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The Impact of Climate Change Education in an Outdoor Classroom on Middle School Students' Attitudes and Understandings Towards Climate Change

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The Impact of Climate Change Education in an Outdoor Classroom on Middle School Students' Attitudes and Understandings Towards Climate Change

by

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DEDICATION

A special thank you to my partner, Sean, for his endless encouragement, patience, positivity, and support through this journey to completion. And to my family, whose value in education and support in my growth have gotten me this far.

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CHAPTER ONE

Overview

The purpose of this capstone project is to understand the impact that outdoor education has on climate change education. If students learn about and investigate climate change in their local outdoor environment, will they obtain a better understanding of it, and will they be more likely to change their behaviors to help mitigate climate change? I will do this by answering the following research question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?*

In Chapter 1, I will discuss how my experiences growing up in the outdoors, as well as my professional experience teaching outdoor education and as a classroom teacher led me to pursue this research question. I also will discuss the significance of climate change education and outdoor education to individual students and our society as a whole.

Personal Background

When I reflect on my childhood many of my most vivid memories happened outside. My neighborhood had many kids that were close in age, so it was not hard to find someone to play with outside. We spent countless hours riding bikes up and down the culs-de-sac, playing games in the backyards, hanging out on someone's playset, and playing outside in the winter. Despite living in a suburban neighborhood, we still were able to find the small areas of natural areas sprinkled throughout, such as the tiny plot of land next to the park with towering trees and giant boulders to climb on and leap between.

I was fortunate enough to gain access to more wild and scenic natural areas due to my family's interest in camping. This was a go-to summer activity that everyone enjoyed. By the time I was ten I had visited several of Minnesota's state parks. Each visit would include cooking over the fire, hiking, swimming, and an interpretive program put on by one of the park rangers. These were my first experiences in outdoor education. Even on a rainy day we could still learn about the park through the Junior Naturalist booklets that we would pick up at the park office and complete on our own to learn about the different biomes around the state.

I also attended summer camp for several years. Despite the fact that very little time was actually ever spent learning about nature, I still spent practically the entire camp outdoors, with our only time being inside to eat and sleep. Camp was designed to be a place to challenge yourself. I participated in activities like rock climbing, canoe overnights, horseback riding, and high ropes courses. Because of these positive challenges and all of my family experiences camping, I had a positive association with nature and the outdoors. I felt comfortable in nature, being outside made me feel good, and I wanted to protect those places so that I could continue to seek enjoyment from them.

Despite my love of being outdoors and in nature, I never really thought of it as science. I never considered science to be one of my interests or favorite subjects. The only days I remember ever going outside to learn science was our annual pond day in elementary school where we visited the school pond and looked for insects, and then once in 8th grade when we blasted off rockets. We did, however, in fifth grade have the opportunity to travel to the Audubon Center of the North Woods (ACNW) in Sandstone,

MN for a two-night, overnight field trip where we learned about ecology and participated in team building activities. I absolutely loved the trip and can still remember using the telemetry device to track students pretending to be wolves. This was one of my most memorable experiences from school, and one that we looked forward to in the years leading up to fifth grade. These experiences had such a profound impact on me that I later sought employment at ACNW.

It wasn't until college that I actually discovered an interest in science. I had originally started at the University of Minnesota with the intent to study business. To fulfill one of my science requirements, I enrolled in an environmental science class. For each of the labs we went outside to collect data. I enjoyed learning about nature in a more structured way, as I had never learned about nature in a formal education setting before. It was in this class that I realized that natural science even existed as a field of study. I would continue on to take several more environmental science classes before changing my major to Environmental Science, Policy, and Management where I would then continue to learn about the natural world in classes such as dendrology, mammalogy, ornithology, and ecology, with most classes having an outdoor component. I also learned about many issues impacting the environment, such as overexploitation, unsustainable farming practices, and had my first introduction to climate change, a topic that was never addressed in my schooling prior to college.

Professional Background

Upon graduation, I was hired as an environmental education intern for the ACNW, the same place I had attended as a student back in fifth grade. As an intern, I taught ecology, adventure, and cultural classes to the students who would come for

residential outdoor education experiences. Visiting schools came from all across the state, and had a wide range of varying exposure to environmental and outdoor education. There were many times that I took students into the woods for the first time in their lives. While I was there, we started to develop some curriculum that incorporated climate change. I taught a wind energy class where students used engineering practices to design and create a wind turbine. While students were engaged in this class, it was one of the few that we taught inside because of the need for electricity to test their wind turbines. We also had a green energy class that explored the different types of renewable energies, using the various renewable energies we had on site, such as geothermal, solar and wind power as visuals. These classes focused on energy sources and conservation. We did not delve into climate change and its effects on ecosystems in any of our ecology classes.

From there I continued on to River Bend Nature Center in Faribault, where all Faribault Public School students visited twice a year for day trips from kindergarten to 6th grade. These students had more exposure to environmental education than most of the students I worked with prior because of their repeated visits. Students had mostly positive experiences with the outdoors and learning through hands-on experiences, but we did not include topics about climate change in any of our class offerings. I ultimately decided that it was time to go back to school and complete my teaching license so I could build longer lasting relationships with students and have more control over their science experience and learning over the course of a full year, rather than just a brief visit.

After finishing my license in 5-8 General Science, I started my first teaching job teaching 7th grade life science at Robbinsdale Middle School. With a mid-year start in December, I did not begin the year with my students. They completed the ecosystem unit

in the fall, and I couldn't help but think of all the missed opportunities for them to learn about ecosystems in the area surrounding the school, which had not been part of the curriculum or their labs. Finally, at the end of the year I took my classes outside for two different labs. In one lab students designed and built a bird's nest that would meet criteria of ensuring the survival of offspring. Students were more engaged in this lab than I had ever seen in the classroom, including several students who tended to have rather low engagement. Students collaborated with each other and used their hands to create something. Students continued to talk about the experience for the next several days, and for the last 3 weeks of school they would ask daily if we were going outside again, a signal to me that it was a valuable, yet unique experience in their schooling.

Despite teaching life science, I did my best to sprinkle in some climate change education throughout topics, especially for the short time I was there during the end of the ecosystem unit. However, I recognized that it is an abstract concept for many 7th graders, and they struggle to see how climate change affects their daily lives without seeing the tangible. This realization is what led me to pursue the research question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* I suspect that if students were directly involved in gathering phenological data or weather data over time, a more vested interest in the subject.

Professional Significance

Climate change education and outdoor education both have benefits to the academic and social-emotional development of students (Meighan & Rubenstein, 2018;

Szczytko et al., 2018). Combining the two provides students with a place-based understanding of the impacts of climate change.

Importance of Climate Change Education

Meeting Next Generation Science Standards

Understanding climate change is one of the Disciplinary Core Ideas of the Next Generation Science Standards (NGSS), the newly adopted science standards in the state of Minnesota (Minnesota Department of Education, 2019). Starting during the 2024-25 academic school year, students in grade five will understand that if earth's global temperatures continue to increase, organisms will be affected. By grade eight, students will understand that human activities are a major contributor to climate change, and by grade twelve, students will be able to use models to understand the complex process occurring over time. Climate change education also meets the NGSS crosscutting concept of stability and change, cause and effect, and scale, proportion, and quantity (National Research Council [NRC], 2012).

Attitudes Toward Climate Change.

When students are exposed to climate change science and data, they are able to form their own opinions about the phenomenon. Knowledge about this topic leads to a higher quality of discussions in class, and inspires interest in other environmental issues (Monroe et al., 2019). One goal hopefully achieved by answering the research question, *How does teaching about climate change in an outdoor classroom impact students' attitudes and understandings toward climate change?,* would be to determine if increased exposure to an outdoor environment results in increased pro-environmental behaviors. These pro-environmental behaviors may include but are not limited to waste reduction,

energy conservation, and reduced littering. As the earth is reaching a crucial tipping point in addressing climate change, it is necessary for all citizens of the earth to recognize our impact and what we can do to help mitigate climate change. Change needs to happen on a government level, by corporations, and on an individual level.

Students are the next leaders of the planet, and this issue of climate change will only become more pressing than it already is. The effects of human activity on the climate cannot be ignored anymore. Most parents agree that climate change should be taught in schools (Marlon et al., 2021). In order for students to learn about this important issue, it is necessary that they learn it in the most effective way.

Importance of Outdoor Education

Outdoor education allows students to learn about and connect to the environment that they live in. Outdoor education also has the potential to provide concrete examples of the topics discussed in a science lesson. In many of the lessons provided by my district's curriculum, it has the students study examples from places like Africa and the rainforest. While it is important for students to learn about other global ecosystems, this may cause them to disassociate from the ecosystems in their own backyard. If students are taught that climate change will cause rising sea levels, that is not relevant to their life in the midwest, so it may lessen the urgency of the impacts of climate change. Getting out and collecting data from their own schoolyard allows them to see the first hand effects. This is place-based learning at its best.

Additionally, not all students have equitable access to the outdoors. Providing outdoor education in school helps get all students outdoors and feeling being there,

allowing them to reap the mental and physical health benefits of spending time outside and in nature (Meighan & Rubenstein, 2018; Szczytko et al., 2018).

Summary

In Chapter 1, I introduced my research question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* Several of my life experiences have led me to an interest in outdoor education as well as climate change. These include my experiences growing up camping with my family and attending summer camp, my outdoor labs during science classes in college, and my experience teaching outdoor and environmental education in several jobs. Outdoor education is an important aspect of place-based learning as it connects students with their environment. Climate change education is necessary to not only meet the NGSS standards, but also to inform our future leaders about the impacts, causes, and consequences of climate change. The rest of this capstone will further the relationship between outdoor education and climate education and how combining the two impacts the knowledge and attitudes of students towards pro-environmental behaviors.

In Chapter 2 I will conduct a literature review on middle school student development, current climate change knowledge and attitudes, the impacts of climate change education, and the impacts of outdoor education, as well as the effects of outdoor education. In Chapter 3 I will discuss the project created for this capstone, which includes a 15 day curriculum unit designed to be completely outdoors on school grounds and incorporate climate change. In Chapter 4 I will discuss the results of the project creation..

CHAPTER 2

Introduction

In order to answer the research question, *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?*, there are several different ideas that are important to research. This literature will touch on four different themes that emerge from this question: middle school development and learning, climate change attitudes and understandings, climate change education, and outdoor education.

First, it is necessary to understand the cognitive, social, and emotional development of middle schoolers. Where they are developmentally provides insight to the types of learning activities that are most appropriate. Designing developmentally appropriate learning activities provides middle schoolers with a better opportunity to learn about and understand climate change and its impacts. Age and development also impacts the perspective that they may take on an issue such as climate change, and suggests the most appropriate ways to discuss a topic of significance as such.

Next, this chapter seeks to understand the current state of the public's attitudes and knowledge of climate change. Attitudes towards climate change impact the behaviors that people take to mitigate the effects of climate change. Understanding current attitudes and the factors that impact attitudes can be used as a guide to develop climate change education that will be most receptive. Information on the public, including middle schoolers, current knowledge of climate change can allude to the effectiveness of current climate change education and information campaigns.

After exploring the current state of climate change attitudes and knowledge, this chapter continues to explore the current state of climate change education. This discussion looks primarily at the effectiveness of climate change education strategies in the formal setting, but also includes some informal education settings. This chapter also investigates the new Next Generation Science Standards (NGSS) and how they address and include climate change.

The research then shifts to include the effectiveness of outdoor education, including impacts to students academically, socially, and emotionally. Focus also includes the impact that place-based education and a connection to place has on student attitudes and behaviors, including pro-environmental behaviors. Pro-environmental behaviors will be defined as behaviors that positively impact the environment, including recycling, energy and/or water conservation, reducing waste, and cleaning up the environment, among others things.

To conclude, this chapter synthesizes research from the previously stated themes to attempt to answer the question, *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* The discussion will analyze the overlap in strategies that are proven to be effective in teaching middle schoolers and teaching climate change, and then explore how outdoor education can be a tool used to further accomplish these goals.

Student Development in Middle School

Students are at a unique age developmentally while in middle school. In terms of cognitive development and social development, there are some key characteristics that

make middle schoolers different from other ages, and therefore there are certain methods that teachers may find successful for student success (Thompson, 1998).

Cognitive Development

When in middle school, students are typically between the ages of eleven and fourteen. This puts students either in the concrete operational stage of development or the formal operational stage of development (Piaget nd., as cited in Woolfolk, 2013). Not every student will be at the same stage of development, and many are transitioning between stages, so it is important for teachers to incorporate needs for both stages.

Students at the concrete operational stage of thinking are at a point where they can use logic when approaching concrete or hands-on problems. This occurs in later elementary through early middle school. There are several strategies that teachers can use to help students. One strategy is using props and visual aids as well as giving students opportunities to manipulate and test ideas with hands-on experiences. These strategies appeal to the concreteness that students need. Teachers should also make readings and presentations brief and organized, allowing students more time to explore and engage. They should use examples that are familiar to students and avoid abstract ideas. One characteristic of this stage is the ability to classify and group objects, so opportunities should be given for students to do so. Lastly, teachers should present problems that require logical analytical thinking; questioning can become more complex (Piaget nd. as cited in Woolfolk, 2013).

Students who are at the formal operational stage, which occurs from adolescence through adulthood, can begin to think hypothetically and deductively. They can better use reasoning and think more scientifically. They are able to approach abstract problems and

consider multiple perspectives. Because of their ability to consider how someone else may be thinking, they may start to develop concerns about social issues, personal identity, and justice. Teachers of students in the formal operational stage should continue to use strategies for the concrete operational student, but should also give students the opportunity to explore hypothetical situations. They should also give opportunities for students to solve problems and use reasoning skills. Topics at this stage of development can become more abstract than they were at the concrete operational stage (Piaget nd. as cited in Woolfolk, 2013).

Social Development

In addition to cognitive development, middle school students are also at a unique stage in their social development. Thompson (1998) highlights several characteristics that teens have in their social development and how teachers can help.

Teens are heavily influenced by peer pressure (McGuire, 2015; Thompson, 1998). They often turn to their peers for support and guidance. Teachers can build individuals' positive identities by including collaborative work to give students the opportunity to work towards a shared goal. They also can utilize peer pressure to help students meet expectations and to expect the same of their classmates (Thompson, 1998).

Another characteristic of teens is that they want to have fun. Students are exposed to a lot of fast-paced entertainment, including cell phone apps, social media, video games, and internet videos. When they are expected to devote their undivided attention to one topic for an extended period of time, they can easily grow restless. Teachers should use this information to devise lessons with several shorter activities, or, if an extended activity is required, they should break it up into smaller sections. Activities should be

planned with variety in mind to allow for things that interest all students. Lessons that include music, art, and popular culture can also be interesting to students. (Thompson, 1998).

Teens also want what they are learning in school to have a practical purpose. This should include a direct application to their lives, not just a statement that they will need it in future schooling. The challenge for teachers is how to make students understand why they need to know the content of each lesson. One thing that can help teachers is to use real-world examples and applications. At the end of class, teachers might guide students in brainstorming how they might use their information learned in class by the end of the day, week, or month (Thompson, 1998).

Science Teaching Methods

For students to effectively learn, they need to be engaged in science. Lessons that are experiential, inquiry-based, or student-led in nature are effective ways to teach science (Monroe et al., 2019). Additionally, lessons that incorporate small group discussions through the use of laboratory experiments and simulations are also engaging for students, especially when they are working together, sharing ideas, making observations, and coming to a group consensus on the result (Monroe et al., 2019).

The Learning Cycle

The learning cycle was originally developed by Karplus and Butts (1977) to show how to show one method that students can construct their own learning through inquiry. Students engage in exploration in order to create their own understanding from observation and data, and then apply that understanding to new concepts. Cycles of learning in this method can occur short term (in one class-period) or over a longer period

of time. Hick (2017) classifies the steps of the cycle into three steps, allowing for ease of teachers to recall the cycle and develop lesson plans that fit it.

The first step is concept discovery. In this step, students are given time to engage in learning activities that allow them to discover something new: a meaning, rule, or relationship. This discovery should happen through their own investigation. The teacher may guide students to the concept they want students to discover through scaffolding and asking questions, however, students may also discover other concepts through their own unique lens (Hick, 2017). Having a real-world example to use as a concept discovery activity could help link the material to students' lives, thus making the topic more relevant to students.

The second step is concept clarification. In this step, the teacher helps students to refine their learnings. Students share their observations in this step and the teacher facilitates a discussion that helps students identify on and off-target responses. New vocabulary is introduced, and other methods of learning–story, lecture, modeling, simulations, readings–may be incorporated to help students build understanding. If it is a skill that requires practice, the practice occurs at this stage as well (Hick, 2017).

The last step of Hick's (2017) learning cycle is concept application. At this stage, a new problem is introduced for students to apply their understanding to. This application could be a formative assessment at the end of the lesson and/or another activity possibly in days to follow. An extended activity may occur that occurs as the application of several concepts in a row (Hick, 2017).

Science and Engineering Practices.

NGSS incorporates the scientific and engineering practices listed in *A Framework for K-12 Science Education*, the guiding document for the creation of the NGSS. These practices are to stress the importance that engaging in scientific inquiry involves both skills and knowledge (NRC, 2012). The practices are as follows: asking questions (for science) and defining problems (for engineering), developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations (for science) and designing solutions (for engineering), engaging in argument from evidence, obtaining, evaluating, and communicating information (NRC, 2012, p. 42). Engaging students in these practices allows them to experience how science is done even by scientists. By doing actual science, students may become more interested, curious, or motivated to continue learning science (NRC, 2012).

Summary and Relation to Research Question

It is necessary to understand middle school cognitive and social development when answering the question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* Learning activities should be designed in a way that is developmentally appropriate and follows strategies that are proven to be effective science teaching methods. Learning activities should be collaborative and hands-on in nature. In an outdoor classroom, there are many opportunities for students to be hands-on with their surroundings, as well as there are many opportunities for students to satisfy their need to have fun. Designing lessons that follow the learning cycle–concept discovery, concept

clarification, concept application–will provide students with an optimal learning environment and help them to connect to and make sense of what they are learning. Again, using the outdoors can be a natural way for students to discover their surroundings and make meaningful local and lasting connections (place-based learning). The next section will seek to explain the current state of students' knowledge and attitudes regarding climate change.

Climate Change Knowledge and Attitudes

Assessing a student's prior knowledge on a topic can allow for a teacher to choose the method of instruction that will best match their learning needs. This same method is also pertinent to climate change education. Getting a snapshot of where students are at in their knowledge and attitudes towards climate change can allow teachers to pick the instructional strategy that will best meet student needs.

Looking at the adult population in the United States; 72% of the population believe that climate change is happening with 58% of the population believing that human activities are the primary cause of climate change (Marlon et al., 2021). When asked whether scientists would agree that climate change is happening, 58% of the population believed that most scientists think global warming is happening (Marlon et al., 2021), when in fact, 97% of climate scientists believe that human caused climate change is occuring (Cook et al., 2016; Molina et al., nd). The Intergovernmental Panel on Climate Change (IPCC) states that human activities have caused an increase in global temperature by 1.0°C from pre-industrial levels (Intergovernmental Panel on Climate Change, 2018). Given this data, it can be concluded that human activities are a contributing factor to climate change.

Knowledge About Climate Change

The goal of the research question–*how does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change*–seeks to look at middle schooler's understandings of climate change. Before receiving formal instruction on climate change, many students come to the classroom aware of the term climate change. Most also come with an understanding that pollutants from fossil fuels are causing climate change (Hestness et al., 2019). With these understandings, many students can make the connection that pollutants in the air are interacting with the atmosphere to cause climate change, though they have different ideas as to how these interactions actually work (Hestness et al., 2019). They lack the concrete scientific knowledge of greenhouse gasses trapping in heat reflected from the earth, thus acting like a heat trapping. Most students are also aware that climate change will impact humans and ecosystems: "a majority (77%) of students indicated that a warmer global climate would have impacts for humans and Earth's ecosystems, and that sea level rise would impact people who live on the coast (68%)." (Hestness et al., 2019, p. 918).

Misunderstandings of Climate Change

Aside from the inability to scientifically explain climate change, students also had misconceptions about climate change. Some claimed that consequences of climate change would include unrelated issues, like acid rain and pollution in waterways (Hestness et al., 2019). Jarrett and Takas (2020) found that students were commonly conflating two issues that both had human causes: climate change and depletion of the ozone layer, and were stating that the depletion of the ozone layer caused by the release of pollutants that include chlorofluorocarbons (CFCs) was allowing more direct

ultraviolet (UV) radiation, and that the extra UV radiation was causing climate change. Other students were found to think that it was greenhouse gasses that are damaging the ozone layer, instead of CFCs, and that the definition of a greenhouse gas includes one that damages the ozone layer: "when asked why oxygen and nitrogen are not greenhouse gasses, 38% said that they do not damage the ozone layer" (Jarrett & Takas, 2020, p. 415). Many of these misunderstandings suggest that students have been hearing about climate change and they have been receptive to the message. They have the general idea that human pollution is contributing to a changing climate, however they lack the scientific knowledge to back up their claims. These misunderstandings show the areas that science teachers need to emphasize in order to correct misconceptions.

Access to Climate Change Information

With the growth and greater accessibility of the internet, students are able to easily access information online about climate change. The internet has become the primary source of information on climate change, with 75% of students referencing media sources when asked where they had learned about climate change (Hestness et al., 2019). Additionally, students have spoken about hearing stories about climate change on the news, including stories about locally relevant impacts of climate change (Hestness et al., 2019; Trott, 2020). Additional sources for information about climate change include books, television, and school or family field trips to places like museums and zoos (Trott, 2020).

Students also referenced learning about climate change through interactions at school as often as they did through media, however, despite learning about it at school and accessing information at home like through the news, "students rarely mentioned

talking to peers or classmates at school about climate change, or to their family members at home" (Hestness et al., 2019, p. 920). This information suggests that students have the access to information about climate change, however, without discussing it, they are passively receiving information.

Overall, students expressed that hearing about climate change made them curious to know more (Trott, 2020). This implies that the more frequently teachers, families, and the media can address climate change, the more interested students will be in learning about it. While it can be argued that climate change is a complicated topic for middle schoolers to understand, "grasping the human dimensions of climate change seemed to make the problem more concrete for children" (Trott, 2020, p. 541). If students have a better understanding of the human impacts of climate change, rather than just the scientific process, the problem may become more approachable.

Attitudes About Climate Change

While knowledge about climate change focused on the extent to which the general public and students in particular knew about climate change and its mechanisms, it did not address the beliefs that people have about climate change regarding its causes, what impacts one's beliefs, actions that need to be taken to help mitigate, and the urgency to which action needs to take place. Bhattacharya et al. (2021) found that teachers and students both believe that climate change is occurring and reported a moderate to high level of concern about it. Despite the consensus that it was happening, there was not a consensus on the causes of climate change, which were attributed to a variety of factors (Bhattacharya, 2021). When adults in the United States were polled, 65% stated that they

were worried about climate change, though only 47% believed that it would harm them personally (Marlon et al., 2021).

Factors that Impact One's Beliefs in Climate Change

Given the complexity of climate change and its position of debate in the political sphere, it should not be a surprise that there are several compounding factors that contribute to one's particular belief in and attitude towards climate change.

Socio-Cultural Identity. One factor that impacts an individual's perception of climate change is their socio-cultural norms and worldview (Monroe et al., 2019). In an individualistic society such as the United States, one might be influenced by the belief that if it doesn't impact them personally at the moment, it is not a problem. Schweizer et al. (2013) furthers this notion by finding that "messages about climate change complexity and impacts resonate when they are nested in the cultural values and beliefs of the audience and are integrated with the experiential meaningfulness of place" (p. 43). These findings imply that cultures that place value on environmental conservation and stewardship may be more perceptive to messages about climate change, especially if they show the direct impact to their place.

Another factor that impacts one's belief in climate change is political ideology (Arya & Maul, 2016; Hart et al., 2015; Monroe et al., 2019). With political identity referring to the tendency to agree with the ideas of a certain political party, evidence suggests that one's political identity may have a greater impact on one's perceptions and beliefs towards climate change than scientific evidence (Hart et al., 2015). If a certain political party does not believe in human-caused climate change, people in that political party may choose not to or be less likely to change actions to help mitigate the effects of

climate change. If a group feels that climate change is impacting their way of life, they may choose to become defensive or seek out data that confirms their beliefs: “the topic of climate change seems to deeply resonate with held values, such that adults respond by protecting their group identity and way of life. One outcome is the tendency to seek and recall information that reinforces one’s initial judgment” (Haidt 2012; Kahan 2010; Kinder 1998; McCright and Dunlap 2011; Nickerson, 1998 as cited in Monroe et al., 2019, p. 792)

While the studies cited in this section refer to the factors that impact adult perceptions on climate change, it can be assumed that these will also have an impact on middle school students. Stapleton (2015) argues that the opinions and feelings youth have on environmental issues are influenced by the people that they interact with. Given that beliefs about climate change are impacted by cultural values and political identity. It can be expected that students will assume the same beliefs shared by those in their cultural and political spheres. They most likely will share the same beliefs as their caretakers, the people they interact with often. Because students may be coming to the classroom with a variety of attitudes towards climate change, it is important that teachers create an environmental welcoming of multiple perspectives, while still being able to address and dispel misconceptions based on socio-cultural factors (Monroe et al., 2019).

Connectedness to Nature. When people spend time in nature, they are more likely to work for its protection (Chawla & Cushing, 2007). The authors argue that nature activities in their youth, as well as examples of people enjoying nature, such as parents and role-models are key factors that lead to the predisposition of environmental protection. The mindset of mindfulness includes taking notice of details, distinctions, and

new things in an environment. The act of being in nature often leads to one improving their mindfulness abilities, making them more aware of their surroundings and changes to their surroundings: “taken together, our research suggested that by focusing on the shifting of cognitive thinking patterns, mindfulness could enhance individuals’ connectedness with nature. The enhancement of connectedness with nature would contribute to increasing their belief in climate change” (Wang et al., 2019, p. 16).

The Personal Impact of Climate Change. Another factor contributing to one’s attitude towards climate change is the impact on their personal lives. For example, students who enjoy outdoor activities such as sports are more likely to make the connection that one consequence of climate change is the inability to participate in those activities. Students who live in areas that are prone to flooding and have experienced flooding in infrastructure are more likely to be concerned about permanent infrastructure damage from climate change because they have experienced that before (Hestness et al., 2019). Ultimately, the more local and personal the impacts, the more personally concerning climate change is to an individual (O’Neill & Nicholson-Cole, 2009). These findings suggest that the more local or personally relevant a lesson about climate change is, the more likely it will impact a students attitude towards climate change.

Emotions About Climate Change

There are several emotions felt when thinking about climate change, including negative ones such as guilt, sadness, fearful, depressed, scared, or distressed, but also positive ones such as hope (Hestness et al., 2019; O’Neill &Nicholson-Cole, 2009). Students felt guilt when thinking about their families’ energy consumption and how it would contribute to climate change and sadness at the thought of possibly not being able

to partake in the same activities that they enjoy doing (Hestness et al., 2019). Other students felt a cause for concern out of the belief in the inadequacy of those around them to take action (Trott, 2020). In the study done by O'Neill and Nicholson-Cole (2009): "the majority of outlooks on future climate were negative and bleak, with many reflecting a degree of uncertainty as to what climate change might mean for [participants]" (p. 369). Hope was experienced when students began to think about their personal and family's actions that served to help mitigate climate change (Hestness et al., 2019).

When looking at messages that are supposed to induce fear with the hopes that action would result, it is found that they were largely ineffective. Fear appeals can lead to "denial of the problem and disengagement with the whole issue in an attempt to avoid the discomfort of contending with it" (O'Neill and Nicholson-Cole, 2009, p. 371). Fear appeals that cause people to disassociate, resulting in them feeling like climate change is a problem for both a distant time and place. These findings show the ineffectiveness of fear appeals and suggest that they lead to attitudes of disengagement instead of attitudes towards action and public engagement (O'Neill and Nicholson-Cole, 2009). Given the lack of impact that fear tactics have on the general public, they also should not be used as a climate change education strategy by teachers in the classroom.

Attitudes Towards Climate Change Education

Public opinion among adults in the United States is that schools should teach about the causes, consequences, and potential solutions to climate change, with 77% of U.S adults believing such (Marlon et al., 2021). Students and teachers also both value climate change education as an important topic to cover (Bhattacharya et al., 2021). Students who are informed about climate change feel a greater sense of competence and

enthusiasm when thinking about mitigation efforts and the future (Trott, 2020) and also are more motivated to engage in pro-environmental behavior (Bhattacharya et al., 2021). Students who would like to be more environmentally active may not know how to do so without the help and support of others that can be provided in a school setting (Stapleton, 2015).

Summary and Relation to Research Question

Understanding where students are at in terms of their knowledge and attitudes towards climate change help us to answer the research question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* Students are going to arrive in class with their own set of preconceptions about climate change that have been impacted by their socio-cultural background and what they value. They also will be impacted by how connected they are to nature. Students with a higher sense of connection to nature will have stronger beliefs about climate change (Wang et al., 2019). Thus, it can be expected that students who have had more exposure to outdoor education will have stronger beliefs in climate change. To increase student belief and desire to act regarding climate change, lessons should be designed to investigate local effects of climate and connect students with their local environment, both of which outdoor education can do.

Students' current understanding of climate change is such that they understand broadly that pollution and the burning of greenhouse gasses is a driving factor, however they fail to understand the scientific workings of climate change. They often conflate the issue with a growing hole in the ozone layer letting in more radiation. Lessons should seek to address these misconceptions and emphasize the heat-trapping effect that

greenhouse gasses have on the atmosphere. Further discussion of climate change education techniques will take place in the next section.

Climate Change Education

Climate change education refers to the teaching and learning of climate change in either the formal classroom setting or the informal education setting outside of school. Holland (2020) argues that only when climate change education becomes a more focal component of content discussed in the classroom will students who deny climate change be able to reexamine their beliefs and accept evidence that human activity is a driver of climate change. While it should be considered that the topic of climate change can be frightening and disempowering to students, by providing more exposure to the topic and providing ample opportunities to learn, students will be less fearful about climate change in the future (Shoreman-Ouimet, 2021). With student as the leaders of the future, we need climate change education that lends its way to capable and confident students: "Facilitating children's constructive climate change engagement means harnessing the transformative potential of young people as agents of present-day as well as future change whose voices and actions can contribute to building a better world" (Trott, 2020, p. 549).

Historical Context of Climate Change Education

In climate change education, there are the concrete concepts–drivers of climate change, chemistry involved in the greenhouse effect, the workings of the carbon cycle–that can be taught directly through the use of scientific theory and application. Beyond the learning of new concepts and skills, there is also an agenda in climate change education that includes mitigation and adaptation strategies for addressing climate

change. The goal of these strategies is to change behavior in order to reduce the risks of climate change (Anderson, 2012). Climate change education is a topic in science education that has a direct impact on humans and their behaviors. Teaching the facts and scientific theory is not enough for students to understand the whole picture of climate change. There is a need to teach the social science aspect so that students understand the human impact.

Despite the broader social science aspect of climate change including behaviors, environmental ethics, and social responsibility, climate change education is primarily happening in the science classroom, specifically in courses that include earth systems: earth science, environmental science, and biology (Bhattacharya et al., 2021). A minority of courses were found to have a specific unit or lessons focused on climate change, though 75-90% of courses report that climate change is addressed in some way at some point during the course. Climate change instruction is primarily teacher-led, with the inclusion of some investigative elements, though teachers generally kept to science content and deemphasized political aspects (Bhattcharya et al., 2021). One overarching challenge is teachers decide to what extent they go into details: “Teachers in many studies articulated challenges in finding space within existing curricula to ‘fit’ Earth’s climate system and science content about [global climate change]. They felt that the complexity inherent to this topic could not be adequately integrated with the topics that they currently taught” (Bhattacharya et al., 2021, p. 228).

Despite the broad context that climate change appropriately fits into science topics, climate change instruction rarely exceeds a week of instructional time over the course of the year. Even then, it is often used as a supplemental topic, an extension, or is

integrated into other content (Bhattacharya et al., 2021). While it is valuable to students to see how climate change fits into other science topics, without the direct instruction of the mechanisms and impacts of climate change, students may not understand the significance and may view it as only a secondary concept. Bhattacharya et al. (2021) finds that the most documented reasons that climate change education is so briefly touched upon is because standards regarding climate change are less prominent and a lack of well-designed curriculum that is comprehensive.

Next Generation Science Standards

The NGSS were created using the ideas mentioned in *A Framework for K-12 Science Education,* released by the National Research Council in 2011. The final version of the NGSS was released in April 2013. The NGSS include standards directly related to climate change at both the middle school and high school level. There are several standards proximally related to climate change at all levels, including elementary. For example, at the kindergarten level, the standard K-ESS2-1 has students "use and share observations of local weather conditions to describe patterns over time" (Achieve, Inc., 2017, p. 8) and the standard K-ESS3-3 has students "communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment" (Achieve, Inc., 2017, p. 9). These proximally related standards could include supplemental instruction to incorporate climate change education into all Disciplinary Core Ideas.

For the standards that directly reference climate change, four are at the high school level (HS-ESS2-4, HS-ESS3-1, HS-ESS3-4, HS-ESS3-5) and one is at the middle school level (MS-ESS3-5) (Achieve, Inc., 2017). Given this distribution of standards, it is

not surprising that climate change is most frequently taught at the secondary level with a greater emphasis in high school than in middle school, as the progression in climate change education should be developmentally appropriate (Bhattacharya et al., 2021). The middle school standard MS-ESS3-5 that addresses climate change states that students will be able to "ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century" (Achieve, Inc., 2017, p. 71). Closely related standards under the same Disciplinary Core Idea of Earth and Human Activity include MS-ESS3-4: "construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems" (Achieve, Inc., 2017, p. 71) and MS-ESS3-3: "apply scientific principles to design a method for monitoring and minimizing a human impact on the environment" (Achieve, Inc., 2017, p. 71). At the middle school level, the primary focus of NGSS is to study the factors leading to the increase in global temperatures, as well as the impacts of climate change (Bhattacharya et al., 2021). One concern with NGSS is that the heavy focus on the science and engineering practices "may reinforce a canonical interpretation as it emphasizes engaging in science to learn science, rather than to act socially or politically" (Clark et al., 2020, p. 1188). Given these standards and the lack of focus on social and political action, teachers may have to supplement additional information so students fully understand climate change on a global scale and the necessity to act to prevent its furthering. However, an emphasis on science and engineering practices is that it can lead to practical solutions and actions.

Best Implementation Strategies to Climate Change Education

There are several best practices when implementing climate change education that are effective tools for learning. These include place-based education, inquiry, a multidisciplinary approach that includes the political context, and an emphasis on scale.

Place-Based and Personal Relevance

One key implementation strategy when teaching about climate change is focusing on it at a local scale. When climate change is discussed on a local scale, it allows for students to more tangibly grasp its effects (Anderson, 2012; Bhattacharya et al., 2021, Scannell & Gifford, 2013). When studied on a local scale, climate change becomes more personally relevant to students by connecting it to their identities and lived experiences (Bhattacharya, 2021), thus making the concept more meaningful and more engaging (Monroe et al., 2019).

A local scale also makes the actionable aspects of climate change such as changing behaviors feel more accomplishable to an individual "by making abstract concepts tangible and by linking the global phenomenon to individual actions" (Anderson, 2012, p.198). When people are seeing or discussing the impacts of climate change on their local environment that they call home, it affects them on a deeper level. When they realize they may be directly impacted, they may become more averse to the risks and more likely to seek action (Scannell & Gifford, 2013) If warmer global temperatures lead to algae blooms and the death of fish in a local lake, students from the United States Midwest who frequently fish on the lake will be more impacted than they would be by learning about sea level rise on the coasts. Schweizer (2013) states that

oftentimes, people need to see that it is real and happening before making more sustainable behavioral decisions.

Given that engagement in climate change was greater among people who had a higher sense of attachment to their local areas (Scannell & Gifford, 2013), education should not only be focused on discussing local issues regarding climate change, but should be making efforts to further connect students to their local environments. Connection to place could be a natural, a social, or an emotional connection. Building community and pride in a school's locality may drive climate change engagement and action.

High Engagement and Inquiry

Students need to be highly engaged in learning for climate change education to be most effective. Teachers cannot rely on a teacher-centered approach to learning in this case: "traditional models of science instruction as delivery of conceptual information are insufficient for fostering such critical, dialogic engagement with issues about an uncertain future" (Arya & Maul, 2016, p. 886). Students should be facilitated through the inquiry process using their own questions and interests to guide learning. When students enjoy and are motivated to learn, their enthusiasm to engage can serve as a direct route to learn, connect, and act on climate change (Trott, 2020). Methods of teaching and learning that are effective in climate change education include small group discussions that allow students to compare and debate viewpoints, using models and visuals to collect and analyze data, flipped classrooms, and project based learning (Monroe et al., 2019).

Project-based learning can also engage students in climate change education. Focusing on a long-term project of personal interest that seeks to answer a challenging

question can allow them to use their own voice in climate change discussions and create work that has personal authenticity (Colaianne, 2015; Monroe et al., 2019). Trott (2019) implemented a program that utilized photography in learning about climate change to create a unique mode of showing understanding. Projects like these allow students to guide their own learning, creating a sense of agency (Trott, 2019).

Multidisciplinary Approach

While the root of climate change learning is through the scientific processes causing it, there is a need to discuss it in non-science courses as well. It is important that climate change is addressed in topics such as geography, language arts, social studies, history, drama, and the arts and not as a stand-alone subject area or even solely within science (Anderson, 2012). Even within science, it is necessary to provide "continuity over the years, [as to] allow students to connect various aspects and models of environmental and climate science to one another, thereby enabling them to integrate their knowledge into their understanding of climate change and their own role it" (Anderson, 2012, p. 198). Climate change should not be discussed solely in earth science, but courses in biology, chemistry, and physics should also build upon the knowledge gained about climate change.

The multidisciplinary approach to teaching about climate change allows for further understanding of the social and political context of climate change. One way to incorporate this into the classroom is through discussion. Despite teachers generally avoiding discussion on the political aspects of climate change (Bhattacharya et al., 2021), creating opportunities for open discussion and personal reflection allows students to understand the topic through a social and political lens (Chawla & Cushing, 2007;

Monroe et al., 2019). It is not enough for science teachers to check for understanding only on the scientific processes of climate change: "while a science teacher would be pleased with students who agree with the scientific consensus on climate change, helping students make sense of the controversy may require that others voice valid concerns about policy debates, economic choices, and the costs and benefits of various mitigation scenarios." (Monroe et al., 2019, p. 802). Challenging students to engage in evidence-based discussions that require them to critically think about, defend with real scientific data, and elaborate on their ideas allows them to hear various perspectives, challenge where these viewpoints come from, and use scientific reasoning to overcome misconceptions (Arya & Maul, 2016; Monroe et al., 2019).

Emphasis of the Scale of Climate Change

Students struggle with scale as it regards to several aspects of climate change. Given that scale and proportion is one of the Cross Cutting Concepts of NGSS, it is important for teachers to intentionally address it. One aspect of scale is the measurement of human contribution and greenhouse gas emissions. Students struggled with overestimation as it related to human contribution to carbon flows, the amount of ultraviolet light in the atmosphere, and the proportion of greenhouse gasses in the atmosphere (Jarrett &Takacs, 2020). The researchers of that study suggest that teaching focuses on explicitly addressing scale, and that even items of small scale can add up over time. While each human or corporation impact is small in scale, the small impacts of individuals can add up over time. Matching the scale of learning to one that a learner could approach is necessary (Monroe et al., 2019), for example, students may struggle to

understand sheer quantities of global greenhouse gas emissions, but they may be able to understand the smaller scale of their own personal emission.

Solution-Based Learning Opportunities

Learning about climate change requires a shift to "motivational framing, with a focus on solutions and values, [which] improves climate change engagement and intent to adopt adaptive behaviors" (Anderson, 2012, p. 198). Students will lose motivation if they feel that there is no solution they can be a part of; apathy will set in. They are more likely to learn and engage when they can see or understand that their actions have impact. Using tools such as carbon or ecological footprint calculators can further connect students with their role in the solution at a scale more appropriate to them (Anderson, 2012).

Constraints to Climate Change Education

Given the variety of implementation options listed above, there are constraints that allow even well-meaning teachers from being able to effectively teach about climate change. One constraint is teacher preparation and confidence. Is it essential that teachers provide an education that allows them to confidently teach about climate change (Anderson, 2012). Proper training leads to an increase in confidence, which is necessary when teaching any subject, but especially a subject that may be of scrutiny to parents. Teachers often fear parental complaints when approaching climate change in the classroom (Trott, 2020). Bhattacharya et al. (2021) finds that teachers feel as though their training is inadequate for being able to teach about climate change to their students directly. They feel like they lack content knowledge and the ability to align and integrate topics that are relevant to climate change on their own. These findings suggest a need for

resources and support for teachers as they approach climate change education, whether they are a science teacher or teach a non-science subject (Bhattacharya et al., 2021).

Another constraint to climate change education is government regulations and political pushback. A review of the NGSS found that they "scrupulously avoid the social and political aspects of climate change and climate action, leaving teachers to figure out for themselves" (Clark et al., 2020, p. 1188). Despite the fact that 77% of adults believe that climate change should be taught in school (Marlon et al., 2021), teachers still fear political backlash from parents (Trott, 2020).

One current failure of climate change education is the lack of focus on justice-oriented outcomes (Clark et al., 2020; Monroe et al., 2019). This shortcoming may prevent students from making the connection that our actions are interdependent. It is possible that the actions of some could inflict harm on others. It is necessary to address the role of power so that students from marginalized communities can be fully included in the conversation (Clark et al., 2020).

Summary and Relation to Research Question

The current state of climate change education, suggested methods of climate change education, and the constraints to climate change education are all critical to understand when addressing the research question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* Currently, students are learning about climate change as a short, standalone topic in science class. It is primarily being taught in earth science class, and not being addressed in its political context. The new NGSS standards have specific standards related to climate change in middle school and high school, though they are

only in earth science. There are several standards proximally related to climate change in other science disciplines.

Methods suggested in implementing climate change education include making it place-based and relevant to students. Using the local environment in an outdoor classroom can provide this opportunity. Students should be highly engaged in inquiry, asking questions, making observations, collecting data, and working to solve problems they are interested in. Again, outdoor education can provide these opportunities. There also should be an intention to teach the scale of the problem and the age-appropriate scale of solutions. Younger students may only be able to understand the scale of their own actions. Given the opportunities that outdoor education provides for climate change education, especially in its ability to focus on the local environment and provide opportunities for high levels of student engagement, it will be discussed in further detail in the next section.

Outdoor Education

Given the research question, *how does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change,* it is necessary to understand the impacts of outdoor education on student's learning and attitudes towards the environment. For the purpose of this capstone project, outdoor education can be defined as any educational setting that takes place outdoors, including education about the environment (environmental education).

Benefits of Outdoor Education

Academic and Environmental Literacy

Outdoor education provides benefits to students that cannot be offered in the traditional classroom. One benefit is in the learning of content and environmental literacy. When learning in an outdoor environment, learning is more likely to be active, experiential and applicable to the real world (Meighan & Rubenstein, 2018; James & Williams, 2017). It is these experiential learning opportunities that are more effective and engaging for student learning and students indicate a higher level of enjoyment in their learning (Ballantyne & Packer, 2009; James & Williams, 2017). When students have an experiential learning experience, they are better able to commit their learning to memory than they are with teacher-directed learning methods (Ballantyne & Packer, 2009; James & Williams, 2017). Outdoor education may also lead to learning that would not have happened otherwise in the classroom: "[it provides]more opportunities to explore new subject matter than traditional, discipline-based teaching, and allowed for more frequent occasions to use innovative instructional strategies" (Meighan and Rubenstein, 2018, p. 166). Given students' innate desire to explore in the outdoors, it may be easier for teachers to desire learning activities that provide for student-driven exploration.

In outdoor education, students have direct access to real-world data and phenomena to explore, which they may not have in the classroom. Students report finding it valuable and worthwhile to use their environment to collect real-world scientific data (James & Williams, 2017). Scientific skills–asking questions, making observations, data collection–can be further developed and scaffolded in an outdoor environment, leading to a deepening of critical thinking skills (James & Williams, 2017). Doing fieldwork and

using real-world data that occurs in nature could potentially lead to a decrease in the gap that may exist between the content that students are learning and how it applies to their real world. For example, if students are learning about how natural areas tend to have more biodiversity than human-built environments, a fieldwork activity such as counting the number of species spotted on the school lawn and then counting the number of species in a small natural area adjacent to the school lawn provide students with real-world data to compare and further understanding.

When thinking about human impacts on the environment, students report having a better understanding of how humans impact the environment when they spend more time in the environment (Young et al., 2020). When students are given opportunities to explore and make observations in their environment, they are more likely to notice slight changes and think about how humans may have contributed to them. When thinking about using an outdoor classroom to teach about climate change: “these sentiments suggest that being in an environment that shows clear and visible signs of rapid climate change made the concept more real and relatable.” (Young et al., 2020, p. 3063). Seeing an environment that may be experiencing the effects of climate change, even if it is just noticing that the grass is drier than usual due to prolonged drought can make climate change feel more relevant and closer to home; it alleviates the distance students might feel between them and the likelihood of climate change impacting their local environment at a rapid pace (Young et al., 2020). Given the increase of proximity to the issue, students may be more likely to adopt pro-environmental behaviors when they feel a sense of responsibility and consequences are more tangible (Schweizer et al., 2013).

Social-Emotional Benefits

Another benefit of outdoor education includes the formation of relationships and forming attachments. Outdoor learning can lead to the formation of an emotional attachment to a landscape. This is rooted in place-attachment theory (Schweizer et al., 2013). If students are only engaging in outdoor education on field trips, it may not feel like their local environment. Thus, having opportunities for students to learn in their own environment allows students to form a connection with their local environment.

Teachers also noticed that while in outdoor environments, cooperation among students increased (Meighan and Rubenstein, 2018). This could potentially be due to having a shared experience with each other. Teachers should utilize this increase in cooperation to their advantage by designing outdoor education activities that intentionally include cooperative learning. Outdoor spaces often encourage creative play which can lead to improved social skills among students (Meighan & Rubenstein, 2018).

Students were also reported to have increased attention spans both during and after outdoor education activities. Amicone et al. (2018) found that students sustained higher levels of sustained attention, working memory, and concentration after spending time in an outdoor environment when students resumed classroom learning. This study suggests the impact that outdoor education has on traditional classroom learning, as it can be used as a tool to increase student engagement for a longer duration of time than the lesson itself. When looking at behavior of students, outdoor education was found to diminish disruptive behaviors among students, including those with emotional behavior disorders (Szczytko et al., 2018).

Finally, outdoor education has been found to have an impact on student confidence and leadership. When in outdoor classrooms, risk was often present (Meighan & Rubenstein, 2018). Risk may present itself to students through a physical, emotional, or social challenge. This risk also presents students with situations where one may assume a leadership role. James and Williams (2017) found that some different students took on leadership roles than the ones that traditionally do in the classroom: we all know students who have little confidence in the classroom because of their lack of comfort or competence in traditional school-related skills involving a lot of reading and writing, sitting, and listening. It is these students who often become the leaders in outdoor education environments" (James & Williams, 2017, p. 7). The researchers stated that students with special needs were often ones to take leadership roles in an outdoor education environment.

Pro-Environmental Behavior

Given the benefits of outdoor education–"learning on school grounds resulted in greater confidence, stronger motivation towards learning, and a greater sense of belonging and responsibility" (Meighan & Rubenstein, 2018, p. 167)– it is not surprising that outdoor education leads to more pro-environmental behaviors. A pro-environmental behavior refers to any behavior that has a positive impact on the environment or the conservation of resources, including but is not limited to waste reduction, energy conservation, and reducing littering.

Connection to Ecosystems and Place

A connection to one's ecosystem leads to the desire to try and protect it. Through learning about ecosystems in outdoor education, students feel a sense of

interconnectedness and relatedness to their environment (Young et al., 2020). When they become familiar with the species that exist in their local ecosystems through outdoor education, attitudes regarding conservation of these species becomes more real and less conceptual, causing a higher likelihood that students will make decisions that serve to protect them (McGuire, 2015). The researcher uses this finding to suggest that students should engage in as many nature-related activities as possible, including outdoor education. A prolonged outdoor education experience is more likely to encourage positive environmental behaviors and attitudes than a shorter, or one-time program (Meighan & Rubenstein, 2018).

Exposure to outdoor education in childhood and youth through role models who show an interest in nature can be an easy way to predispose people to have a continued interest in nature and work for its protection (Chawla & Cushing, 2007). Curriculum that incorporates outdoor education leads to increased awareness of the environment and an increased ethic of care for the environment (Chambers & Radbourne, 2014 as cited in Meighan & Rubenstein, 2018). Young et al., (2020) found that students who had spent time learning outdoors at a site of a glacier had an increased desire for others to be able to experience it as they had. The students in the study left having experienced a small-scale example of human impact to an environment, and despite feeling worried or scared for the glacier's future, they report feeling inspired to adopt more pro-environmental behaviors. These feelings persisted beyond the scope of their outdoor education experience. Their anxiety and surprise of the rate of ice loss on the glacier "acts as motivation for action rather than despair, bolstered by a sense of relatedness to the landscape" (Young et al., 2020, p.3064).

Personal Relevance and Self-Identity

Outdoor education can further encourage pro-environmental behaviors by giving students a chance to initiate environmental actions themselves (Chawla & Cushing, 2007). Putting this learning task on the students allows them to develop self-agency and confidence in their abilities to enact change. Students need to take "personal ownership of the issues that they work on, choosing personally significant goals and integrating action for the common good into their sense of identity" (Chawla & Cushing, 2007, p. 449). As pro-environmental behaviors start to become embedded into a students identity, they are more likely to choose them based on the fact that their actions are driven by emotions, rather than a complicated calculation of how much each specific action they take will impact the environment (McGuire, 2015). The goal should be to get students to take pro-environmental actions on a daily basis because of connections they have formed to the natural world, as those are more likely to persist over time than pro-environmental actions that are made because they are told to make them.

Prioritizing Behaviors

Chawla and Cushing (2007) argue that it is not enough for educators to simply promote actions that will benefit the environment, but actions that have the most impact should be prioritized. For example, turning down the thermostat in the winter saves a lot more energy than turning off the lights. Similarly, McGuire (2015) argues that "[it] is not to say that discrete behaviors such as fluorescent bulb use are not valuable . . .however, unless these behaviors are fostered as part of a broader plan to address an individual's behavior across many domains [they] will never create a lasting, sustainable relationship between people and the natural world" (McGuire, 2015, p. 705). However, in reference to

the earlier discussion about providing climate change solutions at an appropriate scale for students, it might be that suggesting several small changes is a way to lay the foundation that more changes could be added to in the future. When engaging in pro-environmental behaviors, it is crucial that students make the connection as to why this is helping the environment and be able to argue why others should act in the same way (McGuire, 2015).

Collective Action

The mitigation of climate change will require collective action by various stakeholders. If students are only taught about individual efforts they can make, they will not understand the full scope of the problem (Chawla and Cushing, 2007). Giving students the opportunity to participate in collective action at the school or community level allows them to better understand how they can also help make contributions at the local government level (Chawla & Cushing, 2007). A full view of the issue includes students understanding their role as consumers as well:

> it is pertinent that we allow ourselves and our students to see the extent to which this 'rhetoric of recycling' acts as a blinder that narrows our vision and distracts us from acknowledging the true extent to which greenhouse gas emissions and their impacts are the product of multinational corporations, wealthy conglomerates and private companies; and, just as importantly, distracts us from the ways our consumption habits subsidise corporate pollution and increases their wealth, while we, and our increasingly climate-weary students, shoulder the blame and responsibility for environmental damage and repair."
> (Shoreman-Ouimet, 2021, p. 77).

A balance of individual and collective action ideas are necessary to give students the tools they need in order to feel capable of helping to solve problems. As social beings, students have a desire to communicate with and educate others. They are motivated by the consequences of climate change to make a positive impact on the world (Shoreman-Ouimet, 2021).

Summary and Relation to Research Question

Understanding the impacts of outdoor education can help answer the research question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* Outdoor education provides benefits to students learning by being highly experiential and inquisitive in nature. Students work hands-on with real-world data and observations, making the content learned applicable to their daily lives. The social benefits of outdoor learning include improved memory, longer attention spans, leadership opportunities, especially for students who don't often experience being a leader in the classroom, and more cooperative learning opportunities among students. Outdoor education also leads to more pro-environmental behaviors. Students feel a connection to a place which lends to a desire to protect it. Taking actions to protect the environment increases in relevance to students who have made a connection to the environment that will benefit. Outdoor education should strive to prioritize behaviors that will have the greatest impact while also supporting collective action among students.

Conclusion

Teachers can incorporate an understanding of middle school student development, climate change knowledge and attitudes, climate change education, and outdoor

education to successfully teach students about climate change. This conclusion will review some of the connections that can be made between these themes in order to answer the research question: *How does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?*

Outdoor learning provides a natural opportunity to follow the learning cycle. It especially fits into the concept discovery. Students can discover the workings of their natural environment and use their discoveries to ask questions, make connections, and find patterns. Teachers can clarify still outdoors, or even in the classroom. Application can also occur outdoors or in the classroom.

Outdoor education is a developmentally appropriate way to learn for middle school students. Students in the concrete operational stage of development need hands-on opportunities for learning which can be provided in outdoor education. They also benefit from familiar examples being used to help explain complex concepts. Using the local environment to describe the impacts of climate change would be a good example of this in action. Outdoor education provides relevance for learning. This is an important need for middle school students.

Outdoor education gives students a connection to their environment, which is important in order for students to develop attitudes of action against climate change. When students spend time outdoors, they become connected to the place. A connection to place is also a factor that determines students' attitudes towards climate change and their likelihood of adopting pro-environmental behaviors. When students are connected to a place they want to protect it, including protecting it from the effects of climate change.

Climate education and outdoor education both seek a goal of protecting the environment. Using both together amplifies the likelihood of reaching this goal.

When learning about climate change, it can be difficult for students to recognize the scale of the problem. Outdoor education helps to teach about the issue of climate change on a local scale that is more tangible to students. Students can better visualize, or already see, the effects of climate change in their community.

Chapter 2 discussed the stages of development that middle school students are at. It then discussed general science teaching strategies that are effective for students developmentally. Next, the chapter discussed the current state of student knowledge towards climate change as well as factors that impact students attitudes towards climate change: socio-cultural identity, connectedness to nature, personal relevance. It then looked at how climate change is being taught currently as a stand alone topic with little time dedicated to it, as well as the best-implementation strategies for climate change education: place-based, inquiry-based, solution-based, and multidisciplinary. Finally, outdoor education was discussed in having benefits to students academically and socially-emotionally. It leads to a connection to nature which can cause students to adopt pro-environmental behaviors.

Chapter 3 will discuss the project developed in conjunction with the research question: *how does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings of climate change?* The chapter will introduce the curriculum project and review the curriculum design methods used in its creation, the intended audience, setting, and assessment.

CHAPTER 3

Introduction

This chapter will provide detail to the curriculum project developed from the research question: *how does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings toward climate change?* It will provide the necessary theories and methodologies to the curriculum development, including the learning cycle and Understanding by Design. This chapter will then describe the setting that the project will take place in, including a detailed description of the students using the project. A timeline of project development and implementation will be presented, including when and how assessment of the effectiveness of the project will occur.

Project Description

The project developed in this capstone will be a curriculum unit designed to blend outdoor learning and climate change education. The curriculum unit will be a life science unit that addresses ecosystems, biodiversity, and ecosystem services. The unit is designed to be completed over 15 days, with the final two days being the summative project. The summative project will be completed indoors due to the need for technology to complete research. Climate change is not a primary goal of these standards, yet it can be incorporated into discussions of human impacts and changes to ecosystems and biodiversity.

The specific NGSS standards addressed in this unit are MS-LS2-1, MS-LS2-4, MS-LS2-5, which require students to "analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem . . . construct an argument supported by empirical evidence that changes in

physical or biological components of an ecosystem affect populations . . . [and] evaluate competing design solutions for maintaining biodiversity or ecosystem services" (Achieve, Inc., 2017). In Minnesota, these are taught at the 7th grade level.

Given findings that climate change education is more effective in students developing pro-environmental behaviors when it is discussed on a local scale with personal relevance (Anderson, 2012; Monroe et al., 2019), and that students spending more time in an environment leads to increased desires of protection and connection of that environment (Chawla & Cushing, 2007; McGuire, 2015; Young et al., 2020), the curriculum unit will be developed to be fully implemented in an outdoor classroom setting.

The curriculum unit itself will incorporate discussions where students have the opportunity to share their opinion regarding climate change, hands-on learning opportunities that utilize the natural world, data-collection activities that use real-world data from their local environment, and journaling exercises for students to further share their thoughts and reflect on their local environment. The curriculum unit will be designed following the learning cycle. At the end of the unit, students will be assessed on their learning of biodiversity and population dynamics through a climate change lens.

Curriculum Theories and Models

In the development of this curriculum unit, several theories and curriculum models will be used in order to maximize effectiveness of the curriculum and ensure student learning and success. These theories include the learning cycle (Hick, 2017) and Understanding by Design (Wiggins & McTighe, 2011).

The Learning Cycle

The learning cycle, initially developed by Karplus and Butts (1977), is a method in science teaching used to guide students in learning through inquiry. The variation of the learning cycle that will be used in the development of this curriculum is the one that Hick (2017) developed. This version of the learning cycle condenses the steps into three different processes rather than five through combining some of the steps. The three stages of the learning cycle that will be included in the curriculum unit are concept discovery, concept clarification, and concept application. The unit will be designed with several learning cycle opportunities for students. Most learning cycles will be completed in one day, with a couple that will take two days. Student handouts will be created to show students which stage of the learning cycle they are in.

Understanding by Design

In their book, Understanding by Design, Wiggins and McTighe (2011) discuss the concept of backwards planning. Rather than designing a unit of curriculum by first planning the series of learning activities and then figuring out an assessment that relates to learning goals at the end, teachers should be planning backwards. Backwards planning is done in three different steps. The first step is to identify the learning goals or objectives of the unit. Teachers should decide what they want their students to be able to do and know. Then, using those learning goals, an assessment should be created that directly assesses those learning goals Wiggins and McTighe (2011). If something is not a learning goal, it should not be assessed. Once the assessment is created, teachers can now plan their learning activities to meet those learning goals. This method of design helps

teachers avoid the mistake of planning learning activities that, while they may be engaging or hands-on, do not actually help students meet the learning goals desired.

Backwards planning will be used in the development of the curriculum unit in this capstone. First, objectives for the unit will be created that scaffold learning so that students can reach the identified NGSS standard. Then, assessments will be created, both formative and summative, that allow teachers to identify if students are reaching the learning goals identified in the objectives. Finally, learning activities will be intentionally designed for students to meet learning goals.

Setting

The implementation of this curriculum unit will occur at the school of current employment. This school is in a suburb of Minneapolis. The entirety of the curriculum unit will be completed outdoors in 60 minute periods. Upon arriving to the classroom at the beginning of class, students will receive some instructions inside, and then will walk as a class to one of the outdoor teaching spaces available at the school campus. One outdoor teaching space includes the two courtyards enclosed by the school building. These are impermeable surfaces with some picnic benches, with one of them containing a vegetable garden managed by volunteers. Another outdoor teaching space is the sports field which is a giant grassy area surrounded by a row of trees. The tennis courts may also be used as another impermeable surface. Lastly, there is a small wooded area with a creek that may be used. This will be the primary teaching space. Given that the entire unit will be completed outside, students will not use technology, including their school-issued Chromebooks, for any part of the unit, with the exception of the summative assessment. .

Audience

This curriculum unit will be designed for a seventh grade life science class. These students are in their second year at the middle school so this is their second science class at the middle school level. In the first year of implementation, these students will have taken physical science in 6th grade. In the second year and beyond of implementation, these students will have taken earth science in 6th grade due to the adoption of the new NGSS-guided Minnesota standards that changed the sequence of middle school science. Students feed into the middle school from several different elementary schools in the district. The most represented ethnic groups and the percentages of each are as follows: 49% white, 18% Black, 17% Hispanic/Latino, and 8% Asian. The school has an English learner population of 11%, with Spanish and Somali being the most common heritage languages of these students. 35% of the students are eligible for free or reduced-priced lunch (Weisser & Holliday, 2021).

Timeline

This project will be developed in the Fall of 2022 during the initial months of the school year to be completed by December 2022. The project will then be implemented in the Spring of 2023 (or Fall 2023 depending on topic unit).

Assessment

Students will have formal and informal formative assessments throughout the unit that may take the form of exit cards, lab exercises, writing prompts, group discussions, and warm up exercises. Each day has a handout that will be collected as a formal formative assessment. At the end of the unit, students will have a summative project that

requires them to apply their knowledge of ecosystems and biodiversity through a climate change lens.

Chapter Summary

Chapter 3 presented the actual project that will be completed in the capstone. The project is a curriculum unit that addresses climate change and meets NGSS standards about ecosystems and biodiversity that will be taught entirely outdoors. Students will engage in different activities using their local school environment in an outdoor setting. This curriculum will be designed using backwards planning to follow the learning cycle. This curriculum will be taught over 15 days to 7th grade students in their life science course in one of their many outdoor learning environments available. The final two days of the unit will be taught indoors so students can access personal technology for the summative assessment which requires research.

Chapter 4 will provide the conclusion to the capstone after completion of the project. It will review the key findings of the literature review, summative key learnings from the development of the project, and provide limitations and implications of the project.

CHAPTER 4

Conclusion

Chapter Overview

This project was intended to answer the question: *how does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings of climate change?* This final chapter will address what I learned when creating an outdoor ecosystem and biodiversity unit for seventh grade students which incorporated climate change throughout. It will review the challenges to teaching about climate change outdoors, such as lack of access to digital resources, a lack of long-term data for local environments, and the challenge of incorporating climate change into standards that do not directly address climate change.

The chapter will then revisit the literature review which addresses effective science teaching methods, attitudes towards climate change, climate change education and outdoor education. A synopsis will be provided as well as new connections and understandings after completing the curriculum project itself.

Finally, this chapter will address implications of the project and areas for further exploration, such as outdoor climate change units in earth science at both the middle school and high school level, as well as ideas for climate change incorporation into physical science. It will address the limitations of this project, including how NGSS addresses climate change in its standards across varying grade levels and a switch in my subject of teaching from life science to physical science. It will also review ways that this project could be used by myself and others in my profession.

Research Synthesis

Throughout the curriculum writing process, the structure that was the easiest to follow was the abbreviated learning cycle suggested by Hicks (2017) that has only three steps: concept discovery, concept clarification, and concept clarification. I used this abbreviated learning cycle because it was easier to approach and hit all the steps each day than a longer version. I also found it important to stick to the backwards planning approach suggestion by Wiggins and McTighe (2011). I started my unit outline by identifying the standards that the unit would address, then created the objectives needed for students to be able to meet those standards, then created the summative and formative assessments that would assess the objectives I created, and finally put together the learning activities following the three-step learning cycle developed by Hicks (2017).

It was important that the unit remain entirely taught outside due to findings that students who spend more time outside and in nature are more likely to work for its protection (Chawla & Cushing, 2007). Students form emotional attachments to the landscape and then have a greater desire to protect it (Schweizer et al., 2013; McGuire, 2015). I also chose to do the entire unit outside instead of intermittent lessons outside out of the hope that a stronger connection would built between students and their local environment, and to make students more comfortable and ready to learn with the consistency that comes from going outside each day, instead of sporadically. Research has also found that students report finding it valuable to collect real-world scientific data in their local environment (James & Williams, 2017). Given that the standards addressed in this unit included collecting and analyzing data and evidence, it felt natural to have students collect data from the real-world.

In regards to climate change attitudes, most students understand that it will have an impact on humans and ecosystems (Hestness et al., 2019). This idea encouraged me to use the ecosystem unit as my selected unit for this project. The local scale of my project being implemented on school grounds would allow for students to more tangibly grasp the effects of climate change (Anderson, 2012; Bhattacharya et al., 2021; Scannell & Gifford, 2013). Climate change education is most effective when it is highly engaging (Arya & Maul, 2016), so the outdoor classroom was a very appropriate place for this unit to take place due to the nature of outdoor learning being more active, experiential, and applicable to the real world (Meighan & Rubenstein, 2018; James & Williams, 2017).

Reflections on Project Learnings

Given the amount of climate change information accessible online, including readings, videos with helpful infographics, and interactive simulations, it was more difficult than I anticipated to actually teach climate change entirely outdoors. Especially when I got to the summative at the end of the unit, I wanted students to be able to research some of the possible ways to mitigate the impacts of climate change, so I made the decision to have the summative be completed in the standard indoor classroom environment so students could have access to digital devices that would allow them to do further research. The inability to complete research on the effects of climate change led to less student designed learning based on their interests, and more of a scripted approach where I had to provide any resources that discussed climate change. For example, I couldn't have students research about how climate change would impact invasive species, I had to provide a specific article for students to read. Given printing constraints in most schools, it was not feasible to print out a wide variety of additional resources. Not to

mention that it was also not environmentally friendly in a unit designed to promote pro-environmental behavior.

Another challenge faced in this project was incorporating climate change into every single lesson without it feeling unnatural. There were lessons where I felt like it was natural to include it as a main focus, such as biodiversity and climate change's impact on populations, but there were definitely lessons where it felt like the main focus had to be on the scientific concept, like when discussing the types of biodiversity. There were times where I felt like I was having to add a question about climate change to the daily assignment just to keep it on everyone's mind throughout the unit. I expect that it would have been easier to make climate change the main focus in more lessons if I would have created an earth science unit that directly addressed climate change instead of a life science unit where climate change was a supplemental concept to the main ideas of population dynamics, biodiversity, and ecosystem services. This finding makes me further understand why climate change education tends to be an add on to other topics in science education (Bhattacharya et al., 2021)

A final learning was that it was difficult to get into the data of climate change when I did not have long-term localized data for this specific site. In trying to keep the unit investigative on a very local scale by collecting data from just the outdoor classroom area and the school grounds, it was difficult to analyze any long term patterns that could be due to climate change. If this unit was completed over many years, it would be interesting to provide that data to students in the future so that they could look for trends that could be influenced by climate change, but without that, we couldn't necessarily analyze how this specific ecosystem has been impacted by climate change. I ended up

incorporating the investigation of human impact rather than the impact of climate change in several lessons because that was easier to directly observe. It was beneficial to have both an outdoor natural environment as well as the outdoor built environment (school grounds, sports fields, parking lots, gardens) as it provided opportunities to have data collection and comparison happen between the two locations.

Project Limitations

The limitations of this project can be summarized into two main categories: the limitations of my current teaching content and the logistical constraints of implementation.

Teaching Content

One of the limitations of this project is that I am no longer teaching the content that it addresses. In Minnesota, the NGSS standards addressed in this unit–MS-LS2-1, MS-LS2-4, MS-LS2-5 (Achieve, Inc., 2017)–are all taught in 7th grade. When I started this project I was still teaching 7th grade life science, so the intent was that the project would be able to be used in my classroom. Since starting the project, I have not only switched schools, but I have also switched content areas and am now teaching 8th grade physical science. Because of this switch, I will not be able to test out the curriculum unit myself for the foreseeable future and make edits to it based on student success.

Another limitation is that the NGSS standard that specifically addresses climate change, MS-ESS3-5, by having students "ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century" (Achieve, Inc., 2017, p. 71) is addressed in 6th grade in Minnesota. While this suggests that students would have already learned about climate change before completing this curriculum unit,

because they are completing it the year prior, students may not have all retained the same amount of knowledge, and it will be necessary to review the basic ideas of climate change. Their 6th grade science teachers could also persuade their thoughts on climate change if it was taught in a specific way.

Logistics

Another limitation of this project are the logistics required to implement the unit. Because the unit is to be completed entirely outside. There are additional time constraints and logistical challenges to getting a class outside. Time will need to be sacrificed at the beginning and end of each class period to get students prepared to go out and back in on time to make it to their next class. Teachers will need to find a way to prepare and get all needed materials outside and set up in the morning or the day before. If teachers have other duties before or after school that must be completed indoors, this could be a challenge. Teachers will also need to print all materials in advance which can be more work than a digital assignment. It will also need to be determined how students who are absent can make up the work, as many of the activities will not be able to be made up on their own time outside of class.

Another logistical limitation is the classroom space itself. This unit requires a natural area with students to use, preferably with a built environment adjacent to it, a creek or water access, and invasive species. If some of these things are not present then teachers would have to modify some of the lessons in order to make them work. Or they may have to complete certain lessons indoors.

Lastly, the weather and climate will be a limitation. In Minnesota, students will only be able to go outside to learn comfortably in the spring and the fall. Therefore, the

yearly pacing guide will have to be planned with weather in mind to ensure that climate change can be taught either in the spring or the fall. Also, daily weather can be unpredictable, so back-up plans will need to be created in the case of poor weather on a given day. Even if the weather is bad for just a part of the day, plans will have to ensure that all classes throughout the day have equitable learning opportunities.

Project Implications

This project can potentially provide more outdoor time for students. If students are feeling restless in class, this provides them the opportunity to be more active and express curiosity in the natural world. It could allow students to form a stronger connection with the natural world. It could also make students more environmentally conscious after they see how climate change could impact their local environment.

In terms of policy implications, this project could suggest that environmental policy be passed to require climate change education. Given that students with higher levels of knowledge regarding climate change are more likely to engage in pro-environmental behaviors, it makes sense to invest funding into teaching students about climate change. One of the challenges of developing this unit was finding localized climate change data and educational resources. After completing this project, I believe that a good use of funding would be to develop localized climate change curriculum that includes climate data from local communities. This could be done by local government agencies or non-profit organizations.

Future Related Projects

There are several projects that could be created following this project. Given that this project addressed 7th grade NGSS standards which were not directly related to

climate change, a next step would be to create outdoor middle school and high school earth science units that address standards that directly relate to climate change: MS-ESS3-5, HS-ESS2-4, HS-ESS3-1, HS-ESS3-4, and HS-ESS3-5 (Achieve, Inc., 2017). Other possible units that could possibly incorporate climate change education include chemistry units looking at the chemistry behind the greenhouse effect and units on renewable energy.

Project Use and Communication

Despite my current position teaching physical science, I would still share this project with colleagues in my school and other middle schools in the district to utilize with their students. This project benefits the profession because it allows for teachers to teach an entire unit outdoors. Many environmental education lessons are designed for informal education with smaller groups, but this provides a lesson that can be completed by an entire classroom of students.

Conclusion

This chapter summarizes and reflects upon the capstone created to answer the research question: *how does learning about climate change in an outdoor classroom impact middle schoolers' attitudes and understandings of climate change?* In this chapter I synthesize the information gathered in the literature review. I then reflect on my key learnings from completing this project: the challenges of teaching climate change completely outside, incorporating climate change education into life science standards that don't directly address climate change, and the difficulties of not having localized climate change data. Limitations to the project are discussed, such as science content constraints and logistical constraints, as well as implications of the project.

I hope that this project provides a model for further outdoor curriculum development that can be used by a standard classroom. With climate change continuing to be a challenge that will need to be addressed, this unit will hopefully serve as one example of how to address climate change in education at a localized scale. Students will need to be educated about climate change and hopefully this project provides another opportunity for students to learn about it in an outdoor setting.

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