions as citizens. Central to environmental literacy is the ability of students to develop and master critical-thinking skills that will help them to evaluate issues and make informed decisions in regard to the caretaking of their community and our planet.

Students involved in place-based education have been shown to perform better on standardized measures of academic achievement; have improved grades in reading, writing, math, science and social studies; have reduced discipline and classroom management problems; and demonstrate engagement and enthusiasm for learning (Lieberman & Hoody, 1998).

In addition to conventional subject-matter knowledge and basic life skills, the Adopt-A-Watershed non-profit organization (2011), found that place-based education

provided a wide variety of other educational benefits, such as individual empowerment and feeling of ownership, increased awareness of diverse viewpoints as a facet of a democratic society, advanced critical-thinking skills leading to discovery and real-world problem-solving, and a comprehensive understanding of the world and connection to something that is individually meaningful and fulfilling.

Place-based education continues to increase in popularity in a variety of culturally and geographically diverse schools across America. Place-based education is an approach that allows teachers and students to be engaged in hands-on experiences together rather than just reading about science out of a textbook. “Seeing a local bird in a schoolyard is a richer experience than looking at a photo of an exotic bird in a book” (Barnett, 2009, p.7).

Place-based education not only increases students’ level of academic achievement across the curriculum, but it cultivates and builds strong relationships between schools and their local communities. Place-based education provides educators with a unique educational approach that emphasizes hands-on, real-world life experiences that stimulate and engage students to learn and transfer those understandings to new situations.

METHODOLOGY

The treatment for the project occurred over a nine-week period. During that time, students were taught life science process skills in alignment with the district’s science curriculum standards for Grade 5. The purpose of the study was to determine if place-based education helped students’ understand and apply unit concepts to where they live. Numerous qualitative and quantitative data collection strategies were utilized in this

study. 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 Interaction with Nature Pre and Post Assessment contained 14 multiple choice questions, 4 fill-in-the-blanks, and 2 open ended responses and was used to determine the effectiveness of process skill instruction in PBE (Appendix A). I compared and analyzed the data from the pre- and post-assessments to determine if students' previous concept understanding had expanded as a result of my using PBE strategies when teaching lesson concepts. In addition, students were given three formative assessment probes. Each of the three probes related to a specific unit of study and was given twice, before and after each unit of study had been taught. Habitat Change (Keeley, 2005), Wet Jeans (Keeley, 2005), and Where Does Oil Come From? (Keeley, 2005) were used to reveal students' thoughts in science prior to and after each specific unit of study (Appendices B, C, & D). Results from the probes were studied and used for tracking and pin-pointing change in students' conceptual knowledge. These probes provided a richer insight into students' thinking in science than was possible with the pre-and post-assessments alone. Formative unit assessment scores, exit tickets, muddiest point slips, journal entries, and other class assignments were analyzed throughout the nine week treatment period as evidence of achievement.

The second area addressed was student attitude. I wanted to find out if student attitudes toward science had increased as a result of using PBE strategies. I chose to give a modified version of the Test of Science-Related Attitudes survey (Fraser, 1978), before and after the PBE treatment had been applied (Appendix E). The survey recorded

students' thoughts and feelings toward science and was used to collect data to evaluate if students' interest in science had increased due to the use of PBE strategies.

Student interviews were another instrument used to further enrich the data collected. Interviews were conducted at the end of the nine-week study period. Six students from each of the three science classes were randomly selected to take part in the interview process. The students were asked seven questions related to their level of interest towards what had been taught over the treatment period (Appendix F). Responses from the interviews were examined and used to support teacher conclusions. Teacher observations were another key component used in making the determination related to students' change in level of interest.

In addition to documenting students' attitude, a very critical part of this study reflected on my attitude as the teacher as I made and maintained changes in my classroom. I chose to measure change in teacher attitude by maintaining a daily reflective journal. I wrote and reflected about my teaching practices, personal feelings about how lessons were received by students, student progress, and class engagement. I constantly adjusted my format as needed in order to get the most accurate and reliable results. Journal entries at the beginning of the study were compared against those at the end to document to examine if there had been an increase in teacher practices and/or satisfaction with instruction and instructional outcomes. All of the data collection strategies served to answer the project focus questions (Table 1).

Table 1
Triangulation Matrix for Data Collection

Research Questions	Data Source		
	1	2	3
Does incorporating place-based educational strategies while teaching a specific science concept improve students' understanding of science?	Interactions with Nature Pre- and Post-Assessment	Teacher observation	Formative assessments and classroom assignments
Does incorporating place-based educational strategies while teaching a specific science concept improve students' attitude in science?	Test of Science-Related Attitude survey	Student interviews with teacher	Teacher observations
Does incorporating place-based educational strategies while teaching a specific science concept improve teacher attitude in teaching concept material?	Self-reflection journal		

DATA AND ANALYSIS

My primary research question was, does incorporating place-based educational strategies while teaching a specific science concept improve students' understanding and attitudes towards science? Based on analysis of students' Interactions with Nature Pre- and Post-Assessment scores, understanding of specific science concepts did improve throughout the treatment period. The class average score on the Interactions with Nature Pre-Assessment was 36% (N=60). The class average on the post- assessment scores was 87%. The over-all change between the pre- and post-assessment showed a growth of

51%. Students improved in each of the specific science concept areas taught during the treatment: ecosystems, biomes, and weather and climate. The greatest gains were in the area of concepts related to understanding ecosystems. The data revealed that students' pre-assessment average score of ecosystems questions was 43%. Students' average score on post-assessment rose to 85%, indicating that, on average, students answered six out of the seven questions about ecosystems correctly. The weakest area noticeable from the pre- and post-assessment data was concepts related to weather and climate. Initial scores averaged 17%, while post data analysis revealed the group's average to be 47%. Over-all growth in this area was 30%. Summary of the student pre- and post-assessment data are listed below (Figure 1).

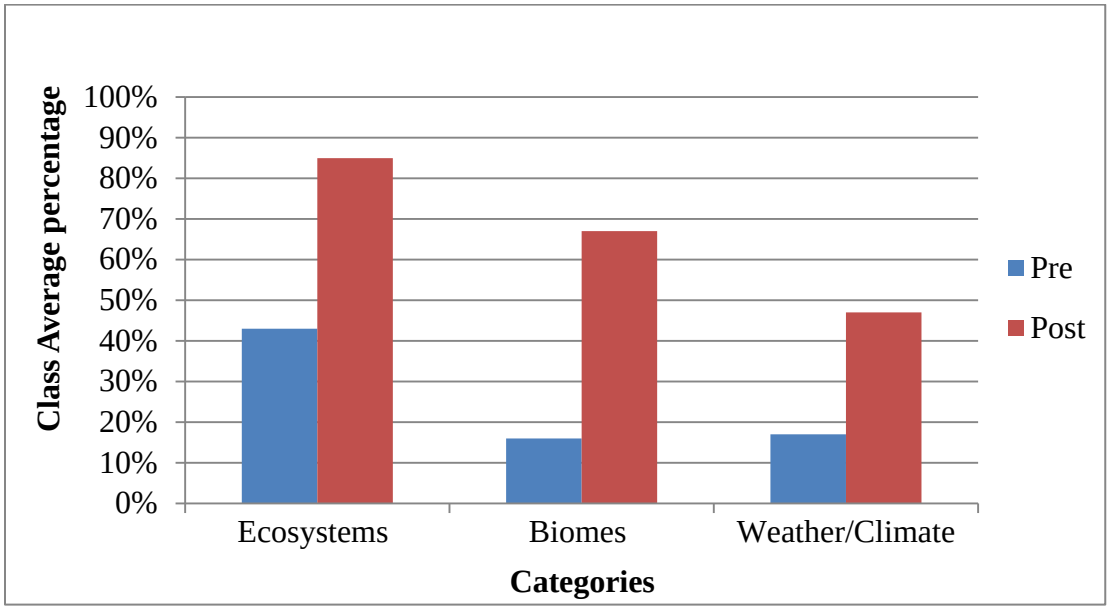

Figure 1. Comparison of pre- and post-assessment data, (*N*=60).

Each of the three probes was administered twice, before and after using PBE for each specific unit. The Wet Jeans probe showed 34% of the students had an understanding of the concept of evaporation on the pre assessment probe. Post probe

showed student understanding of this same concept at 91%. Over-all positive change in conceptual understanding was 57%. On the pre assessment probe one student remarked, "I know that when I help my mom hang up the laundry on the clothes line, the moisture in our clothes just disappears." On the post assessment this same student stated, "I know that after watching our tea pot get heated on the stove, that the water actually changes from a liquid to a gas, so that's what happens to the extra water in the jeans." The student's use of vocabulary in their explanation from pre to post assessment indicates a deeper understanding of the concept that was taught. Data gathered from the other assessment probes revealed similar trends (Figure 2).

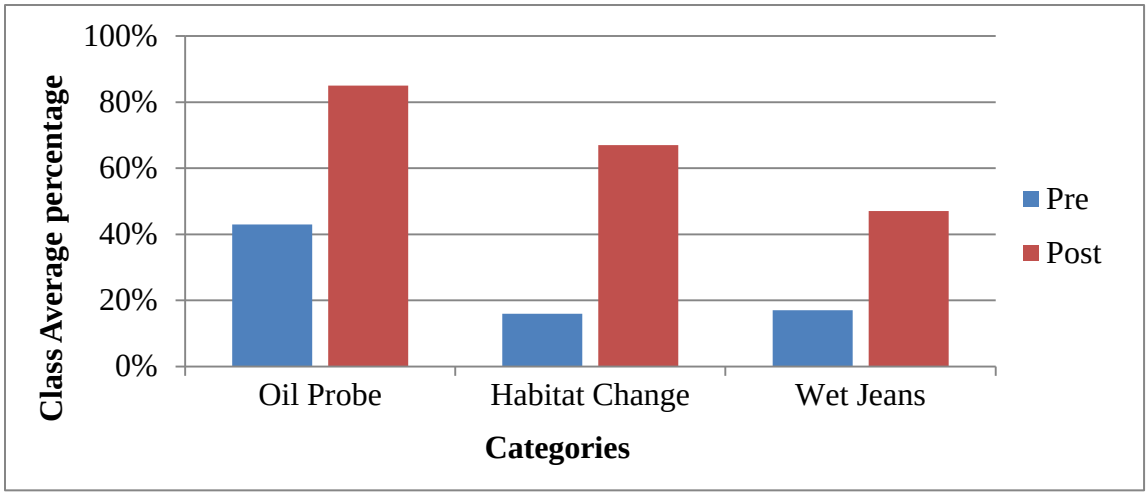

Figure 2. Formative assessment pre and post percentages, (*N*=60).

A secondary consideration for this project was, do PBE strategies improve students' attitude toward science? Data collected from modified version of the TOSRA Survey show positive change in attitude. The pre-survey average response score for all categories was 3.05 and the post-survey average response score was 3.48. The pre- and post- averages response scores indicated an overall positive change of 0.43 in students' attitude. The results reflected a noticeable change in four of the seven categories:

Normality of Scientists, Attitude to Scientific Inquiry, Career Interest in Science, and Enjoyment of Science Lessons (Figure 3).

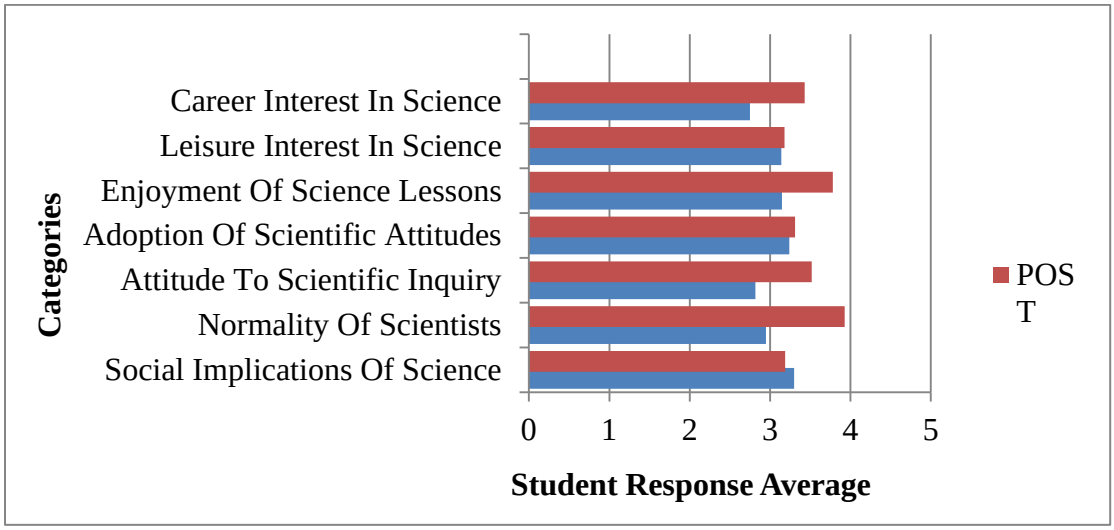

Figure 3. Percent of class average on pre- post TORSA survey, (*N*=60). Positive item responses were scored as 5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree. The scale was reversed for negative item responses.

Four of the seven categories showed an above average increase of 0.21 in response score. However, the Enjoyment of Science Lessons and Normality of Scientists posted students' highest positive movement with 0.63 and 0.98 compared to initial scores selected by students.

Prior to treatment 53% of the students responded that they had enjoyed science lessons in the past. One girl shared this response during a class discussion, "I don't like science because I don't understand what I read from the book." A comment made by this same student during a post treatment interview stated, "She had enjoyed doing the science units because the teacher took time to explain things and gave lots of good local examples, so it made it easier for her and the class to understand." This remark lends positive support to treatment increase in attitude. The following student comments

focused more on a career in science and view of scientist as a person. One class member shared this remark, “I think being a scientist would be boring because you would have to sit in a lab all day and try to find an answer to something.” Another student responded that, “I think it would be cool to be a scientist. I have a neighbor who’s a wildlife biologist and she isn’t in a lab all day.” Following the treatment 74% of students indicated that they might consider a career in science. This positive change is captured in this student’s comment, “Actually, I didn’t realize there were so many different jobs you could do in science. That changed my mind. I just thought scientists were weird guys that wore glasses and stayed inside all the time.”

Formal student interviews supported the TOSRA Survey data. Seventy-five percent of students interviewed considered science to be one of their favorite subjects in school. One student stated that, “I like exploring different topics and liked doing research.” A second student interviewed expressed how they liked all the cool science projects they had gotten to do, instead of just reading out of a textbook. One boy left the interview chanting, “Science is cool, science is awesome, science is cool.”

Data from the teacher observation journal showed students were less disruptive during class while using PBE methods. Entries also noted an increase in students spending more time after class to share their connections to their place with the teacher. Students recorded as negative in attitude prior to treatment, were witnessed as coming to class prepared and less difficult to engage on topic material presented. Students also were observed using science vocabulary on a more frequent basis when responding to teacher questions. Vocabulary included in student responses showed higher congruence to PBE lesson material taught than reading information from the science text. This is shown by

this recorded student comment, “Mrs. Weldon, please do we have to quit, I was just trying to figure out based on this animal’s habitat where it might be on the energy pyramid, please.”

A third consideration was, does incorporating PBE improve teacher attitude? Journal entries also reflected a positive change in teacher attitude while using PBE methods. The entries noted that there was less personal stress in dealing with behavior problems during the treatment period. In addition, comments reflect a large growth in role as a facilitator with students. This journal entry posted at the end of treatment period demonstrates that increase, “They get it! It’s not just this test, but they can actually explain it, give an example, and make that connection to the outside world. They wouldn’t get that just reading out of a science text.”

INTERPRETATION AND CONCLUSION

The results of my study show evidence supported by data, that using place-based instructional strategies does have a positive impact on students’ understanding and attitude in science. Comparison of pre- and post- assessment scores showed a considerable growth in overall class understanding. The three post-assessment probes demonstrated students’ ability to clearly explain their knowledge of scientific concepts taught, while using the appropriate vocabulary. I conclude that the implementation of PBE strategies enhanced my students’ ability in the follow areas: personal development, higher-order thinking, basic academic success skills, and discipline specific knowledge. A student comment during class discussion proved to be an outstanding example that showed growth in understanding perspectives and values different than their own. This is

what one female student had to say, “I know that when we talk about the issue of wolves, it impacts everyone in the Bitterroot Valley differently. It’s important for all of us to listen to each other and decide how to handle the problem.”

The use of PBE methods gave me an opportunity to share assessment results that I had collected during treatment. I explained how it had helped me to make adjustments and focus more accurately on concept of place. One benefit I found to using this technique was that all students saw their participation as valuable. The data materials gave students the opportunity to compare their thinking and reasoning with that of their classmates. By providing immediate feedback, I was able to show students how I valued their participation. I felt that the treatment went well and exposed me to how I could use the information to fit future lessons and unit objectives.

The data collected during the treatment period has made an impact on my daily instruction. I realize after using these instruments that I had made a lot of assumptions about what students know about science concepts. This treatment opportunity opened my eyes to seeing what possible misconceptions my students might hold and how I can use PBE methods to provide a clearer understanding of science concepts.

VALUE

Teaching science through place-based methods proved to be a priceless and rewarding experience for my students and me. My self-confidence and skill to implement place-based educational strategies has been improved as a result of this study. It has given me the opportunity to stand back and realize that I can make changes in my own classroom that not only benefit me, but my students.

Action research is a unique tool that I can easily use to help determine the effectiveness of my teaching practices. When I first began teaching, I set the goal to continually strive to be the best teacher that I could. Action research will support me in keeping that promise.

I realize the role of the teacher has changed considerably over the past 23 years I have being teaching, but the impact I have on my students has not. For example, I assumed that my students had a strong understanding of the place where they lived. The data I collected from my research revealed my assumption was incorrect. I saw that I needed to take a brief detour away from my lessons plans in order to provide a richer foundation for understanding. This modification allowed time for me to examine if my strategies had been effective and to make adjustments.

I believed self-reflection to be the most powerful part of my action research, that of taking the time to reflect on my teaching practices. By doing this, I made adjustments that helped my students gain a deeper knowledge and ownership of place. The research data collected showed that using PBE strategies did help increase students' understanding and attitude. Understanding of place helped students' make vital connections to the real world as shown by this student's comment, "It makes sense to me now why people in Montana are so worried about all the oil and gas drilling, after what happened last year in the Gulf of Mexico with the oil spill." This comment reminds me to continue using teaching practices that provide students the opportunity to make personal connections, develop deeper understanding, and experience a more positive attitude toward learning.

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APPENDICES

APPENDIX A

INTERACTIONS WITH NATURE PRE-AND POST-ASSESSMENT

APPENDIX A

Systems and Interactions in Nature Pre- and Post-Assessment

Name_____ Date_____

There are 20 questions on this test. Thirteen of the questions are followed by four choices, labeled A-D. Read each question carefully. Decide which choice is the best answer. Mark your answer by circling one letter for each of these questions. Five of the questions are fill-in the blank and two are short response. Answer all 20 questions on this test. You may not know the answers to some of the questions, but do the best you can on each one.

1. Burning fossil fuels in cars and factories-
puts oxygen in the air
puts nitrogen in the air
upsets the balance of the nitrogen cycle
upsets the balance of the carbon dioxide-oxygen cycle

2._____ provides energy for plants to grow.
A. natural gas
B. sunlight
C. respiration
D. carbon dioxide

3. Which of the following human activities helps protect ecosystems?
A. using less water
B. using chemical fertilizers
C .strip mining
D. building shopping malls

4. In what process do bacteria and fungi break down a dead organism's tissues and use some of the organic carbon as food?
A. decay
B. photosynthesis
C. water cycle
D. carbon-dioxide-water cycle

5. The three R's of conserving resources are-
A. reduce, reuse, and remind
B. reward, reuse, and recycle
C .refuse, reduce, and release
D. reduce, reuse, and recycle

6. How can planting native plants help restore an ecosystem?
A. the plants provide food for people
B. the plants attract wildlife to the area
C. the plants add water to the habitat
D. the plants attract builders to the area

7. How are forest fires helpful in an ecosystem?
A. they speed up secondary succession
B. they draw nutrients from the soil
C. they destroy unwanted plants and animals
D. they add oxygen to the atmosphere

8. The taiga has-
A. grasses with long slender leaves
B. frozen soil with few plants
C. pine, fir, and spruce trees
D. oak, maple, and hickory trees

9. The floor of the rain forest has little plant life because-
A. the vines and ferns choke off the other plants
B. the rain forest gets too much sunlight
C. very little sunlight gets through the canopy
D. toads and salamanders eat plants on the forest floor

10. Permafrost is found in the ____ biome.
A. grassland C. taiga
B. tundra D. desert

11. Desert biomes have all of the following **except**-

A .hot and sunny days

B. usually cold night temperatures

C. very dry soil and air

D. animals active in the daytime

12. Evergreens are adapted to life in the taiga because they-

A. shed needles that form a thick mat on the forest floor

B. have a waxy covering over their needles

C. grow taller than most deciduous trees

D. have roots that spread out near surface

13. Freshwater ecosystems occur in-

A. swamps and marshes

B. oceans and seas

C. estuaries

D. the intertidal zone

14. Water comes in three states or phases in nature and they are _____, _____, and _____.

15. Low pressure is associated with what type of weather _____.

16. High pressure is associated with_____ weather.

17. _____ clouds mean dry, clear weather and are also called mares' tails.

18. _____ is static electricity caused by nature.

19. Explain the difference between weather and climate?

20. Explain the climate in your area and how is it different than the climate in North Carolina?

APPENDIX B

HABITAT CHANGE PROBE

Habitat Change

A small, short-furred, gray animal called a divo lives on an Island. This island is the only place on Earth where divos live. The island habitat is warm and provides plenty of divos' food _tree ants. The divos live high in the treetops, hidden from predators.

One year the habitat experienced a drastic change that lasted for most of the year. It became very cold and even snowed. All of the ants died. The trees lost their leaves, but plenty of seeds and dried leaves were on the ground.

Circle any of the things you think happened to the divos living on the island after their habitat changed.

A. The divos' fur grew longer and thicker.
B. The divos' switched to eating seeds.
C. The divos' dug holes to live under the leaves or beneath rocks.
D. The divos' hibernated through the cold period until the habitat was warm again.
E. The divos died.

Explain your thinking. How did you decide what effect the change in habitat

_____

_____

_____

_____

APPENDIX C

WET JEANS PROBE

Wet Jeans

Sam washed his favorite pair of jeans.

He hung the wet jeans on a clothesline outside.

An hour later the jeans were dry.

Circle the answer that best describes what happened to the water that was in the wet *jeans an hour later*.

A. It soaked into the ground.
B. It disappeared and no longer exists.
C. It is in the air in an invisible form.
D. It moved up to the clouds.
E. It chemically changed into a new substance.
F. It went up to the sun.
G. It broke down into atoms of hydrogen and oxygen.

Describe your thinking. Provide an explanation for your answer.

_____

_____

_____

_____

APPENDIX D

WHERE DOES OIL COME FROM?

Where Does Oil Come From?

Oil is an important energy resource used by humans. Several friends were arguing about where this energy resource came from. This is what they said:

Julie: "It came mostly from fossil remains of giant ferns and trees that lived millions of years ago."

Ross: "It came mostly from inside ancient rocks that melted inside the Earth millions of years ago."

Delores: "It came mostly from shallow ocean water that changed into oil after millions of years."

Eddie: "It came mostly from a gooey liquid that was inside ancient volcanoes millions of years ago."

Nathan: "It came mostly from the remains of dinosaurs that decayed millions of years ago."

Seth: "It came mostly from microscopic and other ocean organisms millions of years ago."

Justine: "It came mostly from ancient mud, sand, and soil that eventually turned to liquid inside the Earth millions of years ago."

Malia: "It came mostly from gasoline that was trapped inside the Earth's crust for millions of years."

Cecelia: "It came mostly from the rotting blubber of ancient whales that lived millions of years ago."

Circle the person you most agree with. Explain your thinking. Describe where you think oil came from and how it was formed.

_____

APPENDIX E

TEST OF SCIENCE RELATED ATTITUDE SURVEY

Appendix J

ENGLISH TOSRA2-pretest

What do YOU think about science?

This survey is completely confidential. Your participation is voluntary.

Gender: ___ Male ___ Female *Age*: _____ *Ethnicity*: __ African American, __ Asian, __ White, __ Hispanic or Latino, __ Native American, __ Pacific Islander, __ Other.

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree, Strongly Disagree with each statement by marking the best response.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	1	**Money spent on science is well worth spending.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	2	**Scientists usually like to go to their laboratories when they have a day off.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	3	**I would rather find out why something happens by doing an experiment than by being told how it works.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	4	**I find it boring to hear about new ideas.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	5	**Science lessons are fun.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	6	**I would like to belong to a science club.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	7	**I would dislike being a scientist.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	8	**Science is man's worst enemy.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	9	**Scientists are about as fit and healthy as other people.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	10	**Doing experiments does not help me learn as much as finding out information from instructors.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	11	**In science experiments, I like to use methods which I have not tried before.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	12	**I dislike science lessons.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	13	**I get bored watching science programs on TV.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	14	**I would like to work with people who make discoveries in science.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	15	**Public money spent on science in the last few years has been used wisely.**

Continued on back…

Ledbetter, C.E. & Nix, R.K. (2002). Adapted from
Fraser, B.J. (1981). *Test of Science Related Skills*. The Australian Council for Educational Research Limited: Hawthorn, Victoria.

ENGLISH TOSRA2-pretest

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	16	**Scientists do not have enough time to spend with their families.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	17	**I would rather do experiments than read about them.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	18	**I am unwilling to change my ideas even when evidence shows that my ideas are faulty.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	19	**School should have more science lessons each week.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	20	**I would like to be given a science book or a piece of scientific equipment as a present.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	21	**I would dislike a job in a science laboratory.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	22	**Scientific discoveries are doing more harm than good.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	23	**Scientists like sports as much as other people do.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	24	**I would rather agree with other people than do an experiment to find out the information for myself.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	25	**In science experiments, I report unexpected results as well as expected ones.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	26	**Science lessons bore me.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	27	**I dislike reading books about science in my leisure time.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	28	**Working in a science laboratory would be an interesting way to earn a living.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	29	**The government should spend more money on scientific research.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	30	**Scientists are less friendly than other people.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	31	**I would rather do my own experiments than find out information from instructors.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	32	**I dislike listening to other people's opinions.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	33	**Science is one of the most interesting school subjects.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	34	**I would like to do science experiments at home.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	35	**A career in science would be dull and boring.**

ENGLISH TOSRA2-posttest

What do YOU think about science?

This survey is completely confidential. Your participation is voluntary.

Gender: ___ Male ___ Female *Age*: _____ *Ethnicity*: __ African American, __ Asian, __ White, __ Hispanic or Latino, __ Native American, __ Pacific Islander, __ Other.

Please indicate whether you Strongly Agree, Agree, are Not Sure, Disagree, Strongly Disagree with each statement by marking the best response.

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	1	**Too many laboratories are being built at the expense of the rest of education.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	2	**A scientist can have a normal family life.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	3	**I would rather find out about things by asking an expert than by doing an experiment.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	4	**I enjoy reading about things which disagree with my previous ideas.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	5	**Science lessons are a waste of time.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	6	**Talking to friends about science outside of school would be boring.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	7	**I would like a career teaching science.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	8	**Science helps make life better.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	9	**Scientists do not care about their working conditions.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	10	**I would rather solve problems by doing an experiment than be told the answer.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	11	**I dislike repeating experiments to check that I got the same results.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	12	**I enjoy doing science lessons.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	13	**I would enjoy having a job in science during my school break.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	14	**A job as a scientist would be boring.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	15	**This country is spending too much money on science.**

Continued on back…

Ledbetter, C.E. & Nix, R.K. (2002). Adapted from
Fraser, B.J. (1981). *Test of Science Related Skills*. The Australian Council for Educational Research Limited: Hawthorn, Victoria.

ENGLISH TOSRA2- posttest

Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	16	**Scientists are just as interested in art and music as other people are.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	17	**It is better to ask teachers the answer than to find it out by doing experiments.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	18	**I am curious about the world in which we live.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	19	**The material covered in science lessons is uninteresting.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	20	**Listening to science reports on the radio is boring.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	21	**A job as a scientist would be interesting.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	22	**Science can help to make the world a better place in the future.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	23	**Few scientists are happily married.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	24	**I would rather do an experiment on a topic than read about it in science magazines.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	25	**Finding out about new things is unimportant.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	26	**I look forward to science lessons.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	27	**I enjoy visiting science museums during my leisure time.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	28	**I would dislike being a scientist because it requires too much education.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	29	**Money used on scientific projects is wasted.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	30	**If you met a scientist, he/she would look like anyone else you might meet.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	31	**It is better to be told scientific facts than to find them out from experiments.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	32	**I like to listen to people whose opinions are different from mine.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	33	**I would enjoy school more if there were no science lessons.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	34	**I dislike reading newspaper articles about science.**
Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree	35	**I would like a career as a scientist.**

Pre-Test

Scale Allocation and Scoring for Each Item

S Social Implications of Science	**N** Normality of Scientists	**I** Attitude to Scientific Inquiry	**A** Adoption of Scientific Attitudes	**E** Enjoyment of Science Lessons	**L** Leisure Interest in Science	**C** Career Interest in Science
01 (+)	02 (-)	03 (+)	04 (-)	05 (+)	06 (+)	07 (-)
08 (-)	09 (+)	10 (-)	11 (+)	12 (-)	13 (-)	14 (+)
15 (+)	16 (-)	17 (+)	18 (-)	19 (+)	20 (+)	21 (-)
22 (-)	23 (+)	24 (-)	25 (+)	26 (-)	27 (-)	28 (+)
29 (+)	30 (-)	31 (+)	32 (-)	33 (+)	34 (+)	35 (-)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (-), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively. Omitted or invalid responses are scored 3.

Post test

Scale Allocation and Scoring for Each Item

S Social Implications of Science	**N** Normality of Scientists	**I** Attitude to Scientific Inquiry	**A** Adoption of Scientific Attitudes	**E** Enjoyment of Science Lessons	**L** Leisure Interest in Science	**C** Career Interest in Science
01 (-)	02 (+)	03 (-)	04 (+)	05 (-)	06 (-)	07 (+)
08 (+)	09 (-)	10 (+)	11 (-)	12 (+)	13 (+)	14 (-)
15 (-)	16 (+)	17 (-)	18 (+)	19 (-)	20 (-)	21 (+)
22 (+)	23 (-)	24 (+)	25 (-)	26 (+)	27 (+)	28 (-)
29 (-)	30 (+)	31 (-)	32 (+)	33 (-)	34 (-)	35 (+)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (-), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively. Omitted or invalid responses are scored 3.

Adapted from: Fraser, B. J. (1981). *Test of Science Related Skills.* Australian Council for Educational Research. The Australian Council for Educational Research Limited: Hawthorn, Victoria.

APPENDIX F

STUDENT INTERVIEW QUESTIONS

Science Interview Questions

Name:_____ Date:_____

1. What is something you like about our science class? Why?

2. What is something you don't like about our science class? Why?

3. Did learning about the weather and climate of your area help you understand the weather and climate in other areas? Give me an example.

4. Did learning about the ecosystems and how to protect them, make you understand more about the ecosystem where you live? What is one specific thing you learned?

5. After studying biomes, what are some things you learned about the biome where you live as compared to the biome of someone who lives in Alaska?

6. If you could name one thing that we do in science class that helps you learn what would it be? What specifically about this helps you learn?

7. Is there anything else about science that you would like me to know at this time?