

THE IMPACTS OF PLACE BASED EDUCATION IN A MIDDLE SCHOOL
SCIENCE CLASSROOM

by

Cathleen Tinder

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 2018

© COPYRIGHT

by

Cathleen Tinder

2018

All Rights Reserved

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND	1
2. CONCEPTUAL FRAMEWORK.....	2
3. METHODOLOGY	7
4. DATA AND ANALYSIS	12
5. INTERPRETATION AND CONCLUSION	24
6. VALUE.....	27
REFERENCES CITED.....	29
APPENDICES	31
APPENDIX A Institutional Review Board Exemption	32
APPENDIX B Geology Unit Pre-and Post-Test.....	34
APPENDIX C Sample Inquiry Investigation	38
APPENDIX D Sample Field Investigation.....	40
APPENDIX E Self Evaluation Survey	42
APPENDIX F Interview Questions	45
APPENDIX G Field Study Reflection Questions.....	47

LIST OF TABLES

1. Data Triangulation Matrix	11
2. Normalized Gains on Place-Based Learning Questions	15
3. Normalized Gains on General Geology Questions	16
4. Comparison of Question Types on Pre-Post Test	17
5. Percent of Positive Result on Survey Questions	23

LIST OF FIGURES

1. Histogram Distribution of Pre/Post Unit Test Scores12

2. Box Plot Distribution of Student Scores13

3. Recognizing Geologic Change in the Local Environment14

4. Mean Scores on PBE Formative Assessments.....18

5. Mean Scores on Traditional Inquiry Assessments.....18

6. Understanding of Local Rocks.....19

7. Yes/No Interview Questions20

8. Environmental Stewardship Survey.....21

9. Extending Learning Outside of the Classroom.....22

ABSTRACT

Place-Based Education is grounded in teaching and learning in the immediate environment, fostering students' connection to place, creating vibrant partnerships between schools and communities. Lesson plans are focused on local topics, and learning is focused on the natural settings around the school or community. Place-Based Education seeks to remedy the consequences of students having less exposure to the natural world, due to digital screen time saturation. This is particularly relevant to science education, and to instilling a love of science and nature in children. This study was conducted on 33 sixth graders at Sea Crest School, an independent school in the San Francisco Bay Area. PBE-focused curriculum was implemented in partnership with the National Park Service, measuring whether PBE had more of an impact on (1) science comprehension, (2) curiosity about and connection to the local landscape, or (3) curiosity and interest in the subject matter. Quantitative measurements included a pre-and post-test and Likert survey, and weekly assessments during the six-week unit, which cycled equally between PBE and traditional inquiry. Qualitative measurements included student interviews, field investigation journals, and post field trip reflections. The results indicated that PBE had the greatest impact on science learning, with substantial positive gains in connection to environment/sense of stewardship, and curiosity and interest in subject matter.

INTRODUCTION AND BACKGROUND

One of the casualties in striving toward an ever more technological classroom, in an ever more technological world, is the loss of a sense of place—of being connected in a meaningful way to our environment and community, both to the natural world and an enduring cultural perspective. Place-based education (PBE) seeks to remedy this lack of connection by building community partnerships that enhance student learning and interest in science. It frames the curriculum using the local environment and culture and provides experiences where students have the opportunity to directly impact their community, aiming to make learning more personally meaningful and foster students' inherent interest in learning. Whether it is through service learning, partnering with local scientists, or experiencing science in the field, “place-based learning approaches seek to capitalize on the strong affinity people have for their communities to accomplish ecological and cultural literacy, as well as a range of conservation and community stewardship objectives” (Clark, p.18, 2008).

The students I currently teach live in the small coastal suburban town of Half Moon Bay, California. While outdoor experiences abound in this area, many students see more concrete than forest and do not readily connect science lessons to their own lives. These students spend an average of 21 hours a week after school in front of a screen—including both phone and computer time. They live one county away from Silicon Valley, the technology capital of the United States. Place-based learning may be an effective strategy to help these students retain what they have learned, engage meaningfully with their local community, and fuel their love of learning. This study

examined whether and to what degree each of the goals of Place-Based Education were met: Does place-based learning have more of an impact on science comprehension, curiosity about the environment and local surroundings, or interest in subject matter?

Sub-questions include:

- How does place-based learning impact science comprehension?
- How does place-based learning impact student interest and curiosity about their local environment?
- How does place-based learning impact student interest and perceived relevance in Earth Science?

CONCEPTUAL FRAMEWORK

Published research on place-based education examines the following theories and practices: the ubiquitous modern condition of disconnect with nature and community; how experiential, interdisciplinary learning can make an impact; and the efficacy of civic engagement in fostering a sense of place and/or stewardship. This theoretical knowledge has been tested through applied instructional and curriculum strategies such as teaching in outdoor spaces, framing curriculum around local issues, and partnering with scientists and organizations working within the community.

Theoretical Perspectives

Interest in PBE has grown in recent years as an antidote to lifestyles that are increasingly lived indoors and on computer screens. In *Place-based Education: Learning to Be Where We Are*, Gregory Smith describes the movement's ethos:

The primary value of place-based education lies in the way that it serves to strengthen children's connections to others and to the regions in which they live. It

enhances achievement, but, more important, it helps overcome the alienation and isolation of individuals that have become hallmarks of modernity. By reconnecting rather than separating children from the world, place-based education serves both individuals and communities; helping individuals to experience the value they hold for others and allowing communities to benefit from the commitment and contributions of their members (2002, p. 594).

An entire educational movement, called “Leave No Child Inside” aims to remedy the disconnect between children and the outdoors. Richard Louv, journalist and author of *Last Child in the Woods*, coined the phrase ‘Nature Deficit Disorder’ to describe both the causes and effects of children spending less time outside. Causes include parental concerns about keeping children safe, the loss of outdoor spaces to urban development, and kids choosing screen-based forms of recreation and communication (Louv, 2005). Proponents argue that the consequences of these realities range from children having less respect and appreciation for their immediate environment, to health problems including attention-deficit disorder and obesity. The consequences of students having less exposure to the natural world are particularly relevant to science education and to instilling a love of science and nature in children.

Key features of place-based education provide very specific remedies to these symptoms—it is grounded in teaching and learning in the immediate environment, fostering students’ connection to place, and creating vibrant partnerships between schools and communities. Lesson plans are focused on local issues and integrate the natural settings around the school or community. These elements of place-based learning are in direct contrast to what students experience in their daily lives in most traditional school settings and provide the basis for science education reform. Smith (2002) states:

In schools, especially after the early elementary grades, teachers direct children's attention away from their own circumstances and ways of knowing and toward knowledge from other places that has been developed by strangers they most likely will never meet. Learning becomes something gained through reading texts, listening to lectures, or viewing videos rather than through experiencing full-bodied encounters with the world (p. 585).

PBE helps students learn in a real-world context, and often incorporates multiple disciplines, such as science and math, social studies and language arts. Relevance of content may be responsible for much of the success in science skills development through PBE, as it acts as both a great anchor and motivator for learning. Student-centered, active learning is also common in place-based learning, where students develop skills in the field through inquiry and experiential engagement. “Students tend to take ownership of and are more engaged in a project when they are allowed to make key decisions” (Monk, 1991, p. 386). Service learning projects are common experiences, teaching students essential concepts while also imparting lessons of stewardship, providing opportunities to take action in their own backyards and communities.

Existing Place-based Education Research

In a survey of peer-reviewed studies on place-based education programs, the University of Colorado (2012) found overall higher test scores and increased academic performance (Lieberman & Hoody, 1998). They also saw improvements in overall GPA, better attendance rates, and fewer discipline problems. “[Students] are perceived by their teachers to exhibit increased pride in their accomplishments and greater engagement and enthusiasm for learning” (Duffin, 2004). Teacher interviews indicated that PBE programs require that students combine multiple disciplines, formulate and test

hypotheses, investigate issues, take responsibility for their own learning, reflect on what they learn, and connect their learning to their communities.

Monk (2014) studied at-risk high school students who were paired with environmental science mentors from a local university to conduct an environmental-based science project. Mentors also taught students about local environmental issues and future STEM career potentials, participated with students in environmental-themed field trips, and met at the university campus to plan student-driven projects. Results showed that all students successfully competed in the science fair, and twenty-three out of twenty-five graduated high school (92%)—a significantly higher rate of graduation than the local general population. Student surveys indicated an increased enjoyment and understanding of environmental science, field experiences, and learning new things with mentors.

Semken and Freeman (2008) performed research to observe how a sense of place can be utilized through the lens of a culturally and geographically relevant curriculum. They did a comparison study of twenty-seven university freshman in a Geoscience field course as the treatment group, compared to over seven hundred freshmen in a Geoscience lecture course. Place Attachment and Place Meaning Surveys were given as a pre- and post-self-evaluation of student's sense of connection to place. This data was compared to the traditional, lecture-based geoscience course, and showed significant gains in mean pre-to post-scores for the field course group.

In California's largest wetland restoration project, 1,500 low-income sixth through eighth graders and 33 teachers partnered with a watershed and wetland extension

program to help with wetland restoration. Through pre-and post-tests on knowledge and behavior, which measured attitude and behavior changes, students showed an increase in conceptual understanding of science content, more engagement, and more connection to community issues (Myers, 2012).

These studies consistently show that PBE can support students in making stronger connections to their local community, can be used effectively to develop curriculum tied to relevant content, and can turn students into “creators of knowledge rather than consumers of knowledge” (Smith, 2002, p. 594). Through partnerships, community resources, and projects, students increase their levels of engagement, improve conceptual learning of science concepts, and build strong connections between students and teachers, school and community. Active participation through service learning, student-mentor partnerships, and/or outdoor education experiences play a critical role in the positive experiences and outcomes in place-based learning. Together, these best practices combine to make powerful, meaningful learning experiences that extend beyond the walls of the classroom.

METHODOLOGY

The purpose of my study was to examine how PBE can impact student learning and interest in science as well as students' sense of connection with their environment. I was interested in exploring how to help students build stronger ties with their surroundings, as well as local scientists and STEM educators. In forging these connections by way of partnerships and learning in local contexts, my goal was to discover whether students receiving place-based education show greater benefits through

meeting content learning objectives, attitude and curiosity to learn the subject, or interest in the environment. Following this intervention, students were taught using traditional inquiry methods, including hands-on activities and projects. Multiple formative assessments were used during the six-week long unit to measure learning impacts with PBE inquiry methods vs. traditional inquiry. The first three weeks consisted of the PBE intervention, and the last three weeks consisted of tried and true inquiry activities. While the pre-and post-unit test questions focused on concepts, the majority of assessment questions simultaneously measured student ability to apply concepts, using higher order thinking skills that required students not just to recall knowledge, but to think like a geologist (Appendix A). Most questions involved essay or short answer responses, and no multiple choice questions were given. Assessment questions were intentionally set at a high level to measure students' ability to generalize their understanding of vocabulary and concepts. Montana State University's Institutional Review Board approved the research methodology for this project and compliance for working with human subjects was maintained (Appendix B).

Participants

Participants in this study consisted of 33 students in a sixth grade math and Earth science class at Sea Crest School, an independent school in the San Francisco Bay area. This population of students have strong problem-solving and collaboration skills, due to a school climate that values sense-making and in-depth interaction with material. They have access to redwood forests, wetlands, tide pools, and amazing state and national parks in the area, but relatively little exposure to them. The sixth grade class was made up

of 19 male students and 14 female students. The class was divided into two sections—one with 16 students, and one with 17 students. One class was made up of ten males and seven females, and the second class was made up of nine males and seven females. Our K-8 independent school is made up of 273 students; 21% receive financial tuition assistance and 26% self-identify as students of color.

Intervention

I tested the effectiveness of implementing a place-based curriculum and field experience for teaching geology concepts in my earth science classroom. In partnership with the National Park Service, students participated in activities learning about local California geology. The place-based curriculum, called *Rocks on the Move*, related plate tectonics and changes in rock to features found in the Marin Headlands, located just north of San Francisco. The curriculum is aligned with California Next Generation Science Standards for middle school earth science, and used an *Understanding by Design* framework. The essential question of the program was: How do I recognize geologic change in my environment? In addition to lesson content, the partnership included an educational visit to the classroom from park rangers, use of a traveling trunk of teacher and student materials for hands-on inquiry, and use of assessments that measure understanding through reflection essays and models based on evidence. The goals of the program are fourfold: that students enrich their understanding of a place through inquiry while experiencing the national parks as places for learning, develop a personal connection with their local national parks, gain first-hand experience with the results of plate tectonics and active geologic processes, and appreciate the Golden Gate Headlands

as an exemplar of plate tectonics theory. Students collaborated to choose what geologic formations they would investigate in the field and developed investigative questions. Some examples of formations that they could choose from included: pillow basalt arch, ancient beach, or ancient waterfall and river. They analyzed the geologic processes evidenced in the landscape, engaged in informed discussion of the possible future of the landscape, and considered how past and future climate change is a part of the landscape's story. The treatment lessons included the following components of PBE: learning in a local context, student voice and choice, active collaboration, inquiry connected to place, and focused reflection. In the second half of the unit, regular classroom instruction took place, such as traditional inquiry hands-on activities, reading from text, and a research project.

Data Collection

To collect quantitative data, a pre-and post-content unit test measured learning gains in subject matter (Appendix C). This assessment had five questions that targeted PBE instructional content, and five questions that targeted traditional inquiry content. Quantitative data was also collected from treatment and non-treatment formative assessments weekly to compare the effectiveness of each method. Pre- and post-treatment Likert student surveys had 18 questions, six that measured attitudes/ interest toward earth science, six that measured a sense of place, and five that measured understanding of content and its importance (Appendix E).

To gather qualitative data, all students were interviewed in small groups toward the end of the unit; interviews included questions about sense of place and stewardship,

engagement with the material, and the perceived importance of what they were learning (Appendix F). A field study investigation journal captured student work, such as questions, observations, and interpretations out in the field (Appendix D); a post-trip reflection collected student learning, curiosity, and attitudes about time spent in the field (Appendix G).

The variety of data collection tools used to answer the focus question and sub-questions are outlined in Table 1.

Table 1
Data Triangulation Matrix

Focus Question: Does place-based learning have more of an impact on science comprehension, curiosity about the environment and local surroundings, or attitude about/interest in subject matter?

Data Source	Subquestion 1: How does place-based learning impact science comprehension ?	Subquestion 2: How does place-based learning impact student interest and curiosity about their local environment?	Subquestion 3: How does place-based learning impact student interest and perceived relevance in Earth Science?
Pre-Test	X		
Likert Pre-Survey	X	X	X
Student Interviews	X	X	X
Formative Assessments	X		
Post-Test	X		
Likert Post-Survey	X	X	X
Field Study Reflection/ Investigation Journal	X	X	X

Timeline

Research began in mid-February 2018, and was completed in mid-April. The first three weeks of the unit were taught using place-based learning methods, and the last three weeks of the unit were taught using traditional methods. Surveys and pre-tests were given

before any instruction related to geoscience concepts that were covered in this unit. A field study reflection measured student learning following the investigations in the field. Graded assignments took place generally twice a week throughout the unit. Student interviews and a post unit survey took place at the end of the unit of study, along with the content post-test. Teacher reflection and journaling was done weekly, at the end of each week.

DATA AND ANALYSIS

Overall, students showed broad gains across nearly all metrics. Students showed a total average gain for all test questions at 72.6%, and a paired t-test of pre and post tests for all students indicated that this is a significant change ($p=0.00$) (Figure 1).

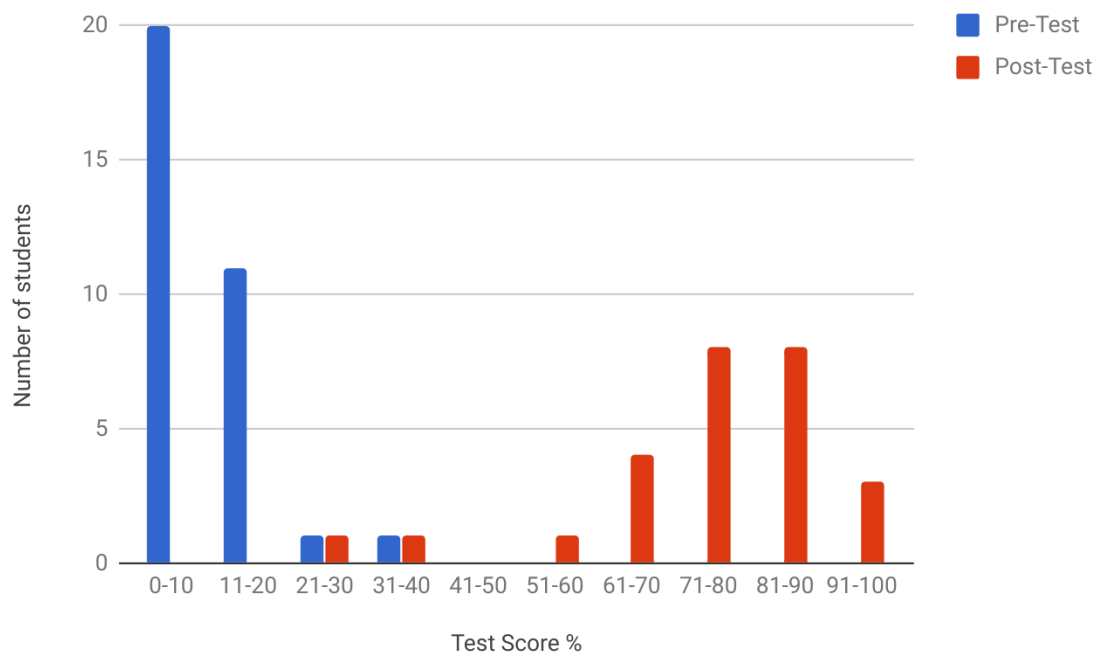


Figure 1. Distribution of pre-and post-test scores.

In a comparison of the distribution of scores from pre-test to post-test, student scores on the pre-test ranged from 0 to 35%, with the median score at 10%. Only six

percent of students scored above 20%. Scores on the post-test ranged from 30% to 100%. Just nine percent of students scored in the lower quartile range (30-55%), while 78% of students scored at least 88% (Figure 2).

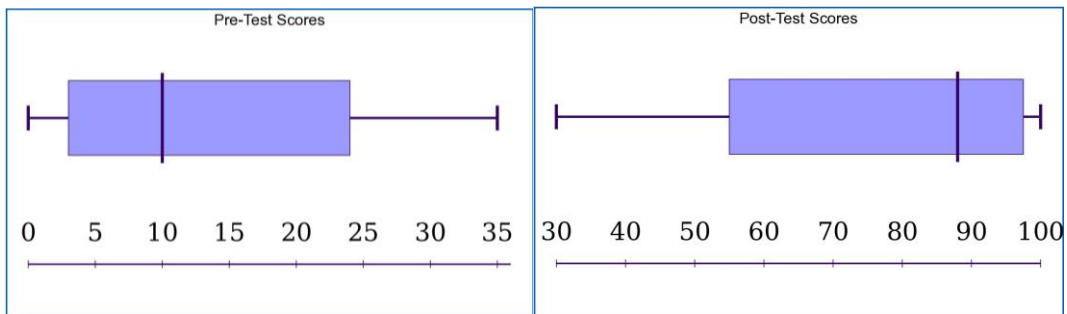


Figure 2. Box plot distribution of student scores (percentage) pre-and post.

Student Likert surveys pre-to post-unit support these findings (Appendix E).

When asked to agree or disagree with the statement *I can recognize geologic change in my environment*, 19 out of 33 students answered *strongly agree or somewhat agree* at the start of the unit, while 28 expressed agreement post unit (Figure 3). Chi square test comparing pre and post-test answers to this question finds that this represents a significant gain ($p=0.019$).

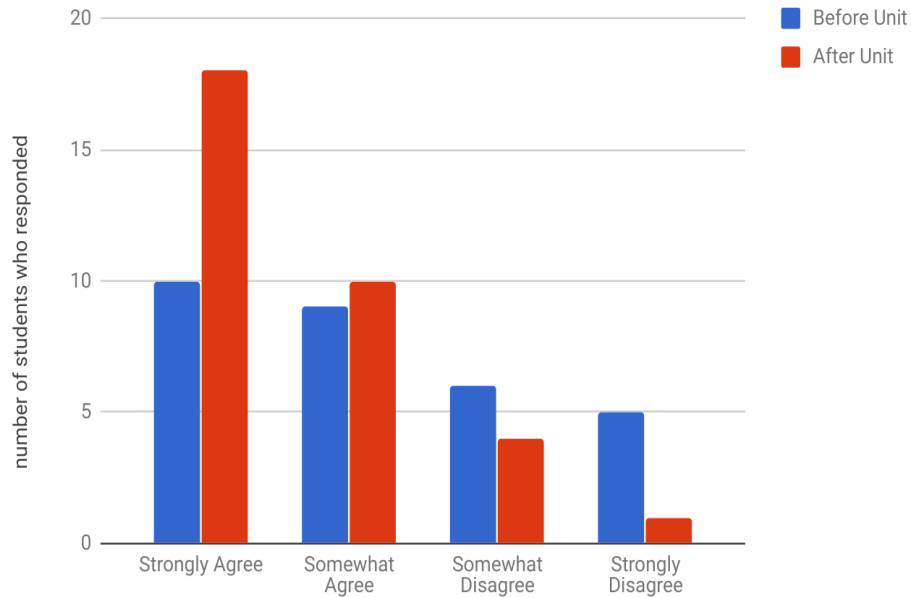


Figure 3. I can recognize Geologic change in my environment Likert survey.

In addition to the broad gains observed, focusing on the implementation of place-based education finds significant enhancements and even greater gains. The average normalized gain for meeting learning objectives on questions related to place was consistently high from .80 to .90 pre-to post-unit, whereas the average normalized gain for meeting learning objectives on questions taught using traditional methods showed an average gain from .52 to .73 in the medium to medium-high range (Tables 2 and 3).

Table 2
*Normalized Gains For Meeting Learning Objectives on Place Based
 Learning Questions from Pre-to-Post Test (N=33)*

Geology Unit Place-Based Test Question	Pre Average (%)	Post Average (%)	Average Gain	Degree of Gain
Identify at least 2 examples of geologic change in the Marin Headlands.	6	81.6	.80	High
Name a common Franciscan rock in the Golden Gate Headlands and describe how it was formed.	0	90.3	.90	High
What tectonic processes have shaped the Golden Gate Headlands landscape? Give 3 examples.	5.6	87.0	.86	High

Table 3
*Normalized Gains For Meeting Learning Objectives on Geology Questions
 Taught with Traditional Methods from Pre-to-Post Test (N=33)*

Geology Unit General Test Question	Pre-Average (%)	Post-Average (%)	Average Gain	Degree of Gain
Draw and label a graphic model to describe the cycling of Earth's tectonic plates and the flow of energy that drives this process.	8	70.9	.68	Medium-High
Define erosion. Give an example of how it contributed to the formation of the Grand Canyon.	1.6	53.2	.52	Medium
What data collected by geologists and paleontologists provides evidence for the past movement of plates? Give 3 examples.	3.2	74.1	.73	Medium-High

In a comparison of pre-test scores for place-based learning questions vs. pre-test scores for geology questions taught utilizing traditional methods, there was not a significant difference in prior knowledge; pre-treatment scores for PBE questions started with a total average of 3.8% correct responses, and non-PBE questions had a total average of 4.2% correct. Place-based test questions showed average gains of 85.3% whereas non-place-based questions had average gains of 64.3% (Table 4).

Table 4

Comparison of Question Types (PBE or Traditional) on Pre-and Post-Test

Question Number	Question Category (PBE/Traditional)	Pre-test Correct Answers	Post-test Correct Answers
1	Traditional	1	26
2	PBE	14	31
3	Traditional	1	21
4	Traditional	17	30
5	Traditional	1	27
6	PBE	1	29
7	PBE	0	32
8	PBE	0	33
9	PBE	0	29
10	Traditional	0	19

Formative assessments collected weekly during PBE and traditional inquiry teaching cycles support greater gains in learning through PBE (Figure 4). The mean score for all assignments during the PBE cycle was 92.66%; the mean score for traditional inquiry assignments was 80.62% (Figure 5).

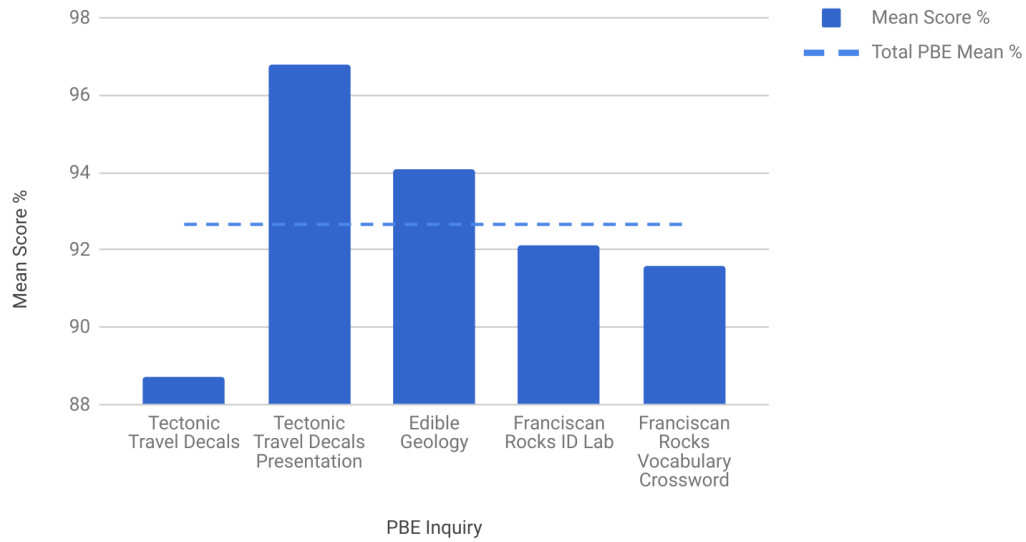


Figure 4. Mean scores on PBE formative assessments.

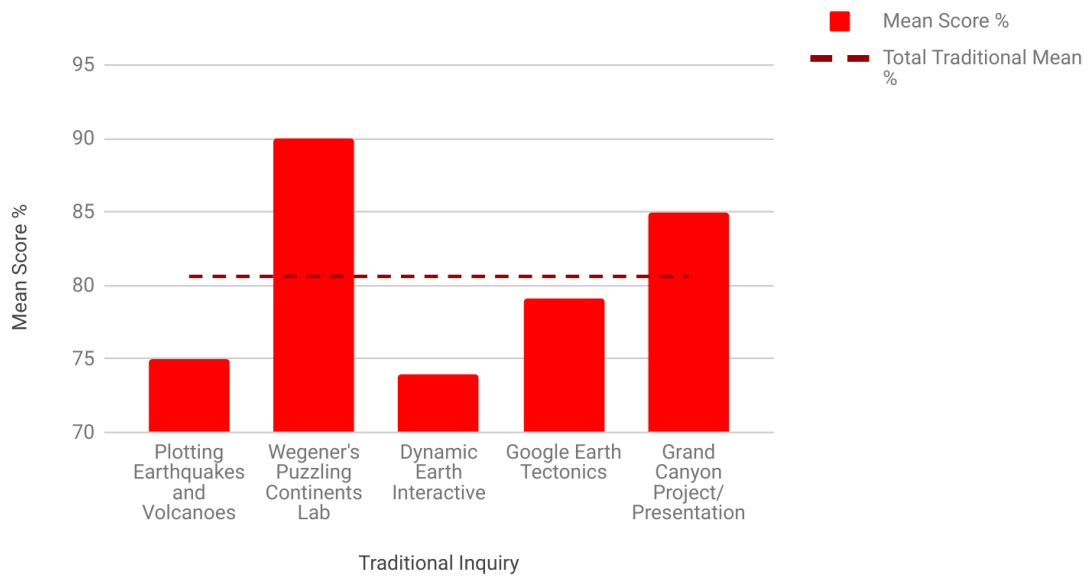


Figure 5. Mean scores on traditional inquiry formative assessments.

Student self-assessment Likert surveys also show that when place-based elements were involved, students showed the greatest increases in understanding. Students exhibited a significant increase in understanding local rock types and how they are formed (Figure 6).

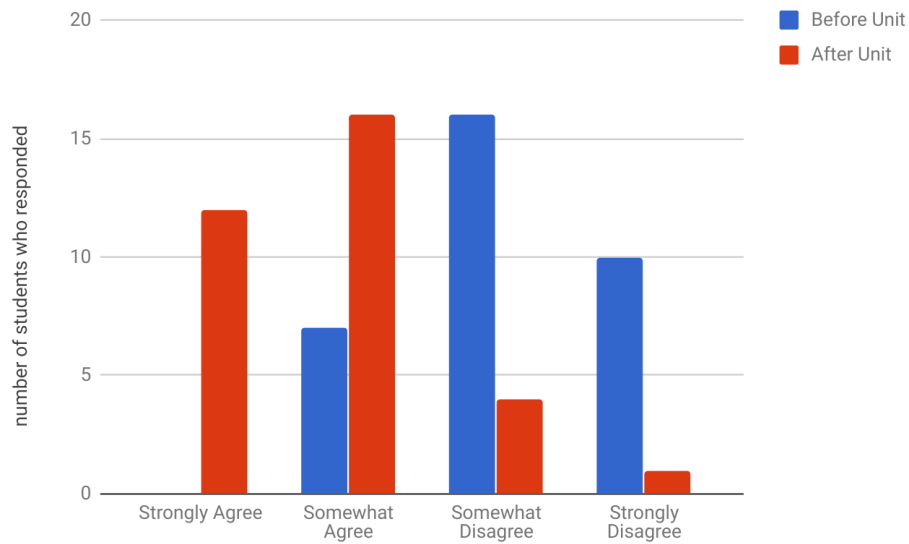


Figure 6. I have a good understanding of the types of rocks that make up my local landscape Likert student survey.

Prior to the start of the unit, 21% of students somewhat agreed with the statement: *I have a good understanding of the types of rocks that make up my local landscape.* A post-unit survey revealed that 84% of students either somewhat agreed or strongly agreed with the statement. A chi-square test confirmed the statistical significance of this change.

In field investigation journals, students were asked to make observations, interpret and think scientifically about how geologic processes had changed the place (Appendix D). They were then asked to provide evidence for their interpretations. One student answered: “Since California is a subduction zone, continental uplift gradually made the beach rise up, above the ocean. My evidence is there is lots of pillow basalt, a rock made from underwater volcano eruptions--something that happens at subduction zones.” During post field investigation reflections, students wrote about how their visit helped them understand earth science and geology. One student wrote, “we got to see changes

the tectonic plates have caused, and it was right in front of us. We got to understand how rocks actually look in the field.” Another stated, “it allowed me to understand how to identify fault lines. In the past, I thought that faults were always the same and always active, but now I know that even faults change.”

In measuring the impact on interest and curiosity about the local environment, students did show an increase; the data supports substantial gains in both interest and curiosity. Students answered a series of yes/no questions as part of an end of unit interview (Appendix E). When asked, “do you feel like you want to spend more time exploring natural areas?”, 75% of students answered *yes* and 21% answered *no*. 69% of students agreed that it made them want to learn more about local geology, and 66% said that they would want to go back again. 78% of students answered *yes* to the question “do you like learning about local geology and 18% answered *no* (Figure 6).

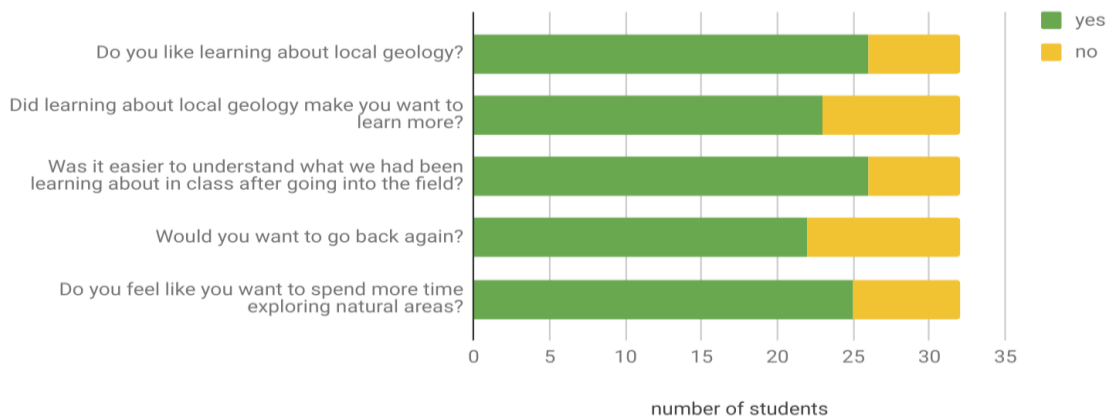


Figure 7. Yes/No interview questions on sub question 2: how does place-based learning impact student interest and curiosity about their local environment? ($N=33$).

Thirty-six percent of students *strongly agreed* with the statement: *It is important to me that I take action in some way to help my local environment* prior to the beginning of the geology unit. Post-unit, 72% of students answered *strongly agree* (Figure 8).

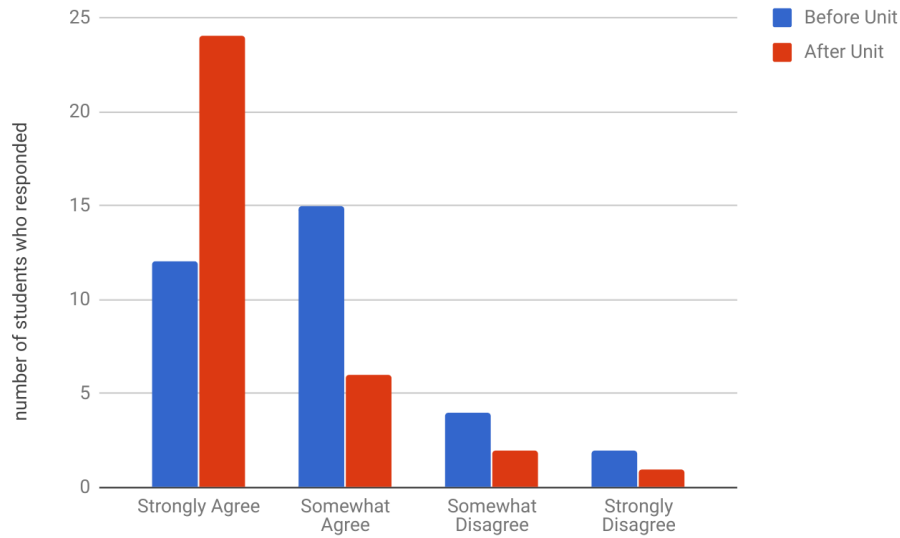


Figure 8. It is important to me that I take action in some way to help my local environment.

Students also showed an increase in noticing things they had learned about in class outside of school, with 81.8% of students either answering that they *strongly agree* or *somewhat agree* with that statement prior to the treatment, and increasing to 93.9% post treatment (Figure 9). Going out into the field only changed 12% of students' attitude about environmental stewardship when interviewed, with those students reporting that it was now more important to them to take care of their environment. No significant difference in sense of connection to community or environment was measured.

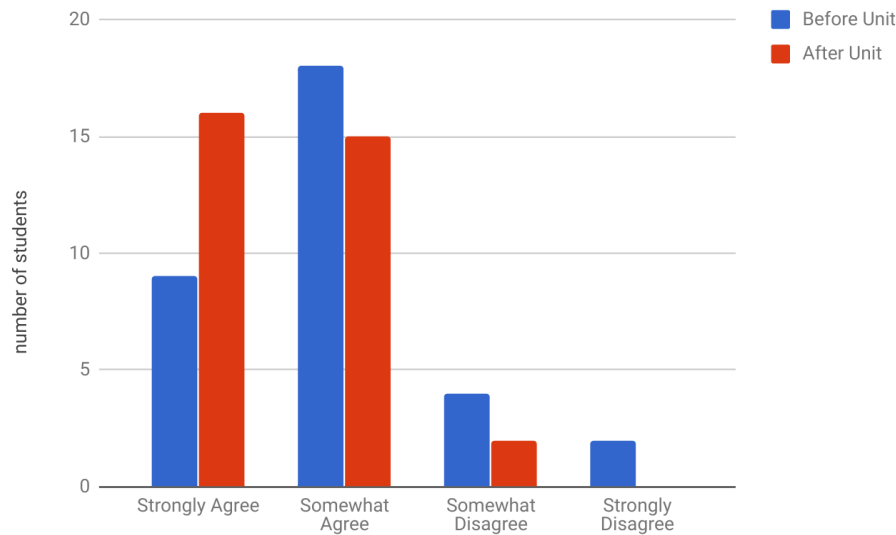


Figure 9. I have noticed things I have learned about in this class happening somewhere outside of school Likert student survey, ($N=33$).

When interviewed about the following questions, “Did learning about local geology make you want to learn more? What interested you the most?” 69.6% of students answered yes, and followed up with statements such as: “Serpentinite interested me the most because of how it is rare everywhere else.” “What interested me the most was learning how the coastal mountains formed”, “I feel that it was fun to learn about stuff that happened in my area”, and “what interested me the most was how things are always changing without us always realizing it.”

Sub-question 3 asked, “How does place-based learning impact student interest and perceived relevance in earth science?” Students demonstrated an increase in perceived relevance, interest, and positive attitude. In this comparison study, the gains in this area were the least significant measured in this study (Table 5).

Table 5
Percent of Positive Result on Likert Survey Questions

Survey Question Topic Category	Number of Positive Results Post Unit	Percentage of Positive Results Post Unit
Interest in Subject Matter	4/6	66.6%
Interest and Curiosity About Environment	5/6	83.3%
Science Comprehension	5/5	100%
Total All Questions	14/17	82.3%

In Likert survey questions related to interest and attitude, 60% of students responded before the unit that they *strongly or somewhat disagree* with the statement, “as a subject, earth sciences do not really relate to my life.” Post unit, 63% either *strongly or somewhat disagreed* with the same statement. To the statement, “earth science has nothing to do with local issues,” 75% of students answered that they *strongly or somewhat disagree* before intervention. Post intervention, 87% disagreed. When students were asked in interview sessions what they liked most about geology field studies, one student answered, “the thing I liked most was we got to explore outdoors”, another said, “what I liked most about the field studies was when we observed and interpreted the geological landmark we chose.”

In student field investigation journals, 78.7% of students generated geology-based investigable field questions that they would be interested in examining for further study that demonstrated an engaged curiosity and interest about the subject. Example questions included, “why does the pillow basalt weather and erode on one side of the trail, but not on the other?”, what will the effects on climate change be on the rocks in this area?, and

“what does a seafloor map of this area look like, and what other features form from a subduction zone?”

INTERPRETATION AND CONCLUSION

This comparison study supports that place-based education (PBE) boosted academic outcomes, impacted student’s sense of place and stewardship, and increased student engagement, with the strongest impact on student learning. The normalized gains in PBE assessment questions reflected high growth, while non PBE assessment questions demonstrated medium to medium-high gains despite an even foundation of prior knowledge on all geology content. In this six-week unit, PBE was introduced at the beginning of the unit, and the intervention was implemented during the first three weeks. Traditional methods took place during the last three weeks of the unit. This shows that PBE has the potential to make a strong, lasting impression on students, as they performed better on PBE-related content.

PBE had powerful impacts on addressing common misconceptions in geology, such as: changes in rock take place in human time frames rather than on geologic scales, that all rocks of a certain type always look the same, that minerals and rocks are the same, or that geology is not all that important to our lives. I noticed that students had a much easier time comprehending the active and dynamic processes of geology by studying it in the field, especially as they gained first-hand experience with making observations and interpretations of the results of these active processes. In post-field study reflections when asked “How did your visit to the park help you understand earth science and geology?”, one student answered, “It helped me to understand how we get

minerals from rocks and what San Francisco is built on.” Another student wrote, “It helped me understand by actively seeing examples in person, not on a screen.” Finally, another student said, “ It helped me understand what all the different rocks actually look like in real life, and also you could see how the tectonic plates are moving and forming Pt. Bonita.” In class and out in the field, students expressed understanding of how PBE lessons related to them. In a classroom lesson on the geologic effects of climate change, we looked at pictures of the Golden Gate Headlands from the past, present, and how it might look in the future. Students were actively engaged by the local connection, eagerly asking questions such as: “What do you think the Golden Gate bridge area will look like in the future?,” and “Why is there no bridge in this picture?” Students could see a tangible connection to what they were learning and with their lives and futures. This has tremendous implications for teaching practices, as it leverages the power of place to enhance critical 21st century learning skills, with the potential for students to become agents of change in their local environments and communities.

For sense of place, Likert survey questions elicited student interest and curiosity about the environment and local surroundings. The questions also qualitatively measured a sense of stewardship, of having the desire to care about, and feel a responsibility towards one’s surrounding environment. Students expressed a high sense of stewardship from the outset when asked the importance of taking action in some way to help their local environment, such that growth in this measure was small. Perhaps this is due to our location in the Bay Area, a place well known for having a strong environmental ethos. In our group interview sessions, I asked students the following questions: “How important

to you is taking care of our environment? Did going out into the field change your opinion?" One student responded, "I think it's very important to take care of our environment because if we don't take care of our surroundings, it can harm all kinds of life and animals, which also affects us." Another student mentioned, "I knew before not to litter, but when we went out in the field, it strengthened my opinion that we should keep our world clean." Another comment from a student was, "it really opened my eyes to see what cool stuff was around me and now I think we really have to conserve it." I was surprised and pleased to see an increase in students noticing things they have learned about in class happening somewhere outside of school, with many students moving from *somewhat agree to strongly agree* on the Likert survey (Figure 8). This is a key indicator that students are extending their learning outside of the classroom and building on the relevance that is inherent in PBE instruction.

Results showed the smallest impact on student curiosity and interest in subject matter. While there were generally positive results in student self-evaluation on attitude and motivation, the gains were sometimes slight--with 60% of students agreeing that earth science relates to their life pre-intervention, to 63% post-intervention. In other cases, larger gains took place--with students moving from 45% disagreeing that earth science has nothing to do with local issues to 87% disagreeing. Even a slight increase in interest can have the potential to have large impacts on learning. In the past while teaching this unit, I have taught about deep sea vents and underwater volcanoes and the life forms that live at these vents. While students have always expressed that they found the material interesting, these students were transfixed when they understood that it was

something that had happened in the place that we were going. I saw an immediate increase in their interest in what we were learning about that helped them also with comprehension of the material, as evidenced in test and survey scores.

Place-based learning has a direct, relatable, and compelling immediacy. There is something very powerful about opening student's eyes and enlarging their experience in a place that is close to them. Even if rocks aren't their favorite thing, following the unit they become more interested in the world around them. Place-based learning taps into their natural curiosity.

VALUE

One of the many benefits of PBE is the teacher is more of a partner than expert in learning with their students. With teacher as facilitator and not the expert, students are put into the role of scientist, which is very compatible with active learning methods of inquiry and project or problem-based learning. Students also liked having choice and generating their own investigative questions. Allowing students to develop their own questions gave students the opportunity to have ownership and to eagerly direct their own learning. Having students split up into groups based on their field research question also benefited instruction, as it allowed for more one-on-one interaction with the scientists.

Place-based learning generated fresh interest in a topic that I have taught for many years. It provided an adventurous means to learning as it provided access to nature and the outdoors. Learning in the field had a dynamic quality that is relevant and exciting. Teaching in partnership with scientists/park rangers was fun and interesting. Everyone's contributions built upon each other, and we enjoyed the satisfaction of partnership with

others who are passionate about the same things. I am interested in doing more PBE that involves connecting with local experts, raising awareness about issues in the local community, projects that involve service learning, and citizen science. From this experience, I've seen how PBE can help students gain a better appreciation of the world around them. I would like to challenge students even further, to see the world through economic, social, and environmental issues, such as climate change or energy resources, to provide interdisciplinary, experiential learning experiences that place them in the role of problem solver and agent of change. There are potent social-emotional benefits for middle schoolers to have that sense of agency in their local communities.

As a curriculum tool, PBE motivated me to keep seeking out relevant ways to approach content and practices. PBE is compatible with Next Generation Science Standards and could be extended beyond a unit or set of lessons to create storylines driven by student questions about place-based phenomenon, and culminating projects that inspire student learning with a local focus. Both San Francisco and Oakland Unified School District in the Bay Area are currently developing NGSS curriculum that integrates PBE. PBE has validated my ideas about teaching in a local context as being inherently meaningful, with powerful implications for learning; I am interested in continuing to find additional experiences to enhance students' sense of place, appreciation for the natural world, and to actively engage the community as classroom.

REFERENCES CITED

- Clark, D. (2008). Learning to Make Choices for the Future: Public Lands, Schools, and Communities Through Place-Based Learning and Civic Engagement. *USDA Forest Service*, 1-80.
- Duffin, M. (2004). Place-based Education Evaluation Collaborative: Report on Cross-Program Research and Other Program Evaluation Activities. [http://www.peecworks.org/PEEC/PEEC_ Reports](http://www.peecworks.org/PEEC/PEEC_Reports)
- Gruenewald, D. A., & Smith, G. A. (Eds.). (2008). Place-based education in the global age: Local diversity. New York: Lawrence Erlbaum.
- Huei, L. & Chang, C. (2016). Sense of Place and Science Achievement in the Place-Based Science Curriculum. *International Journal of Information and Education Technology*, 6(9).
- Liberman, G. & Hoody, L. (1998). Closing the Achievement Gap. *State Education and Environment Roundtable*, 18-20.
- Louv, Richard. (2005) *Last Child in the Woods: Saving our Children From Nature-Deficit Disorder*. Chapel Hill, NC: Algonquin Books of Chapel Hill, 2005.
- Monk, Melissa H. (2014). EnvironMentors: Mentoring At-Risk High School Students through University Partnerships. *International Journal of Environmental and Science Education*, 9(4). 385-397.
- Myers, M. (2012). A Student and Teacher Watershed and Wetland Education Program: Extension to Promote Community Social-Ecological Resilience. *Journal of Extension*, 50(4).
- Semkin S. & Freeman C. (2008). Sense of Place in the Practice and Assessment of Place-Based Science Teaching. *Wiley InterScience*, 1043-1053.
- Smith, G. (2002). Place-Based Education: Learning to be Where we are.. *Phi Delta Kappan*, 83(8). 584-594.
- Williams, F. (2018). *The Nature Fix: Why Nature Makes us Happier, Healthier, and More Creative*. New York, NY: W.W. Norton & Company.

APPENDICES

APPENDIX A
INSTITUTIONAL REVIEW BOARD EXEMPTION



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

960 Technology Blvd. Room 127
 c/o Microbiology & Immunology
 Montana State University
 Bozeman, MT 59718
 Telephone: 406-994-6783
 FAX: 406-994-4303
 E-mail: cherylj@montana.edu

Chair: Mark Quinn
 406-994-4707
 mquinn@montana.edu
Administrator:
 Cheryl Johnson
 406-994-4706
 cherylj@montana.edu

MEMORANDUM

TO: Cathleen Tinder and Eric Brunsell
FROM: Mark Quinn *Mark Quinn CJ*
 Chair, Institutional Review Board for the Protection of Human Subjects
DATE: November 14, 2017
RE: "Place-Based Learning in a Middle School Classroom" [CT111417-EX]

The above research, described in your submission of November 14, 2017, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

SAMPLE PRE AND POST CONTENT TEST

1. Draw and label a graphic model to describe the cycling of Earth's tectonic plates and the flow of energy that drives this process. Check your work: have you shown what causes plates to move? Have you included where this takes place in the Earth?

2. Complete each sentence about common rock characteristics using the word bank.

crystals veining vesicles glassy speckled layered

_____ describes the appearance of shiny obsidian or flinty chert.

The way rocks appear when they have distinct horizontal zones. _____

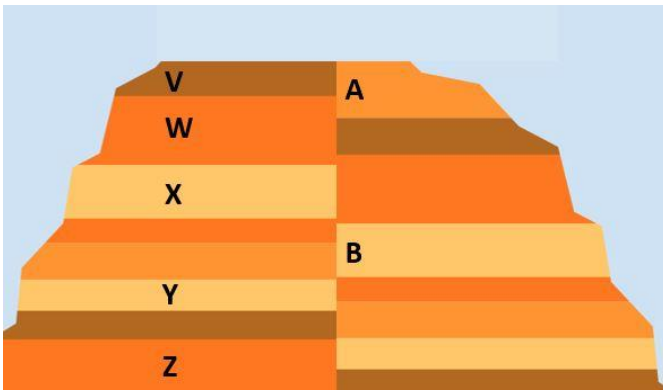
Diabase and granite appear _____ due to the different colored crystals found in these rocks.

_____ is observed in rocks as thin, white lines, or with fibrous appearance in serpentinite.

"Polka-dot" shapes found in some volcanic rocks. _____

_____ are three-dimensional mineral structures in rock; quartz and hornblende are examples found in granite. They can also exist outside of rocks.

3. How are rocks and minerals different? Provide a definition and example of each.



4. Part A:

Layer X and B are the same rock, however, there has been a vertical shift displacing the layers. Provide one explanation that could cause this vertical shift.

Part B:

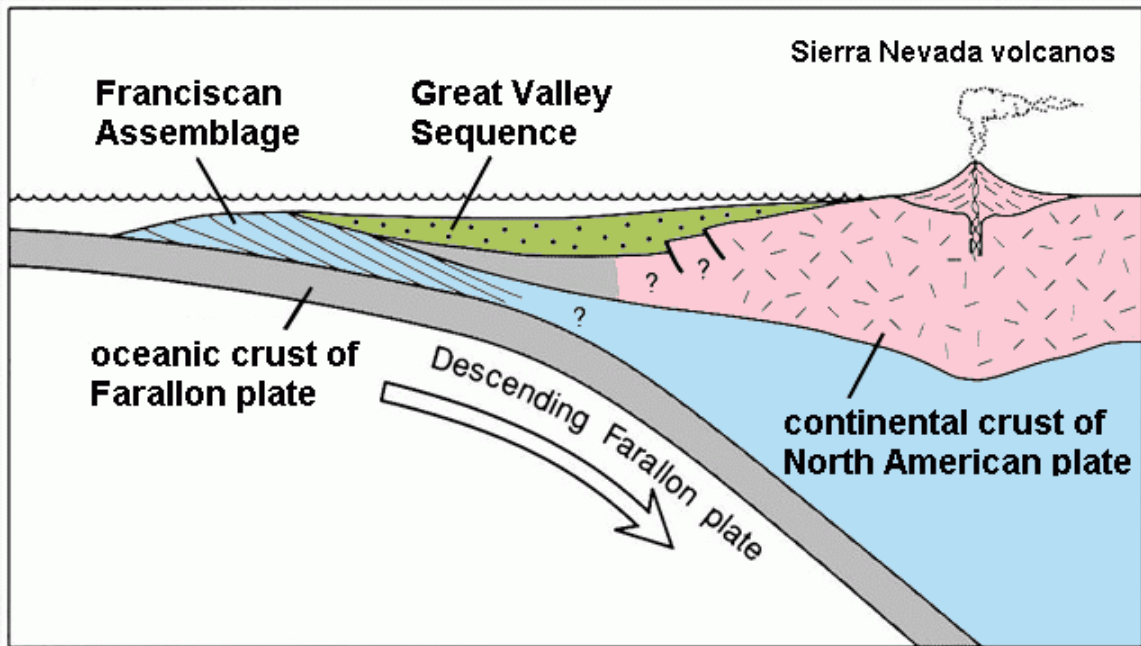
Sediment layer A is present on the right side, but not the left side of the vertical shift.

Name and briefly describe one process that could explain why layer A is missing on the left side.

5. What data collected by geologists and paleontologists provides evidence for past movement of plates? Give 3 examples.

6. Identify at least 2 examples of geologic change in the Marin Headlands.

7. Name a common Franciscan rock in the Golden Gate Headlands and how it was formed.



8. According to the diagram above, what tectonic processes have shaped the Golden Gate Headlands landscape? Give 3 examples.

9. What is taking place at the question marks in the above diagram? Use what you know about geologic/tectonic forces to interpret.

10. Define erosion. Describe how it contributed to the formation of the Grand Canyon.

APPENDIX C
SAMPLE INQUIRY INVESTIGATION

Students learn how a geologist accurately describes rocks, and how observation and description provide clues to the rock's origin and "life history". Have each student select a rock that interests him or her. Then, have them find the other students in the room who have the same rock. After they have found their rock group, the group comes up with a research question about their rock. Research should also include how and where their rock was formed, and how plate tectonics has affected it. After research is completed, students will report back to the class and present their answer to these questions:

1. What is the name of this rock?
2. What does it look like?
3. What is the classification of this rock?
4. Where is it formed?
5. What physical characteristics of this rock sample did you see that helped you identify it?
6. How did your research help you answer your inquiry question?

Questions for written student reflection:

1. What do the Franciscan Complex rocks reveal about the tectonic history of the San Francisco Bay Area?
2. Why are similar rock sequences (pillow basalt, radiolarian chert, greywacke sandstone, diabase) found in other places of the world?
3. Why is knowledge of local rocks useful?
4. How is knowledge of local tectonic history useful to communities?

APPENDIX D
SAMPLE FIELD INVESTIGATION

You can find many examples of geologic change along the trail. Some of the geologic processes that contribute to these changes include erosion, landslides, sea level changes, and tectonic plate movements. As you discover examples of geologic change and label them on the map, think about the following:

1. Where are the rocks weak? How do you know?
2. Where are the rocks strong? What is your evidence?
3. Can you predict the locations along the trail that will experience future landslides?
How?
4. Discuss with someone or sketch how you think climate change will impact this place in the future.
5. Identify rocks at your investigation site. Be ready to share your observations.
6. How have geologic processes changed this place?
7. What is your evidence?
8. Write a question you have about this place.

APPENDIX E

LIKERT SELF EVALUATION SURVEY QUESTIONS

Rated by students on a scale of:**(1) Strongly Disagree, (2) Somewhat Disagree, (3) Somewhat Agree, and (4)****Strongly Agree.**

1. Learning about the Earth Sciences will not help me understand any of the greatest challenges our present society faces.
2. Geologic forces may influence our global society, but are unlikely to directly affect my life or my family.
3. The Earth Sciences appear to consist of disconnected topics that do not relate to one another.
4. The Earth Sciences seem to be some of the more difficult sciences to understand.
5. As a subject, the Earth Sciences do not really relate to my life.
6. Earth Science has nothing to do with local issues.
7. I use information I learn about science to make decisions.
8. It is important to me that I do things to take care of my environment.
9. I feel a sense of responsibility and connection to my community.
10. I feel a sense of responsibility and connection to my environment.
11. I feel like I understand what Earth Sciences means.
12. I have noticed things I have learned about in this class happening somewhere outside of school.
13. I want to show someone else something we saw or talked about in the field.
14. I can recognize geologic change in my environment.

15. I have a good understanding of the types of rocks that make up my local landscape.
16. It is important to me that I take action in some way to help my local environment.
17. I know the agents of weathering that change local landscapes.
18. I know the names and physical characteristics of the primary rocks in the Franciscan Complex.

APPENDIX F
INTERVIEW QUESTIONS

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

1. What interests you in Earth Science?
2. What is enjoyable about this Science class?
3. How do you best like to learn--on your own or working with others?
4. Do you like learning about the geology of our local area? Why or why not?
5. Did learning about local geology make you want to learn more? What interests you most?
6. Did learning about local geology make you want to learn more about this area?
7. Was it easier to understand what we had been learning about in class after going into the field?
8. How confident are you that you understand concepts about plate tectonics, weathering and erosion, and how rocks change?
9. How do you recognize geologic change in your local environment? Can you give some examples?
10. Do you feel like you want to spend more time exploring natural areas?
11. What did you like most about our geology field studies? What did you like least?
12. Would you want to go back again?
13. How important to you is taking care of our environment? Did going out into the field change your opinion?

APPENDIX G
FIELD STUDY REFLECTION QUESTIONS

2. Describe a geologic process or an example of geologic change you investigated in the field.
3. How did your visit to the park help you understand earth science and geology?