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An Outdoor Curriculum Based In Phenology And Ecology Promoting The Environmental Stewardship Of Middle School Students

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AN OUTDOOR CURRICULUM BASED IN PHENOLOGY AND ECOLOGY PROMOTING THE ENVIRONMENTAL STEWARDSHIP OF MIDDLE SCHOOL STUDENTS

by

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TABLE OF CONTENTS

CHAPTER 1

Introduction

"An environment-based education movement -- at all levels of education -- will help students realize that school isn't supposed to be a polite form of incarceration, but a portal to the wider world." -Richard Lou (2005) *Last Child in the Woods: Saving our Children from the Nature Deficit Disorder*

Appreciating the Natural World

We have only one Earth, and we humans are the sole protectors of this natural world. This job, to protect our Earth by making environmentally responsive decisions, was not high on my priority list until I spent extensive time backpacking through Alaska. Being surrounded by the beauty of the mountains gave me a new appreciation for the natural world. Although I studied and taught biology for most of my adult life, it took this adventure for me to realize how closely life science related to the wonders of the environment. That experience also gave me new questions and purpose as a middle school biology teacher. Is it possible to teach my students to appreciate the environment enough to want to protect it? Can I do so by incorporating outdoor education into my curriculum? Because I live in Minnesota, can I incorporate the study of seasonal changes and the relationships of organisms into my curriculum? These thoughts culminated into one research question: *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?* I cannot bring all my students to the mountains of Alaska, but I can help them explore the environment in their own backyard.

In chapter 1, I discuss my personal journey that brought me to this area of focus. In addition, I incorporate the state of our environment, and why it is crucial for students to develop

a sense of environmental stewardship. It is my hope that other science teachers may use this project as inspiration to get their students outside enjoying nature enough to want to protect it.

Personal Journey

Two of my biggest passions are exploring the outdoors and teaching, and neither of them flourished until after I graduated college. I grew up in a middle-class neighborhood the outer suburbs of Minneapolis, and my family was your average city folk. We took part in the occasional outdoor activity, like going to the pool or playing basketball in the driveway, but we were not avid campers or adventurers. I continued this tradition of spending time safely indoors until I turned twenty-two, and my best friend graduated from college and moved to Alaska. I visited her that year, and we backpacked through the mountains for two weeks. It was a crash course into enjoying nature. My world was opened to mountains, wildlife, climbing, hiking, camping, fishing and general adventuring. My obsession with the natural world started, and for the next two years, I would hike in four mountain ranges, visit over ten national parks, and sleep in a tent for over five weeks. I gained an immense appreciation for the environment and all it offered me, and I also realized the fragility of the natural world. I started to understand that if the environment is not protected, all the joys of exploration are gone to negative human impact.

When I was not traveling, I was teaching middle school science in a small rural town outside Madison, Wisconsin. Most of my students were from lower income families, and only about half of them had ever left the state. They spent time outside to work on the family farm or bike to school, but they did not actively choose to enjoy or study nature. As I was cleaning my classroom one day, I found an entire class set of water testing equipment. Our school had a large stream running outside, and I started taking my students to test the water once a week. They would measure turbidity, alkalinity, phosphate, nitrate and chlorine concentrations, and the

amount of dissolved oxygen in the water. They took data for each week, and became very worried about the health of the stream. We ended up devoting several weeks toward water quality, and they designed solutions to increase water health. My students became stronger environmental stewards through this small curriculum change. This experience gave me critical questions as an educator. Did this small shift in curriculum give students a closer connection with nature? How can I give my students other meaningful experiences outside that will influence their environmental stewardship? I wanted to pursue this idea, so I moved to Minnesota and pursued a master's in Natural Science and Environmental Education.

A few years later, I found myself teaching 7th grade science in the suburbs of Minneapolis. I started seeing parallels between my old and new students. They too were not spending time outside to enjoy or study the natural world. I noticed a potential relationship between my adventures outside of the classroom, my experiences with my students in Wisconsin, and the content taught in this new school. Because I was teaching life science again, I started to think critically about how my curriculum could be incorporated outside. I wondered if observation and study of the natural world would allow my students to appreciate the Earth and the environment. Would they have a similar experience to my Wisconsin students? As I got more excited, I realized there was one big hurdle. There are no direct environmental science standards in Minnesota, and we are pressured to cover a wide range of content each year. If I were going to develop an outdoor curriculum, I needed to incorporate current Minnesota standards. Phenology and ecology seemed to bridge the gap between outdoor education and required curriculum content.

Rationale

Louv's (2005) *Last Child in the Woods* exemplified the importance of environmental education today. He called the increasing divide between youth and nature the nature-deficit disorder, and argued how this shortfall will negatively influence our Earth and daily lives (Louv, 2005, p. 36). Louv states that nature-deficit causes attention difficulties, higher rates of physical or emotional illness, and negatively impacts human behavior (Louv, 2005, p. 36). Through Louv's influence and my personal experiences, I feel a personal responsibility for bridging the gap between my students and the natural world. If my students are not going to study or appreciate nature by themselves, I must give them those experiences. I must turn their deficit into a surplus by getting them outside and interacting with their environment. By developing a curriculum that incorporates science standards and outdoor education, I hope students will develop an intimacy with the Earth.

The goal of my curriculum is to develop protectors and admirers of the environment. A meta-analysis of environmental behavior research conducted by Hines et. al (1987) concluded that attitude and an individual's sense of responsibility were associated with responsible environmental behavior. This study connects to the intended effects of my outdoor curriculum. I hope that through creating and implementing a curriculum that gets students outside studying their environment, my students will develop an understanding and appreciation of the natural world. I also hope that this will empower them to make environmentally responsive decisions.

Curriculum Project

I hope to develop a curriculum that studies the changes of the forest ecosystem outside of our suburban middle school during the school year through the lens of ecology and phenology. The goal of this curriculum is to promote environmental stewardship in middle school students.

I hope this curriculum increases students' understanding and appreciation of the natural world, and empowers them to make environmentally responsible decisions. The curriculum will start by observing the flora and fauna of a deciduous forest in an autumn timeline. It will continue studying the seasonal changes of trees throughout the year.

In chapter 2, I will provide research on several topics that inspire and meld into my outdoor curriculum. I start by researching the nature-deficit disorder and how to foster environmental stewardship. I transition into outdoor education, including aspects of phenology and ecology into my research. Because my curriculum will take place in the forest outside our middle school, I end chapter 2 by researching the importance of place-based education in environmental science. In Chapter 3, I provide a detailed explanation of my outdoor curriculum. I identify the intended audience and context in which my curriculum takes place, and I describe the theories used to complete the project. In Chapter 4, I present the curriculum itself and my reflections while writing it.

CHAPTER TWO

Review of Literature

"Exploration of the natural world begins in early childhood, flourishes in middle childhood, and continues in adolescence as a pleasure and a source of strength for social action." David Sobel (1996) Beyond Ecophobia: Reclaiming the Heart in Nature Education

Chapter Overview

Chapter two outlines the literature relating to the curriculum question: *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?* It reviews the nature-deficit disorder and how it stresses the importance of outdoor education. It also reviews some of the literature on fostering environmental stewardship in students and describe the benefits of outdoor and place-based education toward environmental attitudes and behaviors. Since the curriculum is based in phenology and ecology, research on these topics is included throughout this chapter.

Nature-Deficit Disorder

Ask people of an older generation about their childhood, and there will hear stories of time playing outside in unstructured activities; including building forts, roaming in the woods, and embracing nature through the senses (Clements, 2004). Today, research shows children's connection to the natural world is limited and fading (Clements, 2004; Hofferth & Sandberg, 2001). A study conducted by Hofferth and Sandberg (2001) at the University of Maryland looked at children's, ages nine to twelve, outdoor activity levels. They discovered the time spent doing outdoor activities declined 50 percent from 1997 to 2003. These results are supported through parent surveys as well. Clements (2004), a professor of education at Manhattanville College in NY state, surveyed 800 mothers. About 71 percent said they recalled playing outdoors

everyday as children, but only 26 percent said they encourage their children to play outside daily. Interestingly enough, their responses also did not vary a great deal between rural and urban areas (Clements, 2004). This phenomenon of children spending less time outside was termed the "nature-deficit disorder" by Louv (2005). The cause of this alienation from nature is blamed on technology, adult influences, lack of physical space for children to play outside, and ecophobia.

If children are not spending time outside, what are they doing with their time instead? Technology seems to replace at least part of the time older generations spent in nature. Researchers at the University of Maryland found that between 1981 and 2003, children spent less time in unstructured indoor and outdoor play, and computer use doubled (Louv, 2005, p. 119). Furthermore, studies conducted through the Kaiser Family Foundation in 2005 and 2006 found that nearly one-third of children from six months to six years of age lived in households where the television was on most of the time. They also found that children between the ages eight and eighteen years old spent an average of 6.5 hours a day on electronics, and over a fourth of the time, young people were using more than one medium simultaneously (Rideout et al., 2010). In Israel, researchers revealed that nearly all adults surveyed indicated that natural outdoor areas were the most significant environments of their childhoods, while less than half of children ages 8 to 11 shared that view (Louv, 2005, p. 33).

Although adults routinely say they want children to play outside, actions and messages state differently. Fear of the outdoors cause parents to limit their children's experiences in nature (Louv, 2005, p. 14). Clements (2004) surveyed 800 mothers about their children's experiences compared to their own. Results showed 71 percent of the mothers remembered playing outside everyday as children, but only 26 percent stated that their children do the same. While the mothers recognized the benefits of playing outside, they felt concerns about crime, safety and

injury were keeping their children inside. These children are described as the backseat generation. Parents escort them everywhere by car, and they only experience nature through technology (Driessnack, 2009).

A strong argument in Louv's (2005) *Last child in the woods: Saving our children from nature-deficit disorder* is the lack of physical space to explore nature is another culprit to children's lack of outdoor experiences (Louv, 2005, p. 28-33). For example, each year 5,300 acres of land are developed in the Chesapeake Bay watershed. Charlotte, North Carolina region lost 20% of its forest cover between 1982 and 2002. North Carolina also lost farmland and forests at the rate of 383 acres per day. Well-meaning environmental regulations, building regulations and park rules also limit children's access to nature (Louv, 2005, p. 28-33). Treehouses usually need building permits, for example. Camping and fishing may be closed in certain regions due to environmental concerns (Louv, 2005, p. 28-33). Tree climbing may be banned due to injury toward the tree. At California's Oceano Dunes region, kite flying was banned due to scaring off a certain species of bird (Louv, 2005, p. 28-33).

Children's lack of experience with the natural world is apparent throughout research. They can discuss the problems occurring in the Amazon rainforest, but not what flora and fauna occur in their own backyard. A British study, for example, discovered that the average 8 year old knew Pokemon characters more than they knew the plants in their environment. They could identify Pikachu and Metapod, but did not pinpoint a beetle or an oak tree (Balmford et al., 2002).

Although they are not familiar with their current environment, young children can accurately describe the problems with the environment (Driessnack, 2009). Current environmental science practices discuss global warming and the impact of deforestation of the

rainforest, but ignore place-based practices, such as what watershed is affected if they litter outside their house. Direct experiences with nature are being replaced by indirect experiences through electronic media. Children are not experiencing their world directly and are unable to relate to live experiences of their own natural world (Driessnack, 2009).

Today's children are growing up in a world burdened by environmental problems (Sobel, 1996). Children experience distress about worrying about environmental degradation. Sobel (1996) discussed the idea of ecophobia. Ecophobia occurs when children become overwhelmed with the state of the natural environment, and block out environmental issues as a form of defense. Instead of becoming empowered, they become frozen (Sobel, 1996). Strife (2002) found that 82% of children surveyed expressed environmental concern when asked their feelings regarding environmental problems. The concerns included destruction of nature, global warming, air, pollution and killing animals (Strife, 2012, p. 42). However, this may not always be the case. A survey comparing environmental awareness among 1,220 German and Russian youth found that while adolescents in both countries expressed anxiety, sadness and anger about environmental destruction, they were willing to participate in environmental behaviors such as conserving energy and recycling. This shows that even though they have anxiety about the environmental future, they do not feel hopeless about the Earth's situation (Strife, 2012, p. 39).

Fostering Environmental Stewardship

It has been said before, but what is taught to children now will impact the future of our Earth. That is why it is important for educators to teach kids to be environmental stewards, or protectors of the natural environment (Ashbrook, 2016, p. 26). Environmental stewardship is a moral commitment to the environment. It implies that the person contains an intrinsic responsibility to the Earth, and will make choices that reflect that responsibility. In any

environmental education program, it is important to consider the role of values and ethics when fostering environmental stewardship (Siemer, 2001, p. 18).

University students from six countries, Brazil, Czech Republic, India, Germany, New Zealand and Russia, completed a questionnaire to measure environmental attitudes and behaviors. Through this research, Schultz et al. (2005) found three values associated with environmental stewardship: egoistic, altruistic and biospheric values. Egoistic values included health, future and lifestyle. Altruistic values referred to community belonging and being with other people. Lastly, biospheric values included a responsibility to plants, animals and birds (Schultz et al., 2005, p. 457). They also predicted that environmental behaviors were influenced greatly when participants felt a sense of responsibility for local environmental problems (Schultz, et al., 2005, p. 460).

Other research shows that personal experience is important in shaping attitudes and motivation toward protecting nature (Lutz & Srogi, 2010, p. 14). To identify environmental motivation, Bramston et al. (2010) distributed a questionnaire to university students in Australia who were already active environmentalists. The results identified three core aspects of motivation. The first was a sense of belonging within the environmental community. The second was a responsibility toward the Earth, and the third was expanding their personal knowledge on environmental issues (Bramston et al., 2010, p. 776). Studies in the field of environmental education also found that emotion plays a key role in determining environmental motivations. Environmentalists expressed love for nature and outrage at its destruction (Horwitz, 1996).

Personal experience relates closely to environmental identities within students. Environmental identity describes an individual's connection to the natural environment based on personal experiences (Clayton & Opotow, 2003). If students identify with an environmental

responsibility, they are stronger environmental stewards. Student identities can be closely influenced by experiences in the classroom. It is important to establish a personal connection with environmental issues (Blatt, 2014, p. 194). Increasing students' awareness of their local environment helps build a stronger sense of behavioral change and stewardship (Kellert, 1987).

To inspire environmental stewardship in students, researchers suggest helping them discover the wonders of nature. The more students contain an appreciation for the Earth, the more likely they will want to protect it (Litz, 2010, p. 163). Environmental curriculum should develop a sense of stewardship equivalent to students' developmental level. In younger grades, for example, students can explore and examine species in their local environments (Ashbrook, 2016, p. 26).

Outdoor Education

When describing outdoor education, it can mean one of three things. The outdoors can be a medium for learning different cultural or environmental topics. The outdoors can be used to increase conservation sensitivity and awareness. Lastly, the outdoors can be a place where learning happens. Most research looks at the benefits of the last meaning, and focuses on how moving students outside benefits their environmental awareness (Crompton & Sellar, 1981, p. 21).

Direct nature experiences are known to foster positive environmental attitudes. Bogner (1998) surveyed students before and after a one-month outdoor biology program. He collected student responses regarding attitude and behavior toward the environment (p. 18). Students enrolled in the program had higher scores in comparison to average populations. The results showed a positive change in the understanding and sensitivity toward man-made environments and a new acknowledgement for natural and ecological systems (p. 26). Similarly, Millard

(1973) investigated the effect that a five-day outdoor program had on sixth grader attitudes toward outdoor concepts. The students were given a pretest and a post test, and he measured student attitudes toward the environment. The groups of students report significant changes in total attitude scores after one week of the program (Millard, 1973). If Millard's students showed changes after only week, there is hope to see even bigger changes in students that go through an outdoor curriculum throughout the year.

The goal of outdoor education is to develop students' awareness and concern about their local ecosystem and shape student behavior toward environmental conservation (Bogner, 1998, p. 17). Environmental education that focuses on local and natural areas can lead to the development of environmental sensitivity (Sturner et al., 2013, p. 71). For example, in 2010, students at Gulf Shore Middle School in Alabama witnessed an oil spill practically in their backyard. A science teacher, Will Tuggle, introduced the students to the ideas of environmental concern and convinced them to get involved outside with the cleanup. The students ended up launching a program called Citizen Environmental Organization that focuses on local environmental issues (Kaye, 2011, p. 11). Their outdoor education program allowed the students to become stewards of their local environment. When students are introduced to local environmental issues, they become personally linked to nature (Bogner, 1998, p. 27).

Outdoor education can facilitate positive environmental attitudes and a stimulating learning environment if the area of study is meaningful for the students and the duration of the program is long enough (Crompton & Sellar, 1981, p. 29). Bogner (1998) noticed that the longer the outdoor biology program, the better the students' attitude and behavior toward the environment (p. 26).

Phenology Curriculum. One of the ways to bring science curriculum outdoors in an authentic way is through phenology. Phenology is the branch of science dealing with relationships between climate and the changing flora and fauna. Students keep track of blooming flowers, seeding and passing of plants, the coming and going of fungi, and insect patterns (Weber, 2013, p. 9). Larry Weber, the 1998 National Biology Teacher Association's Middle School Life Science Teacher of the Year and the 1993 Minnesota Secondary Science Teacher of the Year, used phenology as the basis for his science curriculum (Weber, 2011). In his book, *Minnesota Phenology: Seasonal Northland Nature* (2013), he discussed how he used phenology in his classroom by studying whatever was going on that time of year. Every week or two, they would go outside to see natural phenomena (Weber, 2013, p. 11).

Ecology Curriculum. Humans affect the ecology of the Earth in numerous ways. Negative environmental actions will have consequences and costs -- it already has. Human choices are largely determined by the knowledge of what we affect. Therefore, teaching about ecology and nature matters for the health and sustainability of our earth (Kricher, 2009, p. 4). Outdoor biology education has a long tradition of focusing on environmental protection and conservation (Bogner, 1998, p. 18). However, conservation now means so much more than the protection of endangered species. It now deals with how to bring economic, social and environmental issues together in a way that the ecosystems will continue to survive (Kricher, 2009, p. 192).

One element lacking in many science curriculums is the joy of discovery. Outdoor learning provides a setting where students can experience the fun of learning (Hammerman & Hammerman, 1973, p. 13). Evidence suggests that using teacher-centered strategies exclusively fails students, and they should not be the primary form of instruction. Learning does not need to

be confined to a classroom or school building. Outdoor learning allows students to engage with their world in meaningful and authentic ways (Ellison, 2013, p. 180). Outdoor programs allow students to learn through the full use of the five senses, and connects to the visual, auditory and kinesthetic styles of learning (Priest, 1986, p. 13). Priest (1986) argued that any content that can be best learned through experience dealing directly with nature and life situations should be located outside (p. 14).

Place-Based Education

In the early 20th century, nature walks and direct contact with plants and animals in their natural surroundings were the foundation of natural science (Baker, 2005, p. 268). Now, students spend about 1,000 hours in school. Because school is the primary way students receive ways to think, speak and relate to the world, it is instrumental in passing on cultural templates to the next generation. However, general education teaches students that their relationship with their natural environments is unimportant. Textbooks, for example, place value on general and national examples and facts. They take students away from their own experience of place, family and community (Sanger, 1997, p. 4). To help students grow into responsible citizens in their own community, teachers must give them the opportunity to be culturally and ecologically competent in their own communities (Sanger, 1997, p. 5). There should be a learning model that fosters a deep and meaningful connection to their natural environment, otherwise students become disconnected from their place (Ellison, 2013, p. 186).

Place-based education puts students back into their own communities and natural environments. It allows students to learn in an environment that is local, whether it be the history, culture or environment of their own community. A student's sense of place is a combination of his or her understanding of and the connection to the area they inhabit. It refers to

the natural processes, communities, and history of one's place (Sanger, 1997, p. 4). The framework for place-based education focuses on direct observation and sensory experiences, beginning with students interacting with the natural world directly (Ellison, 2013, p. 185).

The place needs to be a tool where knowledge can be constructed (Ellison, 2013, p. 183). Teachers need to start questioning if students are becoming actively engaged in their natural environments, or if they are just passing through it (Baker, 2005, p. 269). The first step in developing a connection to the natural environment requires direct experience. Educators need to create a value with the environment by taking students outside to experience the natural processes around them. When teachers emphasize the importance of place, it shows students that the land has value. It also connects the real world to the students (Sanger, 1997, p. 5). It relates to the importance of environmental education. When students see a meaningful relationship with a place, they are more likely to care for it (Ellison, 2013, p. 183).

Educators can create a sense of place with students by allowing them to discover a belonging to the land. By experiencing an area through all the senses, including emotionally, the land relates more to who students are and becomes part of their identity (Baker, 2005, p. 270). Baker (2005) suggested an inquiry approach to outdoor place-based education. She increases student awareness of their surroundings, and incorporates natural and cultural history of the area. She wants her students to know how the land has changed over time (Baker, 2005, p. 273).

Often place-based education focuses on the environmental attributes of place, but the history and culture of the area is important as well. Students need to understand sense of place as a social construct as well that forms their personal cultural identity. If this is neglected, it may disconnect students from their roots (Ellison, 2013, p. 186). If history is incorporated, students start to see themselves as a continuous line from the past to the present. They will be able to

visualize their role in the future, and become responsible citizens of their community (Sanger, 1997, p. 5). In fact, a common critique of place-based education is the lack of local social and cultural contexts. When indigenous culture and heritage are incorporated into the curriculum, it links power and education (Greenwood, 2013, p. 454).

Conclusion

Children's lack of experience with the natural world is apparent throughout research (Louv, 2005., Driessnack, 2009., Clements, 2004). Outdoor education is a solution that can help students interact with nature while fostering a positive attitude with the environment (Bogner, 1998, p. 18). If added, place-based education can further help students realize their place in the future of the environment (Sanger, 1997, p. 5). These concepts formulated the ideas for a curriculum that help students value the environment. Chapter three will describe the curriculum project that answers the question: *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?*

CHAPTER 3

Methods

"If we want children to flourish to become truly, empowered let us allow them to love the Earth before we ask them to save it." David Sobel (1996) Beyond Ecophobia: Reclaiming the Heart in Nature Education

Chapter Overview

The purpose of this capstone was to complete the research question: *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?* I wrote an outdoor curriculum based in phenology and ecology to increase environmental stewardship of middle school students. The curriculum utilizes place-based education in a science outdoor setting to foster positive attitudes towards the environment. Because outdoor education creates an understanding and sensitivity toward the environment and natural and ecological systems, it was the basis for the curriculum design (Bogner, 1998, p. 26). Chapter three discusses the rationale behind this capstone curriculum, the process used during development, the setting and participants, and the outline of the curriculum.

Rationale

Research shows that personal experience is important in shaping attitudes and motivation toward protecting nature (Lutz & Srogi, 2010, p. 14). This curriculum aimed to provide middle school students with positive experiences in nature while learning phenology and ecology of their own natural environment. Learning in their local environment helps students understand and connect to nature (Sanger, 1997, p. 4). Furthermore, using the foundation of phenology and ecology will bring more meaning to this curriculum. Teaching about ecology and nature matters for the health and sustainability of our earth (Kricher, 2009, p. 4). Phenology connects students

with the relationships between climate and the changing flora and fauna (Weber, 2013, p. 9). Together, these aspects developed a curriculum that should foster environmental stewardship.

Project Description

The format used to design this curriculum is based in Understanding by Design, outlined by Wiggins and McTighe (2011). Understanding by Design focuses on the development and deepening of student understanding through big ideas and essential questions (p. 4). Effective curriculum is planned backwards, with results as the forefront of planning, and focus on learning, not just teaching (Wiggins & McTighe, 2011, p. 4). The curriculum focused on two big essential questions. The first question involves phenological research: *How do deciduous trees change with the seasons?* The students explore this question through an ongoing, weekly phenological study. The second question involved place-based outdoor exploration: *What is in the forest that I've never seen before?* The students explore the forest's trees, grasses, vernal ponds and forest floor.

Phenology Study. Phenology and ecology are common themes throughout the curriculum, and they are the basis for the content. Weber's *Minnesota phenology: Seasonal northland nature* (2013) provided inspiration for observations found in this curriculum. Outdoor education can facilitate positive environmental attitudes and a stimulating learning environment if the area of study is meaningful for the students and the duration of the program is long enough (Crompton & Sellar, 1981, p. 29). To create a meaningful and lengthy outdoor experience for students, I included a weekly phenology journal into this curriculum. The students first identify two trees in the forest that are the same species. They observe the changes these trees encounter as the day length decreases and winter approaches. Bogner (1998) noticed that the longer the outdoor biology program, the better the students' attitude and behavior toward the environment

(p. 26). Because I want my curriculum to promote environmental stewardship, the students complete these observations once a week. Their observations focus on the stages of change deciduous trees encounter throughout the seasons, including leaf folding, leaf color, leaf dropping, flowering and fruits. This activity can be found in Appendix A.

Forest Exploration. This part of the curriculum focused on place-based education in the outdoors. The framework for place-based education emphasizes direct observation and sensory experiences, beginning with students interacting with the natural world directly (Ellison, 2013, p. 185). Direct interactions with the environment are highlighted throughout the development of this curriculum. Furthermore, outdoor programs allow students to learn through the full use of the five senses, and connects to the visual, auditory, and kinesthetic styles of learning (Priest, 1986, p. 13). The students start by observing and identifying the types of trees in the forest. They are using the dichotomous key from Rathke (1995) *Beginners Guide to Minnesota Trees* to find five different species in the forest. They also answer two post-lab questions that are consistent among all activities in this curriculum: *1) What did you see today that you've never seen before? 2) How do you think your observations would change with the changing seasons?* I chose these two questions, because it maintained the focus on outdoor discovery and phenology. This activity can be found in Appendix B.

The students continue their outdoor exploration through labs that focus on observations in the forest understory, the vernal ponds, and the grasses that surround the forest. For the forest understory lab, they move over logs and observe any type of organism found on the ground. The students collect macroinvertebrates and other organisms found in the vernal ponds, and use sweep nets to collect organisms among the grasses. These three activities are focusing on discovery. Like the tree identification lab, they end with the two questions: *1) What did you see*

today that you've never seen before? 2) How do you think your observations would change with the changing seasons? These activities can be found in Appendix C, D, and E.

Curriculum Assessment

The goal of my curriculum is to foster environmental stewardship and give students a sense of place in nature. To asses if it is effective, I plan to survey the students and about the importance of protecting the environment as well as descriptions of both nature before and after implementation. The survey is simple and consists of only three major questions: *1) When you think of "the environment," what comes to mind? 2) When you walk into a forest, what do you expect to see? 3) Why should we protect the environment?* The survey can be found in Appendix F. Each of these questions focuses on what I hope to accomplish with the curriculum. If the curriculum was successful in giving students a sense of place, the idea of "the environment" will become closer to home. If the curriculum truly immersed students in nature, they will be more descriptive and aware of what is in the forest. Lastly, if the curriculum fostered environmental stewardship, the students will describe that passion and why we should protect it. These questions help me assess if my curriculum answers the research question: *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?*

Setting and Participants

This curriculum was written for a formal education setting. It can be used in any middle school classroom that has access to an outdoor deciduous forest or vernal pond. The phenology base for the curriculum is specific to Minnesota, therefore only Minnesotan schools should use it directly. However, modifications may be made to accommodate other climates, flora, and fauna.

The size of the class will also influence the curriculum's effectiveness. To increase student-to-student interactions, the class size should accommodate groups of three or four students.

Timeline

The timeline of this capstone was two semesters. The literature review and background for the capstone was completed between September 2016 and January 2017. The development of the curriculum and reflection was completed in June 2017. The capstone was completed and presented in August 7th, 2017.

Conclusion

Chapter three defines the rationale and process used when guiding curriculum development. It provides a detailed explanation of the curriculum that was developed to answer the research question, *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?* It also includes the setting and participants of the curriculum. Chapter four includes my reflection on the curriculum writing process, and it describes why it will be effective with middle school science students.

CHAPTER 4

Reflection

"Instead of being a science of firsts, phenology has become a science of everything." Larry Weber (2013) *Minnesota phenology: Seasonal northland nature*

Chapter Overview

Chapter four provides my reflection on the curriculum question: *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?* It reviews why phenology and ecological discovery are the focus of my curriculum. It also discusses my reflection on curriculum design and my future plans for implementation.

Phenology Curriculum

Starting this capstone, I had limited knowledge on Minnesota's phenology phenomena. Weber's *Minnesota phenology: Seasonal northland nature* (2013) inspired a major aspect of my phenology curriculum. It taught me how seasonal changes can be observed through a Minnesota lens, and I used these ideas to create a time every week for students to observe their natural environment in a structured way. Weber (2013) provided a basis for an effective curriculum model, because it inspired an extended time for students to be outside exploring nature. However, I dealt with difficulty on how to approach these ideas with outdoor lessons. The phenology observations were clear, but how to implement them was not. Through researching, I found two online databases that collect phenological research from students, USA Phenology Network (n.d) and Regular Reports: Deciduous Trees and Shrubs (2016). I used these websites as a guide for developing my own observational tool for my students. This aspect of my curriculum allows students to keep a journal record, so they can return to it and analyze seasonal

changes. Writing the journal outline was the most fun for me. I wanted something that was structured enough for students, but allowed their voice to come through in the observations. I am particularly excited about implementing this part of my curriculum. I'm curious to see if my students get excited to check their trees every week. I believe this phenology study will allow my curriculum to be effective in its goal, and it will bring students a closer connection to their natural world.

Ecological Research Curriculum

The biggest idea I learned during this capstone is how simply spending time outside can inspire love for the environment. Research shows that outdoor education programs allow students to become stewards of their local environment and linking them closer to nature (Bogner, 1998, p. 27). Furthermore, when teachers emphasize the importance of place, it shows students that the land has value. It also connects the real world to the students (Sanger, 1997, p. 5). My goal was to connect students to their local environment through ecological studies. Hopefully, in the end, they would be inspired to protect it. I thought it would be more difficult to narrow down activities to conduct ecological observations, but I focused on the different habitats located within the forest. My hope is that other educators can use them as inspiration to look at the different habitats within similar ecosystems.

Implementation

I will implement my curriculum with thirty students in Fall 2017. I will use the phenology activity found in Appendix A once a week for a total of eight weeks. I will also use the ecological research activities the first week of their science course. I will assess the curriculum and its effectiveness on environmental stewardship using the student survey found in Appendix F. The survey will be given to the students in September and December of 2017.

Limitations

When writing my curriculum, I thought about its limitations. Time was always in the back of my mind. As educators, we are often fighting an endless battle of teaching all the standards fully in the limited school year. In creating my curriculum, I knew it had to account for the limited time of the educator. Therefore, I created a phenology discovery that can be applied each week, once every two weeks, or once a month. I also created four other ecological research activities that can be used consecutively, once a week, or once a month. It is important to create a flexible curriculum if other teachers choose to implement, and I think I accomplished that throughout the development.

The second biggest limitation for my curriculum is the accessibility of materials and an appropriate ecosystem. If the school or educator cannot access the materials needed for the activities, they cannot conduct them. Furthermore, the school needs to be close to a natural environment that contains trees, vernal ponds, grasslands, and ground cover. If the school is not near this type of ecosystem, it will be impossible for them to use my curriculum. Lastly, my curriculum focuses on deciduous trees. These need to be accessible for the students.

Thinking Forward

During the research and writing of this capstone, I discovered Minnesota's lack of environmental education standards. Furthermore, the standards that involve the environment were not place-based practices (Minnesota academic standards in science, 2009). For example, the closest academic standard that relates to place-based environmental education asks students to describe a natural system in Minnesota in terms of their living and nonliving parts (Minnesota academic standards, 2009). It does not require students to explore the natural world or take observations. The research was clear throughout my study; there are obvious benefits for

students spending time outside observing and interacting with nature. If enough teachers and students experience these benefits, policy could change and environmental standards could be added to the next academic standards.

Conclusion

Throughout development of my curriculum, I successfully answered my question *How can an outdoor curriculum based in phenology and ecology that promotes environmental stewardship in middle school students be developed?* I used Weber's *Minnesota phenology: Seasonal northland nature* (2013) as my inspiration for the phenological research activities. Because research shows that outdoor education programs allow students to become stewards of their local environment, I incorporated many outdoor explorations into the ecological aspect of my curriculum (Bogner, 1998, p. 27). I plan to implement and assessing my curriculum in Fall, 2017. Limitations of my curriculum include timing and accessibility to resources. I believe one of my most important jobs as an educator is to connect students to the environment and the natural world. I believe my curriculum will do so.

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APPENDIX A

Phenology Weekly Journal

Your Tree Selection
Common Name: _____ Scientific Name: _____

Tree Locations	
Tree 1 Latitude: _____ Longitude:_____	Tree 2 Latitude: _____ Longitude:_____

Phenophase Guide

Leaf Folding: A leaf is considered "unfolded" when it's entire length has emerged from a bud, stem node or growing stem tip (USA National Phenology Network, n.d.).

Leaf Coloring: Leaves changing color is a fantastic phenomenon to witness. These plants are aware of the diminishing sunlight, and stop chlorophyll production to get ready for winter. Their other pigments, carotenoids and anthocyanins, begin to show. Leaves can also turn color due to drought or stress.

Leaf Dropping: Deciduous trees lose their leaves to prevent water loss in the winter. Leaf dropping is a sign that winter is coming.

Flowering: Most trees in our forest are angiosperms. Angiosperms are plants that contain seeds inside an ovule, or fruit. Be very observant when looking for flowers! They are often smaller than the leaf and easily missed.

Fruits: Later in the growing season, the flowers on these deciduous trees will transform into fruits. Some fruits are obvious and well known, like apples on an apple tree. Others are harder to see. It is best to research the type of fruit found on your tree before you go searching for it.

Adapted from USA Phenology Network (n.d) and Regular Reports: Deciduous Trees and Shrubs. (2016)

Phenology Observations: Tree 1

Date: _____
Time: _____
Air Temperature:_____
Current Weather Conditions: _____
Time of Sunrise:_____
Time of Sunset: _____
Daylength: _____
Soil Temperature:_____

Describe what is happening with leaf folding:
What percentage of total canopy space is full of leaves? _____
Describe what is happening with leaf color:
What percentage of leaves changed color? _____
Describe what is happening with leaves dropping:
What percentage of leaves dropped from the tree? _____
How many flowers do you see present? _____
If visible, describe the flowers on your tree:
How many fruits are present? _____
If visible, describe the fruits on your tree:
How many fruits or seeds have dropped to the forest floor? _____

Phenology Observations: Tree 2

Time: _____

Soil Temperature:_____

Describe what is happening with leaf folding:
What percentage of total canopy space is full of leaves? _____
Describe what is happening with leaf color:
What percentage of leaves changed color? _____
Describe what is happening with leaves dropping:
What percentage of leaves dropped from the tree? _____
How many flowers do you see present? _____
If visible, describe the flowers on your tree:
How many fruits are present? _____
If visible, describe the fruits on your tree:
How many fruits or seeds have dropped to the forest floor? _____

Adapted from USA Phenology Network (n.d) and Regular Reports: Deciduous Trees and Shrubs. (2016)

Phenology Analysis

1. How did your trees change since your last observations? Describe leaf folding, coloring, dropping, the flowers and fruits:

2. How do your trees compare to each other? Are there any differences? What may cause the differences you observed?

3. How are the trees using cues from the weather and climate?

Adapted from USA Phenology Network (n.d) and Regular Reports: Deciduous Trees and Shrubs. (2016)

APPENDIX B
Minnesota Forest Tree Identification

Background:

Using a dichotomous key, you are going to identify the different trees of the forest. A dichotomous key is a tool that uses a series of two choices to help the user identify items in the natural world (Jensen et al., n.d). You will use the key by David Rathke (1995) *Beginner's Guide to Minnesota Trees* today.

Materials:

- A copy of *Beginner's Guide to Minnesota Trees*

Procedure:

1) Find five different trees throughout the forest.
2) Use the dichotomous key to identify these trees.
3) As you are identifying, draw the branching, leaves, and leaf edges of your selected tree.

Data and Observations:

Tree 1

Branching	Leaves	Leaf Edges

Type of tree:_____

Tree 2

Branching	Leaves	Leaf Edges

Type of tree:_____

Tree 3

Branching	Leaves	Leaf Edges

Type of tree:_____

Tree 4

Branching	Leaves	Leaf Edges

Type of tree:_____

Tree 5

Branching	Leaves	Leaf Edges

Type of tree:_____

Post-Lab Question:

1. What did you see today that you've never seen before?

2. How do you think your observations would change with the changing seasons?

Adapted from Jensen et al (n.d) and Rathke (1995)

APPENDIX C

Forest Understory and Decomposers

Background:

How often have you looked closely at organisms on the forest floor? Sometimes the ones we haven't observed are the most interesting.

Materials:

- Jars
- Petri Dishes
- White Paper Plates
- Magnifying Glasses

Procedure:

1. Examine a log on the forest floor for animal life. Be careful when turning over the logs as to disturb the habitat as little as possible.
2. Collect the animals that are living in this habitat and observe them. Draw your observations.
3. Return the log to it's original position.

Data and Observations:

Don't forget to label the organism! Labels should include antennae, number of legs, eyes, color of organisms, and any other unique characteristics. Also decide if the organism is a insect, insect larvae, spider, mite, millipede, centipede, sowbug, earthworm, nematode or other.

Type of Organism: _____	Type of Organism: _____	Type of Organism: _____
Type of Organism: _____	Type of Organism: _____	Type of Organism: _____

Post-Lab Question:

1. What did you see today that you've never seen before?

2. How do you think your observations would change with the changing seasons?

Adapted from Forest Ecology (2016)

APPENDIX D

Grass Organism Study

Background:

How often have you looked closely at organisms in the grasses surrounding our forest? Sometimes the ones we haven't observed are the most interesting.

Materials:

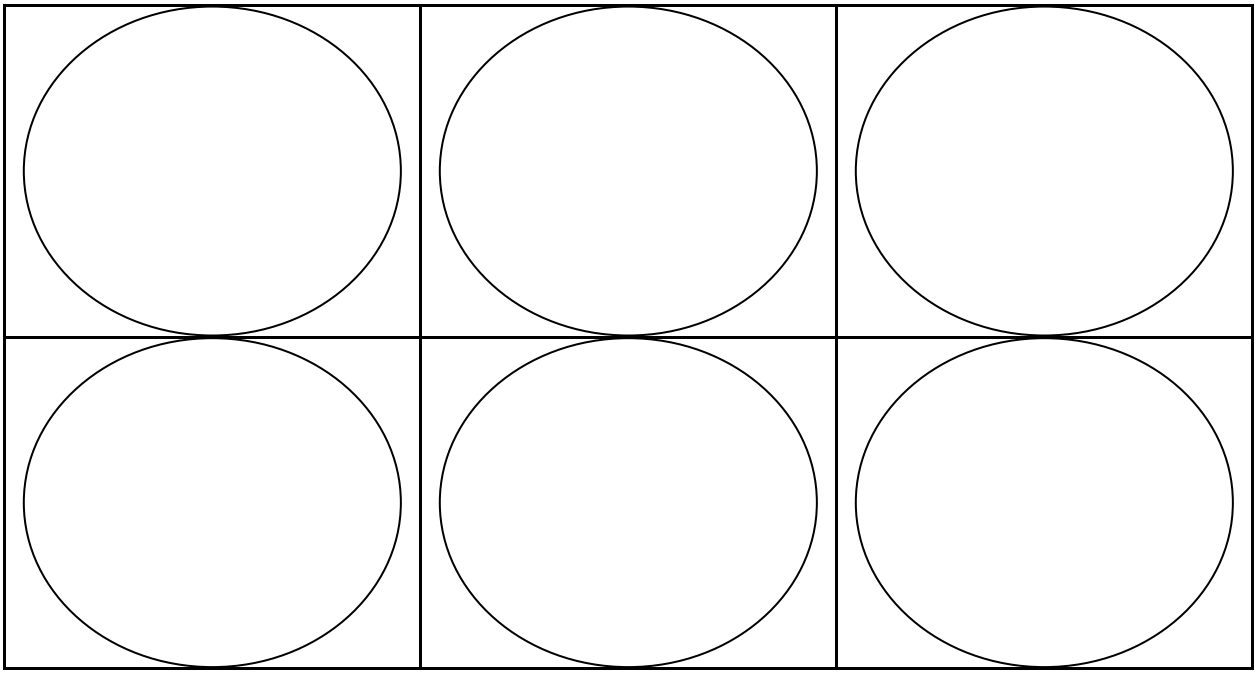
- Sweep Nets
- White Painters Tarps
- Petri Dishes

Procedure:

1. Using the sweep nets, sweep the tops of the grasses outside of the forest for two minutes.
2. Once you are done sweeping, bring the net and its contents back to the white painters tarp.
3. Carefully put your specimen in petri dishes, and draw them.
4. Place the specimen back, and repeat until you've seen multiple different organisms.

Data and Observations:

Don't forget to label the organism! Labels should include antennae, number of legs, eyes, color of organisms, and any other unique characteristics.



Post-Lab Questions:

1. What did you see today that you've never seen before?

2. How do you think your observations would change with the changing seasons?

Adapted from Weber (2013)

APPENDIX E
Vernal Pond Macroinvertebrate Study

Background:

Macroinvertebrates are organisms that lack a spine and are large enough to be seen with the naked eye. Examples would be flatworms, crayfish, snails, clams, and insects. In the OMS forest, there are two vernal ponds. A vernal pond is a type of pond associated with a forest, and it usually goes through annual cycles of becoming dry and wet. We will be study the macroinvertebrates inside the vernal ponds for this lab. The amount of biodiversity shows the health of the pond.

Materials:

- Waders
- Boots
- Rakes
- Buckets
- Spoons
- Ice Trays
- Specimen Trays
- Magnifying Glasses

Procedure:

1. The vernal pond contains many leaves at the bottom where macroinvertebrates like to reside. With waders or boots, rake the bottom of the pond to stir up the leaves. Only one person should do this per group.
2. Place a small amount of water into a large bucket.
3. Put the stirred leaves into the bucket of water.
4. Distribute the contents of the bucket into one specimen tray per group.
5. Using a spoon, scoop any macroinvertebrates found into the sections of an ice tray. Put different macroinvertebrates in each section.
6. Draw what you find and describe your observations.

Data and Observations:

Drawing of Organism/ Macroinvertebrate (label the characteristics of the organism):	**Describe the color and pattern:**

Drawing of Organism/ Macroinvertebrate:	**Describe the color and pattern:**

Post-Lab Question:

1. What did you see today that you've never seen before?

2. How do you think your observations would change with the changing seasons?

Adapted from Weber (2013)

APPENDIX F

Student Survey

What does the environment mean to you?

1. When you think of “the environment,” what comes to mind?

2. When you walk into a forest, what do you expect to see?

3. Why should we protect the environment?