STREAM ECOLOGY AS PLACE-BASED EDUCATION

by

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ABSTRACT

Much of modern-day education is not related the lives of students. Place-based education has been noted to increase academic performance, and students' connection to the place they live. This study used the local stream to investigate the impact of place-based education in an Earth and Space science class. Student summative assessment scores and Likert-style surveys were used in both treatment and non-treatment units to analyze academic growth, sense of place, and self-efficacy regarding scientific skills. A questionnaire was given at the end of the treatment unit and used to collect qualitative data to support the conclusions. Normalized gains and percentages of summative assessment scores identified student growth in all areas studied.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

Context of the Study

I teach at a Poynette High School, a small rural high school in south-central Wisconsin. This public school has 321 students and a teacher-student ratio of 12:1. This study was conducted in my Earth and space science class which consisted of 23 students. The graduation rate is 95%, the average ACT score is 25, and 24 % of the students are enrolled in AP level courses (Niche: Find the School That Fits You Best, n.d).

All the units in my Earth and space science class are phenomena-based storylines. Story lining in the science classroom involves a specific sequence of lessons that build upon the anchoring phenomenon, using student ideas and questions to drive instruction (What are Storylines, n.d.). This differs from the traditional way of science teaching because the unit begins with a scientific phenomenon that drives the entire unit. Many scientific concepts are built upon each other to provide students with a holistic understanding of the phenomena. Traditional methods of teaching science focus on one concept at a time and are often presented as a body of disconnected facts, rather than a whole story. Presenting the learning experience as a science story enables students to see the connection between what we are learning in class and real-world events. This enables a deeper academic experience. I have had great success with this methodology. However, I have noticed that students are often lacking enthusiasm for learning, which is vital for a rich academic experience. The current curriculum develops an understanding of how science works in the real world, but it is lacking a connection between what we are

learning and how it impacts our own community. There are various interconnected social and environmental justice issues all around us and making connections to our community is vital to understanding these problems and developing solutions. Currently, our natural habitats are being destroyed, we are amid major climate change, and species are going extinct at an alarming rate (*UN report: Nature's dangerous decline 'unprecedented'; species extinction rates 'accelerating' - United Nations Sustainable Development*).

When students can use science to investigate the environment around their home, these anthropogenic impacts are more relatable. To build a future generation that will be successful in making changes to promote environmental justice, which relates to social justice, it is critical to foster a sense of place in students. To deepen their community connections and increase academic enthusiasm, I have investigated the effects of place-based education (PBE) on students' connection to their community and academic growth. PBE has been effective at creating cultural and environmental awareness in students, bringing them closer to their community, and increasing student enthusiasm in the classroom. This connection ultimately increases student achievement and awareness of their community (Deringer, 2017).

Focus Question

The following question was addressed during this research, How does the integration of Place-Based Education affect student growth? For the purpose of this study growth is defined as an increase in academic scores, sense of place, and self-efficacy related to scientific skills.

CHAPTER TWO

CONCEPTUAL FRAMEWORK

Purpose of Place-Based Education

Traditional education is typically uniform globally and regionally, often not considering the cultural diversity, gender, and socioeconomic status of individuals. Curriculum and teachers are held responsible for student state testing scores, ultimately leading to teaching to the standardized test. This type of educational community is teacher centered and most often does not help students grow as learners (Jerald, 2006). Lessons are centered on teachers as the ultimate holders of knowledge, rather than firsthand experiences of the learner. Little opportunity is given to the students to investigate their own questions and learn about events that are relevant to their daily life (Green, 2008). PBE is an education framework that serves to connect students to their place using local resources as an extension of the classroom. This educational framework has the potential to build a new generation who has the ability and drive to restore and preserve their communities.

PBE has a long history but has recently come to the forefront of education to build curriculum that is contextual for each student regarding their community and the impact they can have on it. The school system was originally set up to support the American democracy, focusing on basic academics while also teaching morals and citizenship. To build a strong nation, with citizens who can protect their freedoms, public schools must also educate students in social issues while that require strong character and high morals (Kober, 2019). PBE serves to connect students to their place. This is accomplished by providing an opportunity to give our student

citizens the skill and knowledge to make differences in their communities and the lives of those around them. Contextualized experiences help students develop a sense of stewardship and connection to their local environment, as building deeper connections helps to build a community of engaged citizens. PBE is not a new idea, as prominent people in education, such as Freire and Dewey have long proposed the importance of forming a bridge between place and education as students learn better when faced with real world problems and experiences (Deringer, 2017).

An influential educational philosopher, Paulo Freire, advocated for education as a tool of emancipation enabling underserved students to gain equity as citizens (Freire, 1972). To do this education must go above and beyond the basic academic skills. All too often students are expected to memorize information, making them passive learners. This is not a valuable experience to our children because it is disconnected from real world experiences that are relevant to their lives, hence suppressing their creativity as learners. Freire's critical pedagogy focuses on enhancing the student-teacher dialog by creating a conversation between them. Using the local community and environment gives students the opportunity to bring what they know about their world to classroom discussions. John Dewey also addresses the impact of using the local environment as a tool for learning. Much of his work focused on education as an experience for students in which students should be immersed in purposeful learning (Dewey, 1938). Using the students' home environment is a powerful way to immerse them in this type of learning. When education and community are separated, we remove an integral piece to the learning journey that serves to build an empowered generation that can make a positive impact in our world (Nweke & Owoh, 2020).

Approach of Place-Based Education

The approach of place-based education differs from tradition education in both the role of the teacher and the value of the local environment. PBE uses the local community to enrich student education. This approach is cross curricular, including opportunities for students to delve into their local cultural and environment, solve problems that matter to them, and experience local internships (Deringer, 2017). PBE engages students in content, such as math, science, social studies, and art through the lens of contextualized learning that is set in the local community (Ngai & Koehn, 2010). The role of the teacher in PBE is shifted away from the holder of knowledge to a facilitator in student experiences that are grounded in the local environment and community. To teach PBE effectively, teachers must invest in getting to know their local community, history, and ecology. During PBE curriculum is integrated and the learner develops social awareness, which builds character development and civic citizenship (Tan & Atencio, 2016).

Student Impact

Place-based education contributes to the emergence of engaged civic citizens who are aware of social and environmental justice issues. Through PBE, students gain critical thinking skills built around local problems. This enables students to identify and solve issues that arise in their community. Through PBE, students also become aware of environmental issues that are impacting their community, such as clean water and air. Awareness that inequality is occurring in their community helps students work to make a better place environment by building awareness of cultural and economic diversity. As social justice issues are brought to light student

become aware that the amount of effort one puts into their life is not directly related to their success. Students learn through experience that some people and communities are set up to have disadvantages in the current social system. This motivates students to have a voice and becoming a pivot point in their local community. The combined knowledge of environmental and social justice issues involving their community helps future adults become responsible citizens (Deringer, 2017).

Often environmental and social justice issues are interconnected and PBE helps students to make these connections. For example, in a rural community the connection between watershed knowledge and awareness of human health issues were investigated through a place-based approach (Eppley, 2011). Students' initial knowledge of the watershed was used as a baseline upon which they built on throughout the unit. It was found that students' knowledge of the environmental impacts related to economics and leisure in their home greatly increased. Additionally, students' ability to be leaders also increased because they learned that they could have an impact in their community.

The implementation of PBE builds awareness and acceptance of diverse cultures. Students who participate in a PBE have been shown to gain cultural awareness regarding their local indigenous communities which can ultimately reduce negative stereotyping. During one study, students were immersed in primary education that interwove a variety of cultural and indigenous perspectives, and members of local tribes were brought to the classroom to share their worldview through stories songs and language (Ngai & Koehn, 2010). Teachers worked with indigenous leaders to integrate Native culture into the current curriculum. This integration

of place and content ultimately increased student acceptance of cultural differences between communities.

Contextualized learning experiences have been shown to increase student interest in STEM and the development of transferable skills. In PBE students often work in a group setting with a common goal. The skill gained here includes the ability to work collaboratively, which is an essential skill as an adult. Additionally, students learn critical communication skills. These skills include negotiation and the ability and confidence to be able to exchange information with other community groups and students become conscious of the world around them. Students who participate in PBE show a higher interest in STEM in comparison to those receiving a traditional form of education. The connection to their local community and environment increases the relevancy for students, developing their ability to have a voice and confidence to make a difference in the work around them (Holmes et al., 2021).

Limitations

There is an abundance of benefits delivered via PBE. However, the availability of time, and professional development are some of the existing limitations. Teachers must collaborate to with each other and with community members to develop strategies and curriculum. Students must be able to take field trips outside of the classroom to engage with local community members and investigate their local ecological systems (Althauser & Harter, 2016; Fuz, 2018). Teachers are pressed for time and are often required to teach specific standardized content. Therefore, setting the necessary time aside for PBE can be challenging. Additionally, teachers need to be set up for success when delivering PBE. Professional development opportunities would increase teachers' knowledge of the local community, content, pedagogy, and the ability

to address social justice issues (Iverson & Jónsdóttir, 2019). Teacher training programs typically fail to provide new teachers with the foundational resources to implement PBE. Institutions could provide the background to incorporate PBE, helping teachers develop a sense of place and inspiring them to provide students for what they need to become engaged civic representatives who can make a difference both locally and globally (Üztemur,& Dere, 2022).

CHAPTER THREE

METHODOLOGY

Demographics

Poynette High School is in rural Wisconsin, just northeast of Madison. There is a Class 1 trout stream running through the school property just behind the football field. There are Students here are required to take three science classes. Science 9 and biology are required credits. After those have been fulfilled students choose chemistry or Earth and space as the third mandatory science credit. The school runs on a semester block schedule. Students have four 87-minute classes per day each semester. I teach Science 9, Earth and space science, biology, and AP Biology. Poynette High School is a standards-based school. Students receive proficiency standards, based on skills, rather than traditional percentage grades. The standards range from beginning (BE), developing (DE), proficient (PR), and advanced (AD). The purpose behind standards-based grading in our school is to track student growth over time. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for work with human subjects was maintained (Appendix A).

Treatment

This study was designed to explore the impact of place-based education on student growth. Growth is defined as increases in self-efficacy regarding scientific skills, connection to the local environment, and summative assessment scores. PBE uses the students' local environment to engage them in the curriculum, while building knowledge of their local

environment. The traditional science curriculum in our school focuses on content typically found in a textbook with no connection to a student's personal life.

Students in Earth and space science received both the treatment and non-treatment units. The non-treatment group was focused on a unit based on the formation of the Universe. Here, the students used simulations, videos, and readings to investigate the question: How did the Universe begin? The assessment for this unit was based on the scientific argumentation skill of claim, evidence, and reasoning (CER). Here students make a claim that answers the science question, provide evidence, and use science concepts that make connections between their claim and evidence to justify their reasoning. The evidence in the non-treatment unit was gained through reading various scientific texts.

During the treatment unit students used the local trout stream as an outdoor classroom. The unit began with a slideshow presentation of Rowan creek that provides some background information, along with beautiful pictures. Next, students filled out an initial thinking sheet, which is designed to activate prior knowledge and have them make predictions, and we discussed our ideas as a class. We then collected water quality data to first answer the question: Is Rowan creek healthy? The reason I began with this question relates to scientific literacy. I did not want students to just believe me when I told them it was healthy. I wanted them to collect data to figure this out for themselves. We walked to the stream on several occasions to collect abiotic and biotic data. The biotic data included sampling for aquatic macroinvertebrates, which are used by freshwater ecologists to analyze water quality. Student groups used nets to collect the samples, identified the macroinvertebrates using a dichotomous key, then analyzed the data using a biotic index, which is a calculation to identify water quality based on the organisms present.

The abiotic data collected included dissolved oxygen, turbidity, pH, and temperature. Student groups combined their data and took averages for each variable. Scientific literature was used to identify the acceptable range for a cold-water stream. I had them use scientific resources such for this to encourage students to make independent conclusions, rather than relying on me to be the source of knowledge. After analyzing the data, students wrote a CER to answer the first guiding question.

To begin the second part of the unit, students were asked how they know if Rowan Creek is healthy? To answer this question students read about the connections between land and water, such as the impact of riparian habitat and forests. Student groups collected riparian data first, which included canopy cover, ground cover, and vegetation types growing along the stream. Students entered the data in Google Sheets and averaged the data. Rowan creek is also surrounded by a forest that is managed by the Wisconsin Department of Natural Resources to maintain the fishery. The health of the surrounding forest also impacts water quality, so students also took forest data. We walked to the forest and collected data on forest health, including regeneration, tree diversity, presence of snags and course woody debris, tree disease, and lichen abundance. Students entered and averaged group data to make a robust conclusion. Each student wrote a CER to answer the big question, then wrote a scientific paper that was modeled after a journal article with an introduction and background information, methods, results, and a conclusion.

The impact of place-based education on student growth was evaluated through several outlets. Students were given a CER as a summative assessment in the space unit (non-treatment) and the Rowan Creek unit (treatment). Percentages were taken and compared between the two

units. Two surveys were given both pre-treatment and post-treatment. The Self-efficacy Likert-style Survey was used to assess how confident students were in scientific skills, such as collecting and analyzing data. The Sense of Place Likert-style Survey was used to address the level of connectedness students felt to their environment. Examples of questions used in this survey include, I feel connected to the place I live, and I want to preserve the place I live for future generations. The End of Unit Questionnaire was given after the treatment unit and used as a qualitative method to support the findings from the quantitative data collected.

Data Collection Instruments

Student growth was defined as increases in self efficacy related to scientific skills, sense of place and academic scores between pre-treatment treatment units. To identify academic growth summative assessments were compared between the two groups (Appendix B). The non-treatment summative assessment, which was in a claim, evidence (CER), reasoning format, was given during the Big Bang unit. The treatment unit assessment was composed of two CER's, I took an average of the two scores Poynette High School is a standards-based school, so percentage grades are not given. The rubric used is scaled using scores ranging from advanced to beginning. To convert the standard to numerical data, I assigned numbers to each level. A four represented advanced, a three for proficient, a two for developing, and a one for beginning. Averages were taken for both units to identify growth in proficiency standards.

The Self-efficacy Survey was also used to identify growth in students' self-confidence related to scientific skills (Appendix C). This Likert-style survey was given both pre- and post-treatment, focusing on statement such as I feel comfortable collecting and analyzing data. Student responses were in a scale of A through E, with A being strongly agree and E being

strongly disagree. A Hake normalized gain was used to identify growth in sense of place. Normalized gains greater than 0.7 were considered high, gains 0.3 to 0.7 were considered a medium gain and normalized gains greater than 0.7 were considered high (Hake, 1998).

To analyze the impact of the treatment unit on the students' sense of place, the Sense of Place Pre- and Post-treatment Survey was given (Appendix D). In this Likert-style survey, students were asked a variety of questions related to their feelings of connectedness to their home. The survey consisted of 4 questions for which students could answer A) strongly agree, B) agree, C) neutral, D) disagree, E) strongly disagree. A Hake normalized gain was used to identify growth in sense of place.

Students participated in the End of Unit Questionnaire (Appendix E). The purpose of this was to uncover student perspectives regarding the place-based unit. It included questions such as "How did using the local creek affect your engagement in the unit," and "Do you feel more knowledgeable about Rowan Creek." This method was used to collect qualitative data regarding student perspectives on PBE which was used to support the quantitative data collected during the study.

Table 1. Data Triangulation Matrix

Research Question	Data Source # 1	Data Source # 2	Data Source # 3	Data Source # 4
How does PBE affect student growth?	Summative Assessment – CER	Self-efficacy Likert-style Survey	Sense of Place Likert-style Survey	End of Unit Questionnaire

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

Summative Assessment scores between the treatment and non-treatment groups were analyzed to identify academic growth in students. Poynette High School is a standards-based school. The rubric ranges from advanced (AD), proficient (PR), developing (DE), and beginning (BE). On average students experienced an increase of one proficiency level. Numeric scores were assigned for each rubric level. BE scores received a one, DE a two, PR a three, and AD scores were assigned a four. The average score in the non-treatment unit was 2.26, which is considered a DE. The average score in the treatment unit was 3, which is a PR. Additionally, there was a shift away from BE scores towards AD scores. AD scores moved from 17% in the non-treatment unit to 39% in the treatment unit, while BE scores moved from 35% in the non-treatment unit to 9% in the treatment unit (Table 2).

Table 2. Percentage comparisons between the pre-treatment and treatment Summative Assessment CER scores, (*N*=25). *Note.* (AD=advanced, PR = proficient, DE = developing, BE = beginning).

Proficiency Score	Non-treatment	Treatment
AD	17%	39%
PR	26%	26%
DE	22%	26%
BE	35%	9%

In the Summative Assessment CER for the non-treatment unit one student claimed, “The Universe began with a small ball of matter that expanded slowly, as it was creating more light, redshift, and sound in the Universe.” For the evidence they stated, “Scientists have created a telescope that can see far into space, which helps them create theories and predictions.” This claim is good, but the evidence the student is using id not related to what we discussed during class. We looked at redshift galaxies, cosmic microwave background radiation and the percent composition of matter in the Universe, which they discussed in the claim. The reasoning stated, “The Universe began with a small ball of matter that expanded slowly, as it created more light, redshift, and sound in the Universe. One way scientists have come to this conclusion is, that they have a telescope that allows them to see far into space which helps them a lot with observations and conclusions. This shows that scientists have found a way to deceive information on stars and planets. In conclusion, the Universe started off as a small ball of matter, then slowly expanded to be what we now know as the universe.” They mentioned the evidence but provided no explanation of how it supports the claim. On this assessment the student earned a BE.

In the Summative Assessment CER for the Rowan Creek treatment unit the same student claimed that the stream was healthy because the land around it was healthy. This student used a table to provide evidence for their claim and backed it up with a solid reasoning piece. The evidence included data on canopy cover, and percent and types of ground cover. In the reasoning they discussed how a riparian area increases stream integrity. He stated, “The riparian shows that we have a healthy strip of land surrounding the stream by reducing erosion and regulating the flow of the water stream. Riparian vegetation contributes shade, food, and shelter for aquatic organisms. The riparian zone is also home to many animals that move between land and water,

such as insects, amphibians, and waterfowl. We looked at the area covered and we found that the majority of the canopy covered the creek and kept the water cool, and provides food for aquatic organisms in the stream by dropping leaf litter into the stream. We collected data and totaled points and from the data, we can see that we have a healthy and good amount of riparian habitat." Here, the student earned an AD because they explained how each piece of evidence they used supported the claim.

A normalized gain was used to evaluate growth of self-efficacy in science related skills (Hake, 1998). The normalized gain for the Self-efficacy Survey demonstrates a medium gain of 0.32 between the pre and post-treatment surveys (*N*=23) (Table 3).

Table 3. Self-efficacy in science related skills normalized gains, (*N*=23). Note: < .3= low gain; .3 -.7= medium gain; >.7= high gain, (Hake, 1998).

	Pre-treatment	Post-treatment	Gain
Strongly Agree	2.75	8.75	0.32
Agree	10.75	9.25	-0.08
Neutral	5.5	2.75	-0.18
Disagree	0	0	0
Strongly Disagree	0	0	0

On average 48% of students felt strongly about their self-efficacy in the post-treatment survey, while only 20% felt strongly in the pre-treatment survey (Figures 1 & 2). In the End of

Unit Questionnaire one student said, “I gained significant skills that I never knew I could have.”

Another said, “I feel good at collecting good quality data and talking about it now.”

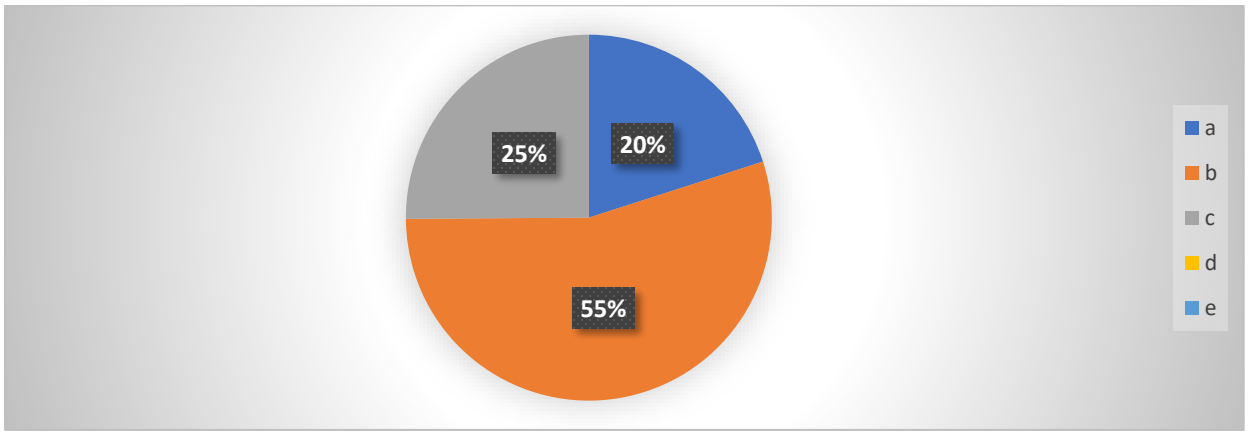

Figure 1. Self-efficacy Likert-style Survey pre-treatment, (*N*=23*). Note*. a=Strongly agree, b=Agree, c=Neutral, d=Disagree, e=Strongly disagree.

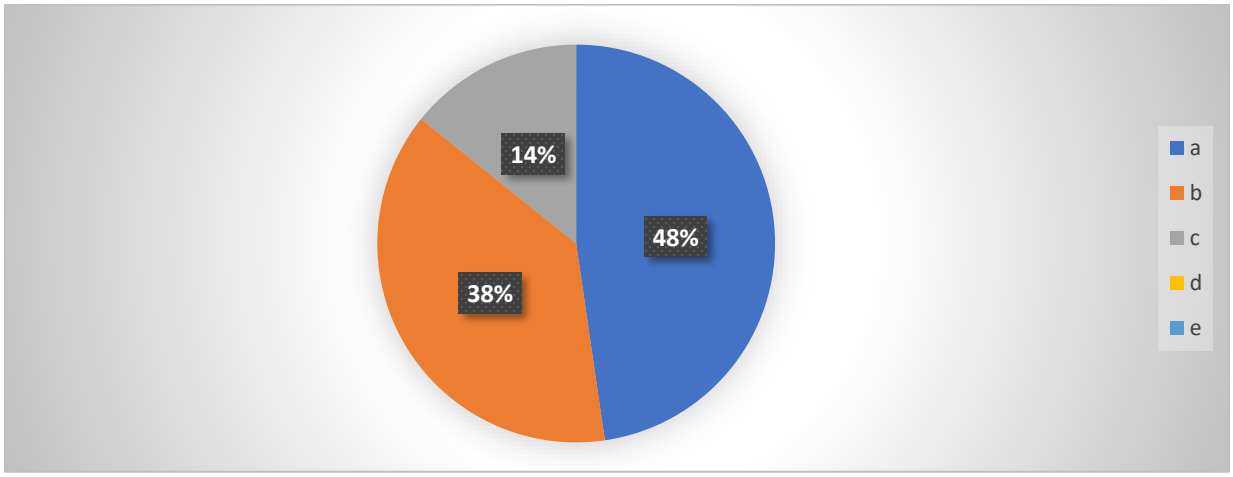

Figure 2. Self-efficacy Likert-style Survey post-treatment (*N*=21). *Note*. a=Strongly agree, b=Agree, c=Neutral, d=Disagree, e=Strongly disagree

A normalized gain was used to identify student growth in student's connection to their home environment. The normalized gain for the Sense of Place Likert-style Survey shows a low gain of 0.22 (*N*=21)(Table 4).

Table 4. Hake Normalized Gains show a low gain in the strongly agree category for Students sense of place, (*N*=21).

	Pre-treatment	Post-treatment	Hake
Strongly Agree	5.75	9.25	0.22
Agree	9.25	8.75	-0.04
Neutral	3.75	2.75	-0.06
Disagree	0.75	0.25	-0.02
Strongly Disagree	0.5	0	0

Likert-style Sense of Place surveys were given to students pre- and post-treatment. Averages were taken for each question on the survey. Then percentages in each category (strongly agree, agree, neutral, disagree, and strongly disagree) were compared between surveys. Twenty-five percent of students scored themselves in the strongly agree category, and fifteen percent scored themselves in the disagree category. In the post-treatment survey forty eight percent scored themselves in the strongly agree category and zero percent in the disagree category. Examples of questions in this survey are I feel connected to the place I live, and I want to preserve the place I live for future generations. In the End of the Unit Questionnaire one

student said, “I enjoyed this unit because it helped me to understand the impact I can have on our home environment."

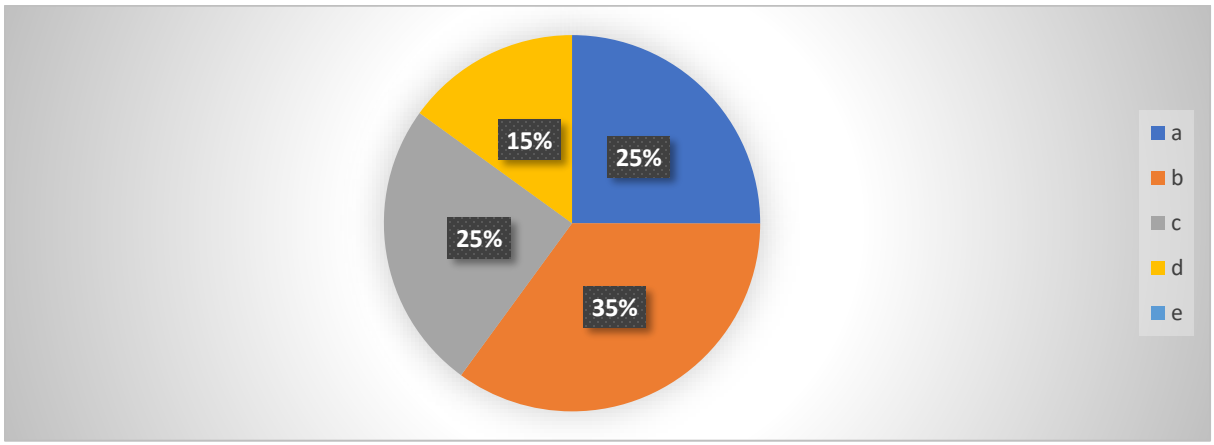

Figure 3. Sense of Place Likert-style Survey pre-treatment (*N*=21). *Note*. a=Strongly agree, b=Agree, d=Neutral, d=Disagree, e=Strongly disagree.

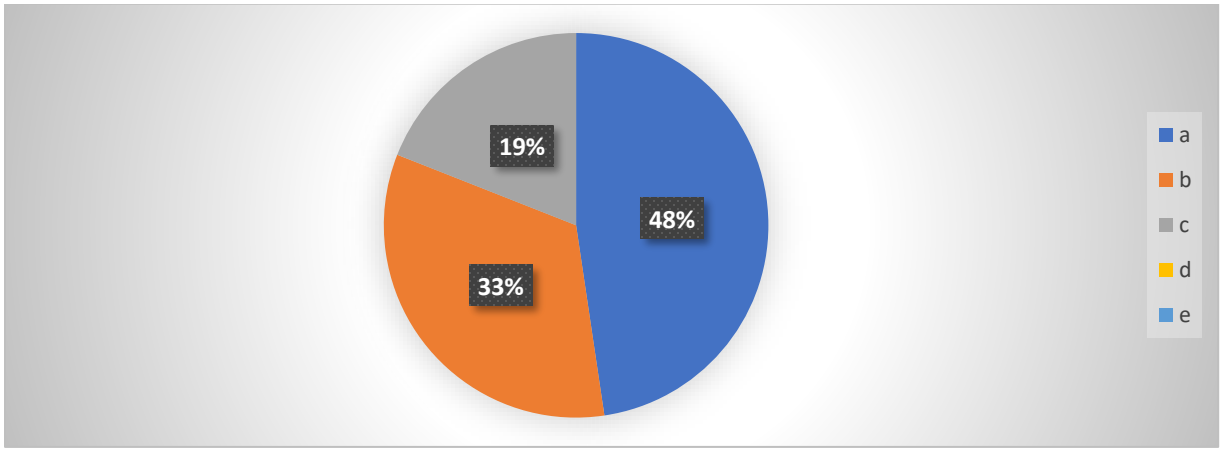

Figure 4. Sense of Place Likert-style Survey post-treatment (*N*=21). *Note.* a=Strongly agree, b=Agree, d=Neutral, d=Disagree, e=Strongly disagree.

CHAPTER FIVE

CLAIMS, EVIDENCE, AND REASONING

Claims From the Study

The purpose of this action research study was to identify the impact of place-based education (PBE) on student growth, defined as increased academic achievement, sense of place, and self-efficacy related to scientific skills. Three claims were able to be determined through analysis of the data:

1) Student academic achievement increased in the PBE unit

2) Students experienced an increased sense of place during the PBE unit

3) Student self-efficacy increased in the PBE unit.

The average score on the Summative Assessment CER increased by 0.74 on a four-point scale. The normalized gain for the Self-efficacy Survey was 0.32, reflecting a medium gain. The normalized gain for the Sense of Place Surveys were 0.22, reflecting a low gain (Hake, 1998). Comments in the End of Unit Questionnaire make connections between the claims and student attitudes towards place-based education. When asked how the Rowan Creek unit affected their academic engagement one student said, “It helped a lot, I have a connection to the creek and being able to learn in that environment was lovely.” Another said, “It felt more meaningful because I was looking at something close to home.” When asked if they feel more knowledgeable regarding the local environment one student said” Yes, I feel like I know how to take care of my environment now.” Another said “Yes! I now understand the connection between land and water and understand what makes our stream resilient.” The increase in student

self-efficacy is supported by student quotes as well. When asked if they felt like they gained scientific skills one student said “Yes I do. I feel like I learned more on how to gather a lot of good quality data. This is because we gathered so much, and I eventually got really good at it.” Another student said “Yes, I would not know how to collect and analyze data without this experience.” Through analysis of the student quotes, it is clear that the Rowan Creek unit had a positive impact on student growth.

A comparison of summative assessment scores (N=23) between the treatment and non-treatment units shows an increase in academic achievement. The biggest growth area was a shift away from BE scores towards AD scores. At Poynette High School, Earth and space science has a wide gap in student achievement. Students are required to take 3 science courses. Science 9 and biology are required courses. After those credits are filled, students choose from chemistry and Earth and space to complete their last required credit. Because of this, many students who are not academically confident in their science skills choose Earth and space. These students make up the predominant portion of the class. Then, there are the students who are excited about science and take it as an elective. The shift away from beginning scores and towards advanced scores in the Summative Assessment CER’s shows how PBE has positively impacted academic achievement. It is especially important to me to see growth in academic achievement in students who typically receive lower rubric scores. These are the students who grew the most throughout the Rowan Creek unit. I identified thirteen students who experienced an increase in summative assessment scores, three of whom increased by three proficiency levels. These students moved from a BE to an AD. Six students experienced an increase of two proficiency levels, and four increased by one level. Four students experienced no change and six students decreased in

proficiency scores. However, the jump was not as dramatic in the group who decreased. Two of these students decreased by two levels, and two decreased by one level. To calculate an average score, numbers were assigned to each level. BE was assigned 1, DE 2, PR 3, and AD 4. On average, students experienced an increase of 0.74 which is close to one proficiency level (Figure 1).

During the treatment unit I saw an increase in academic engagement in all students, but students who were typically disconnected from school had a greater increase in academic success. In the End of Unit Questionnaire student responses support my observations. Here, one student said, “This affected my engagement because it was something in my town and this made me care about it more.” Another student said, “I felt more interested in what we were learning because I could see the impact it had on my community and how it carried over to the real world.” Students clearly felt more connected to what they were learning in the PBE unit in comparison to the more traditional method conducted during the non-treatment unit.

Place-based education resulted in a stronger sense of place for students in Earth and space science. The pre-treatment Sense of Place Likert-style survey shows that 23.8% of students felt a strong sense of place, while the post-treatment survey shows 47.6% of students felt a strong sense of place (Figure 5). Interestingly, for the survey question, I want to preserve that place I live two students answered in the strongly disagree category in the pre-treatment survey. Zero students responded in the strongly disagree and disagree categories in the post-treatment survey. This demonstrates the impact PBE on students in Poynette. Students felt more connected and knowledgeable about Rowan Creek, which is a place most of them grew up with. In the End of Unit Questionnaire one student said, “This unit helped me because now I know why Rowan

Creek is healthy and I want to keep her that way." Another student said, "I know how to take care of my environment now." Educational research also shows that students develop a stronger connection to their local environment when participating in PBE. This stronger connection helps to build a new generation who is knowledgeable and able to make solid decisions regarding their own community. By building an awareness of environmental impacts and the inequality this creates, students become more driven to have a voice in their community (Deringer, 2017).

Values of the Study and Considerations for Further Research

This study was conducted during two different units. The non-treatment unit occurred during our space unit. Here students read articles about the beginning of the Universe and the evidence that supports the Big Bang theory. They participated in hands on labs and activities to demonstrate the supporting evidence. This culminated in reading a packet that lists all the evidence and how it supports the theory. The CER information was at their fingertips, they were allowed to use notes, and their scores were considerably lower. In contrast, during the Rowan Creek unit, students collected data and sorted through aquatic and terrestrial ecology readings to figure out what their data meant. The Rowan Creek unit was more involved and required many sources to complete the CER. This demonstrates how the students achieved high academic scores when they were able to conduct a study in their local community. Many of the students reported that they feel more connected to what they are researching and that enabled them to be interested in what they were learning. Rowan Creek is a place that most of the class grew up with. Throughout the unit I heard so many stories of their childhood when they would fish and play in the creek, some students even live on property in which the stream intertwines. I can see how the connection they already felt impacted their investment in the unit.

The clear impact of this study shows me how valuable PBE is for students. It connects them to their local environment, builds confidence in scientific skill, and increases academic achievement. This study has motivated to include PBE units in all my classes. I am currently designing two new units because of this study. In general biology, I am creating a unit that collects data to calculate the biodiversity of Rowan Creek. Here, students will identify and record plant and animal species within the creek alongside the adjacent forest. Class data will be combined, and students will calculate biodiversity. Additionally, in AP Biology, students will design a study identifying the impact of our local water treatment plant. I would like them to look at stream species composition upstream, at the point where the treated water enters the stream, and downstream to see if there is an impact on the aquatic ecosystem. I would also like the students to talk to people working at the water treatment plant to discuss the process of treating the water.

Impact of the Action Research on the Author

I have a strong background in ecology and feel that it's important for students to care about the place they live. When we care about a place, we tend to have an urge to protect it. This study has shown me that I can impact students' relationship with their local environment in a positive manner. Increases in sense of place and self-efficacy will help to build a future generation of voters who are knowledgeable and confident enough to speak out for what is right regarding their local environment. The health of our land and water is directly related to the health of our community. In the End of Unit Questionnaire, one student said, "I can now see that what we do to the land impacts our water." This statement had a profound effect on me. I can see that I have impacted the way students feel about caring for their local environment.

The overall feedback that was received through the End of the Unit Questionnaire was positive, students enjoyed the learning process, felt they gained skill, and are in favor of more place-based curriculum. In the End of the Unit Questionnaire, one student said, “It was great to get to go outside and do real world science.” Another said, “I want more place-based units because I learn better when doing the science because it allows me to understand it better. I knew what was happening and why.” Lastly, one student said, “I like place-based because what we are learning is relatable.” Creating PBE is time consuming, but the overall impact is priceless.

The process of this action research project inspired me to speak at the Wisconsin Society of Teachers Association. I couldn’t wait to talk to peers about what I had learned. My presentation went beautifully. I felt confident and excited regarding my research. The room was full, and there were a lot of questions, which created a lively discussion. After I spoke about the project and the impact it had on my students, we had time to brainstorm ideas involving the implementation of PBE in other classrooms. I made many contacts during this experience as well. One person I met invited my AP Biology class out to Upham Woods Learning Center to participate in an environmental DNA study next spring. I have grown significantly throughout my study, gaining confidence and expertise that I would not have otherwise had.

During this process I came across a meme by Mindful of Dreams (*n.d*) that resonated with me regarding my experience with the Montana State Science Education program (Figure 5). The idea behind this meme is that we should take care of ourselves like we would a plant. Among many worthy quotes, the text says to be patient with yourself good things take time. This is what needed to happen. The process is rigorous as there are so many revisions and expectations are high. I wanted everything to be perfect all at once, but that’s not how life works.

To have an outcome like I did in this program I had to be patient with myself. Additionally, the meme says to do what makes you bloom. That's what education does for me, both as a teacher and a student. Learning to do action research of this caliber has been invaluable to me. I now have the skill to conduct classroom research independently, which will serve me greatly throughout my career. Lastly, being a teacher is food for my soul. The weeks are long and overwhelmingly busy. Ultimately, the relationships I have with my students and the experience of watching them bloom throughout their high school experience is one of the most valued things in my life.

Figure 5. Treat Yourself Like a Plant (Mindful of Dreams *n.d.*).

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APPENDICES

APPENDIX A

IRB APPROVAL

Your protocol was reviewed by the IRB and has been approved.

PI: Schlobohm, Jennifer

Approval Date: 2/1/2023

Title: Place-based Education and Student Growth

Protocol #: 2023-513-EXEMPT

Review Type: Exempt Review

Expiration Date: 2/1/2028

APPENDIX B

SUMMATIVE ASSESSMENTS

Is Rowan Creek Healthy CER

1. Standard: Explains the structure and function of systems.

Advanced	*Proficient*	*Developing*	*Beginning*
Demonstrates a complex level of understanding of the relationship between systems.	Explains the relationship between parts within a system accurately.	Finds and identifies more complex parts and describes related functions.	Finds and identifies Developing parts and describes related functions.

Claim - One sentence answer to the question	
Evidence - Data that supports your claim	
Reasoning - Use scientific concepts to explain how your data supports your claim	

Why is Rowan Creek Healthy CER

1. Standard: Explains the structure and function of systems.

Advanced	*Proficient*	*Developing*	*Beginning*
Demonstrates a complex level of understanding of the relationship between systems.	Explains the relationship between parts within a system accurately.	Finds and identifies more complex parts and describes related functions.	Finds and identifies Developing parts and describes related functions.

Claim- One sentence answer to the question	
Evidence - Data that supports your claim	
Reasoning Use scientific concepts to explain how your data supports your claim	

How did the Universe begin CER?

1. Standard: Explains the structure and function of systems.

Advanced	***Proficient***	***Developing***	***Beginning***
Demonstrates a complex level of understanding of the relationship between systems.	Explains the relationship between parts within a system accurately.	Finds and identifies more complex parts and describes related functions.	Finds and identifies Developing parts and describes related functions.

Claim: • One sentence answer to the question	
Evidence: • scientific data that supports the claim	
Reasoning: • Paragraph form • Connect to each piece of evidence using scientific ideas that explain how the evidence supports the claim	

APPENDIX C

SELF-EFFICAY LIKERT-STYLE SURVEY

Student Survey
Earth and Space Science

Participation is anonymous, voluntary, and will not affect your grade, or standing in any way.

1. I feel confident and comfortable in my ability to make evidence-based conclusions.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

2. I feel confident and comfortable in my ability to collect data.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

3. I feel confident and comfortable in my ability to analyze data.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

4. I feel confident and comfortable in my ability to do background research on a particular area of science.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

APPENDIX D

SENSE OF PLACE LIKERT-STYLE SURVEY

Student Survey
Earth and Space Science

Participation is anonymous, voluntary, and will not affect your grade, or standing in any way.

1. I feel connected to the place I live.
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

2. I feel I have the knowledge to make sustainable decisions regarding the place I live in.
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

3. I want to take care of the place I live.
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

4. I want to preserve the place I live for future generations.
   a. Strongly Agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly Disagree

APPENDIX E

END OF UNIT INTERVIEW QUESTIONAIRE

End of Unit Questionnaire

Participation is anonymous, voluntary, and will not affect your grade, or standing in any way.

1. How did using the local creek affect your engagement in the unit?

2. What did you like most about the Rowan Creek unit? Why?

3. Which teaching method do you prefer, traditional or place-based?

4. Do you feel more knowledgeable regarding our local environment through the Rowan Creek unit? Explain.

5. Do you feel that you gained scientific skills, such as collecting and analyzing data, and communicating scientifically? Explain.

6. Do you feel like you were successful in the Rowan Creek unit? What do you think contributed to that success, or lack of success?

7. Would you like more science curriculum to be place-based? Why?