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Supporting the Development of Ecoliteracy in Middle School Students through the use of
Phenology

By

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A capstone submitted in partial fulfillment of the requirements for the degree of
Master of Arts in Education: Natural Science and Environmental Education

Hamline University

Saint Paul, Minnesota

December 2018

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To my husband for your support in this process. Your patience, wisdom, and humor are what allow me to follow my passions and develop a deeper understanding of who I am as a professional and a partner.

“Fundamentalists have mistaken the relation between passion, emotion, and good science. These are not antithetical, but complexly interdependent. The point in either case is not to cut off various appendages and qualities, but rather to learn to coordinate and discipline them to good use.”

David Orr

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CHAPTER ONE

Introduction

As teachers, we all approach our work in the classroom with the foundational belief that students are the future we are nurturing and putting our hopes into. That could be a heavy burden depending on our expectations, and my own personal hopes for what can be done with the environment and natural world are impacted by what we are currently experiencing as a result of past practices. In order to make a positive and lasting change, my students will need to have a connection to the world around them and the topic of my research is *How does knowledge of local phenology impact the development of ecoliteracy?*

In chapter one, I will share the experiences I have had that led to my passion for, and concern about, the environment and natural world we all share. Those experiences have helped guide my own thinking as well as shape what I want to see in my classroom from students. My goal in this research is to guide and encourage students to make informed choices within a framework of understanding that actions have impacts and we all have a responsibility to our families and communities.

My Past

I credit my father with developing my sense of wonder in and connection to the world around me. He grew up on a farm in northern Minnesota and shared stories of his adventures in the woods with me as a child. He also made an effort to take me outside not only for big events like family camping trips, but for daily activities where he taught and

encouraged me to explore and ask questions about what I noticed. That sense of connection to the natural world has been a part of who I am ever since.

When I started college, I developed my own path towards environmentalism. I focused on science immediately and knew that I wanted to have a career in that field. I became a vegetarian, researched cosmetics companies to make choices that were healthy and animal friendly, and learned to reduce my footprint on the planet. To say I embraced environmentalism would be an understatement and I reveled in the ability to make thoughtful, informed choices in my daily life. I continued to work on a biology degree but was still working through what that would ultimately mean as a career.

It was during a winter tropical biology class that culminated in a trip to Costa Rica that the direction I wanted my life to take became clear. During those twelve days traveling around the country and staying in biological reserves, I realized that I was just a small part of something bigger and that choices had global consequences. Hiking through rain and cloud forests, talking to local experts about the environmental changes they had seen over the years, and seeing the burning swaths of land being cleared in order to raise more cattle to sell as food had a huge impact on me. I realized that I wanted to minimize the impact I have on the planet and help conserve and protect what was already there.

As a result of that trip to Costa Rica, I decided to focus on environmental science and to apply for the Peace Corps. Over the next year and a half, I finished my coursework and worked through the process of applications and interviews with the goal of going somewhere in South America so I could continue my journey there. As the story goes for

many Peace Corps Volunteers, I was sent to Africa instead, which turned out to be the perfect fit even though it was not what I had planned.

I was sent to Senegal, West Africa, in March of 1995 carrying two backpacks and a lot of hopes. I did not set out to save the world, I just wanted to experience whatever I could and hopefully help people along the way. I was trained as an Agroforestry Extension Agent which involved trees and crops which were managed with water conservation methods so that planting practices were sustainable. On arrival at my first assigned village, I had to change plans for my work due to lack of water and salt water intrusion. Instead, I focused on soil conservation practices and methods to bring fertility back to soils that had seen years of monocropping, the repeated planting of the same crop year after year without a break or change to allow soil to rebound, in addition to heavy erosion from rain and wind.

I lived in a village of about fifty people for my first year and moved to a small city to manage the regional training center for my second year. In both settings I had the opportunity to work with farmers, make connections with families, and learn from local officials. Those connections helped me develop not only a deep respect for the people I met, but also an appreciation for living more simply, with direct connections to the land and environment that was tied so directly to life and how you lived. I learned a sense of self-sufficiency I never would have developed in the communities I came from, and I also learned that simply wanting something did not make it a necessity. Choices have impacts and living in a developing country where waste removal is not generally available forces you to deal with your choices in ways you do not have to in the United States.

When I returned to the U.S., I eventually went back to school to get my teaching license. I knew I wanted to teach science, my primary reason for wanting to become a teacher, but I ended up teaching preschool during the three and a half years that I was working on my coursework. One of the things I was struck by was the amount of waste that seems to be inherent in the profession, especially for younger-aged students. The amount of paper used for display boards, art projects, and other daily activities was overwhelming and frustrating to me. While I was living a life of conservation at home, I struggled to translate that to my classroom in any meaningful way. While it was not a conscious effort to waste resources, there was an assumed sense of what was expected to happen in classrooms that included a lot of throw-away items and activities.

I have since taught a variety of grade levels and in a range of socio-economic settings and, with the exception of settings with specific environmental focus in their design, there tends to be a distinct lack of understanding about resources and the impact our consumption makes. There is also a notable absence of outdoor experiences for a large part of our district population. This is in spite of being near the St. Croix river and having a multitude of state and county parks within reach of most neighborhoods.

Our Present

In my current setting as a middle school science teacher, I work with a relatively diverse group of students. This diversity includes cultures as well as socio-economic factors that impact how our families navigate their lives and activities. While we have a lot of natural areas scattered throughout the community, there are many families who do not use them. I am not certain what reasons exist for this, and it is possible that needing

permits and lack of public access to most of the riverway is a factor, but I have also detected a lack of interest or habit. There is a county park located less than two miles from our school site but few of my current students visit it on a regular basis. The irony of the close location is that there are no safe ways for us to walk there and the cost of renting buses is prohibitive, especially if multiple visits are desired.

If we were to visit the nearby county park, students would have access to a variety of systems in a setting dedicated to restoring habitats as close to the original condition as possible. They would also learn about pollution affecting groundwater and a lake where fish caught cannot be eaten because of contaminants. Of the five main species caught as food sources in the lake, none are recommended for consumption by anyone in the general population based on updated thresholds for contaminants starting in Spring, 2018 (Minnesota Department of Health, 2018). The primary contaminants are mercury and perfluorooctane sulfonate or PFOS. PFOS contamination in the region is due to waste disposal sites used by a local company that has infiltrated the local water table and was the subject of a recent settlement with the state of Minnesota (Minnesota 3M PFC Settlement, 2018). Wells are contaminated which affect families in our district and the large number of lakes and streams in the area have seen damage as well. This is an ongoing problem and we are in the early stages of finding out what the long-term impacts will be to the health of all inhabitants over time.

In general, my students seem to lack a connection to the natural world and environment. For example, in my classroom I started the year with three recycling bins that I have had to pare down to one for the time being. Although I have repeatedly

reviewed what can and cannot be recycled, the bins are always filled with gum, facial tissues, and garbage. It has not made a difference in changing locations for the bins, if they are not close to a garbage can they become a garbage can. I now have one bin that I keep at the front of the room. I do not get the sense that students recognize a need to conserve or recycle the items they use or why it might matter.

Another area that students struggle with is recycling and composting in the cafeteria. We have three bins with a stainless-steel top over them and pictures to show what goes into each. Students were instructed at the beginning of the year to pay attention to where they throw things so that we are able to keep sorting as clean and easy as possible. Grade-level teachers take turns with lunch duty and when it has been my responsibility, regardless of how long school has been in session, I watch as one of our custodians uses tongs to pull things out of the wrong bins and sorts them or empties bags of food into the compost bin after the unopened bags have been thrown in the garbage. This is repeated daily without end, standing near the bins and coaching does not make enough impact to see a change. It is disheartening and leaves me wondering what is missing that would make a difference.

My final frustration is in regards to the use of materials like paper, pencils, erasers, and other supplies that are a standard and expected part of each school year. Mechanical pencils and pens are regularly taken apart and daily I find random pieces in corners of my room or under tables. Erasers are stabbed with pencils, ripped apart, and lost at a rate I cannot seem to keep up with. Like my experiences teaching preschool, the amount of things we ask students to bring and the struggle for them to keep track of or

take care of them is overwhelming. We as educators have a responsibility in what we ask families to supply and students are asked to keep track of those items.

The ability to care about others is displayed by all students on a regular basis but the connection to recycling and conservation, and why it matters, seems to be missing. The capacity to connect is there but the reason for doing so is not yet clearly understood.

Their Future

The generation of students in our schools right now have a lot of issues that will need to be resolved once they reach adulthood and “No generation has ever faced a more daunting agenda.” (Orr, p. 26). Goleman (2012) describes the current period in history, in contrast to the past when natural events were responsible for changing the natural landscape, as:

characterized primarily by the ways in which humans are changing nature’s systems. And since all life depends on those systems for basic needs, including food, water, and a hospitable climate, there is clearly much at stake. (p. 2).

We, as humans, are directly impacting the world around us. We make choices each day in what we eat and wear, how we get to school or work, what we purchase, and how we get rid of waste. The costs of all of those daily choices are often hidden and, without having a relationship to the natural world, we are unlikely to see the effects until damage has been done. “The complexity of the web of connections that characterize our global society has created a vast collective blind spot about the effects of human behavior on natural systems” (Goleman, p. 5).

While we all play a part in the damages being done to our world, we also have the power to heal the wounds we are inflicting. In order to do that, we have to know the world we live in. We need to explore and observe and spend time outside to develop a relationship with the very thing supporting our lives. “I do not know if it is possible to love the planet or not, but I do know that it is possible to love the places we can see, touch, smell, and experience.” (Orr, p. 147).

Currently, discussions and buy-in regarding environmentalism and climate sciences are wide ranging and without consensus, and it can be challenging to stand up for what you believe in. Regardless of how much these students buy into the idea that the environment matters, there are policies and resulting impacts that will matter either ethically or economically. While I do not expect everyone to have the same depth of feeling about environmental issues as I do, my hope is that all students have enough knowledge and connection to make informed decisions and choices when they have the opportunity and responsibility of being our next leaders.

On a local level, my current students may find later in life that they have been impacted by the contamination in the soil and water they were exposed to growing up. They are living and experiencing firsthand how decisions and actions can have lasting consequences and might also be able to witness how some of that damage can be addressed. This is an issue that affects their lives but knowledge is power and connections have impact.

In order to connect to the world around them, students need to be exposed to and experience nature. Without those connections, the reasons for recycling and conserving

what we have do not have a context and tend to be less important. Phenology, the study of natural cycles and changes in living things, can be a tool used to make connections to a community. It is rare to not find some way to engage students once you have them outside, I plan to use this interest to make connections to what students observe over time. In the context of phenology in the classroom, my goal will be to tie school grounds and neighborhoods together to find common things like species of birds and plants. Along with the local observations, we would research data that has been collected in the county to see similarities and differences. In this way, I hope to help students connect local cycles and living things to a bigger context of why and how choices matter.

In chapter two, the literature review will explore the history and foundational elements of environmental education, strategies for developing environmental literacy, and the use of phenology and place-based education skills to connect a community. With a focus on phenology, I hope to find ways to support and enrich environmental education strategies by building skills that foster ethical, educated decision-making practices to support environmental health and sustainability.

CHAPTER TWO

Review of the Literature

Environmental education has a long history of striving to inform about and to develop a passion for the health and condition of the Earth. With many different approaches in how to address the impacts humans have on the planet, there are differing viewpoints on what is important and what can or should be done to address concerns about the conditions our planet has reached due to past practices. A common thread throughout the practices and values placed on environmental learning, however, is the idea that connections and relationships matter. How we interact with the world around us and how we come to value the resources we use is a product of interacting with the world in a real and tangible way.

Knowing that environmentalism as a discipline has existed for some time, one may wonder why we continue to find ourselves struggling to find solutions to crises of our own making. Have we not learned from the past or are the approaches and methods we have been using ineffective? We live in a time where many factors influence the efficacy of environmental practices including politics, values, and experiences. Given the research, data, and visible results of what we experience directly, it is difficult to argue that our planet is in fine shape and conditions do not need to be addressed. The conflicts often arise when the discussion focuses on why and how we need to go about changing our attitudes and habits.

Environmental themes and activities tie to real-world situations and settings that we experience every day regardless of where we live. We connect to things we see and

feel, and we base our value of those things according to what we get out of them.

Connections matter, and many people feel those connections deeply. In the development of connections comes the possibility of creating a sense of hopelessness, however, when discovering the condition of the soil, water, and other resources around them. Children, particularly, can end up feeling despair rather than hope when faced with issues even adults struggle with. Educators have a reason to approach teaching environmental issues with care and thought, a lack of belief in the ability to make change can end productive discussions. Without hope and connections, we cannot expect positive and lasting change to happen for younger generations coping with environmental issues that have been left to them.

How, then, have we come to this place in time where we know there are problems but we still do not seem to know what to do? How do connections to the world around us develop? Do those connections truly encourage change and advocacy for more environmentally sound practices and choices? How do educators share real issues without creating a sense of doom and inability to find positive solutions? To find answers to these questions we can look to research and work completed in the field of environmental education and how it has been applied to instruction and practices in a variety of settings. The history of environmental studies has led to the development of specific practices within the field including Ecoliteracy and Place-Based Education. In order to answer the question *How does knowledge of local phenology impact the development of ecoliteracy?*, these areas, along with nationally developed standards and expectations will be explored in the literature reviewed in this chapter, along with a

specific approach, Phenology, as a way to understand how approaches have developed and how they form a foundation for understanding the complex issues and needs of the planet Earth.

Environmental Education

Environmental education as a discipline has a long, uneven history of both formal and informal approaches and beliefs which have been shaped by ideals and experiences in a variety of settings. Asking ten professionals in the field of environmental studies what environmental education is may yield the same number of different responses. While there are disputes over where and how the term environmental education was first coined, a formalized approach to incorporating environmental issues in educational settings appears to have occurred following the 1972 gathering for the *United Nations Conference on the Human Environment* in Stockholm, Sweden (Carter & Simmons, 2010). Much of the drive for this movement came from the environmental disasters of previous decades including conditions of waterways, species extinction, and resource scarcity. The general approach at the time tended to be reactionary in nature with an eye to what could be fixed or maintained, while continuing to support development and economies, rather than viewing human interactions as a part of whole system's health and what responsibilities humans ultimately have to the world they live in. Orr (2004) contended "all education is environmental education. By what is included or excluded, students are taught that they are part of or apart from the natural world" (p. 12).

History

During a time when a long list of environmental regulations were being put into place to address damages to all parts of the Earth's systems, conditions were favorable for advocacy and educational foundations. In 1970, the National Environmental Policy Act was enacted and it continues to guide and determine environmental laws today (Carter & Simmons, 2010). One of the key statements of purpose used in the National Environmental Policy Act (2007) to guide the creation of policy is that it will:

use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. (p. 1).

This marked the first time that a guiding act looked to prevention of future damage and failing systems. The history of the United States and resource management had been put together as territory was added to the country. There were also growing pains as populations grew and strained once plentiful resources. The 1960's and 1970's marked a time of reckoning for past failures.

The 1970's ushered in a complex series of laws, movements, and pushes toward more ecological awareness and conservation approaches to land and waterways that, until that point, had been under-regulated and unprotected. The culminating action of that decade, with far-reaching global impacts, occurred in Tbilisi, Georgia, USSR when the *Tbilisi Declaration* was created during the Intergovernmental Conference on

Environmental Education (Carter & Simmons, 2010). The Declaration is still considered a blueprint for what environmental education can, and should, be globally. It stresses the importance of understanding the interdependence of all living things, advocates for equal access for all global citizens to strategies and skills to live in ecologically sound ways, and emphasizes that behaviors and attitudes towards the environment need to change.

Authors like Aldo Leopold were being recognized during this era for their observations and reflections on nature and natural resources. Leopold is considered to be foundational in the conservation movement and development of environmental education programs (The Aldo Leopold Foundation, 2018). His interest in the natural world started early in life and continued through his studies and career as well as in his personal life. He developed the Land Ethic, an essay included at the end of his book *A Sand County Almanac*, which was based on the idea that care must be shown to the entire living and non-living community as a moral responsibility (The Aldo Leopold Foundation, 2018). His ethic is summarized by his statement “We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect” (Leopold, 1970, p. xix).

Leopold’s views on educational practices stressed the importance of a community that understood their own part and impact in relationship to the greater good of the whole (The Aldo Leopold Foundation, 2018). He did not agree with the practice of deep but limited learning, like memorizing the names of lists of plants or animals, arguing that for anyone not specializing in a field or with specific keen interests, that level of knowledge was not necessary. He also felt this type of learning limited what people saw when they

were out in nature, being so busy paying attention to detail that they missed the scale of what they were experiencing. He encouraged people to pursue time outdoors, paying attention to what they noticed, the feelings and emotions related to their experiences instead of just the academics. In order to develop true understanding, ethical connections need to be formed and that can only be done by spending time with, and cultivating feelings for, nature (Leopold, 1970).

Decline

The decades following the peak of environmental education advocacy in the 1970's saw a sharp decline in support for environmental causes and suspicion from governing groups who began to loosen or eliminate regulations. There were also changes to the educational system and, ultimately, the removal of environmental education as a formal study when the No Child Left Behind Act was put into place (Carter & Simmons, 2010). While there were still organizations and groups working in the environmental education field and producing recommendations for how to teach environmental education principles, the requirement to include the work in educational settings was weakened enough for it to all but disappear unless it was already embedded in existing systems.

With all of the surges and changes in the environmental movement, there have been a number of ways to view its importance. Political influences have had profound impacts on how environmentalism is perceived and, even for those in the field, the way the word itself is defined leads to confusion about what actions can, should, or need to be taken. "While conflicts over environmental issues are often argued on 'practical' grounds,

most environmental debates ultimately involve value conflicts” (Callenbach, 2005, p. 46). It is often seen in extreme terms, whether positive or negative, and has led to the piecemeal way that environmental education is positioned in today’s educational settings. For many educators, the approach of environmental education practices in their current form tend toward “issues and catastrophe education” instead of developing problem-solving skills (Sobel, 2005, p. 13).

Current Status

The current definition used by the United States Environmental Protection Agency (EPA) for environmental education is:

Environmental Education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. (United States Environmental Protection Agency, 2018, p. 1)

While the EPA does not advocate for or against specific practices or approaches, the core mission is to support informed thinking and action when impacts to the environment are involved. Since 1990, the EPA has been a part of advocating for environmental literacy in conjunction with the National Environmental Education Act of 1990 (United States Environmental Protection Agency, 2018). The Act defined what is considered environmentally related, clarifies that both urban and rural areas are impacted by human use, and outlines the work that is expected to be done between agencies and educational groups regarding the development of environmental education curriculum.

While environmental education does have multiple suggested sets of standards developed by different groups of environmental learning associations, there are currently no explicit requirements to incorporate environmental education in traditional educational settings other than incorporating it into existing work. For example, when the most recent adoption of science standards was completed in Minnesota for implementation in the 2011-2012 school year, it was noted that the content strands “now has a substrand on ‘human interactions’” and “these substrands have standards on human interactions with the environment” (Olson, 2010, p. 2). Upon inspection, using sixth grade standards as an example, the actual application of the use of human interactions as an emphasis is blended into the substrand “Interactions Among Science, Technology, Engineering, Mathematics and Society” and stated that “Current and emerging technologies have enabled humans to develop and use models to understand and communicate how natural and designed systems work and interact” (Minnesota Department of Education, 2015, p. 16). There are two strands that include societal interactions substrands, but neither goes beyond how humans use tools to measure systems and converting those measurements between standard and metric units. Sixth grade in Minnesota focuses primarily on Physical Science topics, there is no additional requirement to supplement core standards with environmental education unless a teacher chooses to add lessons within the school year.

Resurgence

In response to the limited scope of focus standard settings often provide for science instruction, Next Generation Science Standards, or NGSS, were developed as a

partnership between The National Research Council (NRC), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science, and Achieve and published in 2013 (Next Generation Science Standards, 2013). This work included input from individual states in order to develop national standards that address current needs for science education. While state adoption is not required at this time, many states have either adopted the NGSS framework completely or are in the process of changing to them as they evaluate current standards and practices.

In clarifying how to look at the adoption of new science curriculum, Coyle (2014) described the difference between Next Generation Science Standards and past versions of national standards as the “focus on how much they emphasize real-world contexts for education and the weight they place on young people learning to think and act like scientists and engineers while they are learning” (p. 2). Environmental teaching principles, through NGSS, now have an application in science standards that allow students to explore and look for big-picture connections and associations. The current process of folding environmental education standards into traditional standards, where they may or may not be taught, is now addressed through NGSS by allowing traditional settings like schools to understand how to incorporate those experiences into the structure of what is taught during a school year so that students can expect to find ways to experience environmental work regardless of their setting (Coyle, 2014).

Next Generation Science Standards uses three parts to form each standard taught; practices, cross-cutting concepts, and disciplinary core ideas (Next Generation Science Standards, 2013). Practices encourage students to allow students to explore practices

followed by scientists and engineers as they work through phenomena. Cross-cutting concepts incorporate activities like determining cause and effect or collecting data, so that students understand how to apply skills to all science domains (Next Generation Science Standards, 2013). Disciplinary core ideas cover what NGSS has determined are the four domains of science; physical science, life science, earth and space science, and engineering, technology, and application (Next Generation Science Standards, 2013). The incorporation of all three strands with each standard allow for repeated exposure to broad aspects of scientific practice in a consistent and regular way.

Although the term environmental education has been in use for some time, the application of principles and practices has been limited for many within traditional educational settings. Unlike Environmental Science, which stresses knowledge of specific systems and their functions within a system, environmental education seeks to address the community as a whole, living thing with each part tied to the next. Educational groups have created standards for use in a variety of settings but implementation of those standards has been left up to government and educational groups with mixed results. Current science standards being adopted by states around the country reflect guiding laws that have been put into place regarding how citizens of the United States are educated regarding the environment but there is work to be done to ensure they are implemented. Without guidance, the goal of environmentally informed citizens will continue to stagnate but “If education does not teach these things, then what is education for?” (Leopold, 1970, p. 209).

The reemergence of environmental education in current standards and practices after a long absence provides support for the development of relationships between the systems and organisms on the planet. By developing the idea that humans are global citizens who are a part of, not apart from, the world we foster the idea of relationships and the responsibility that goes along with those ties.

Ecoliteracy

Orr (2004), in describing what we need from environmental education for the future, said:

Education is no guarantee of decency, prudence, or wisdom. More of the same kind of education will only compound our problems. This is not an argument of ignorance but rather a statement that the worth of education must now be measured against the standards of decency and human survival - the issues now looming so large before us in the twenty-first century. It is not education, but education of a certain kind can save us. (p. 8)

Ecoliteracy, one of the foundational parts of environmental education, strives to prepare youth for the challenges they will face regarding the condition of the environment and how humans have changed the Earth's surfaces and structures (Goleman, Bennett, & Barlow, 2012, p. 2). To be ecoliterate, one must understand ecosystems and the relationships between all living things found within them. Sustainability and the protection of basic needs for life is driven by compassion and engagement. The Earth is treated as a living thing and decisions are based on the overall health of the global community as a whole. "Ecologically oriented citizens believe that

we have a moral obligation to achieve sustainability, so that we do not diminish the chances of future generations to meet their needs” (Callenbach, 2005, p. 47).

The exact origin and first use of the term ecoliteracy has been debated over time but the essence of the practice has been in existence over the last fifty years (McBride, Brewer, Berkowitz, & Borrie, 2013, p. 3). As time has passed, the terms Environmental Literacy, Ecological Literacy, and Ecoliteracy began being used interchangeably with some arguing that all terms started to lose their meaning or focus. In order to clarify, one of the most accepted definitions for environmental literacy was developed by the North American Association for Environmental Education and stated:

Quality environmental education programs help develop an environmentally literate citizenry that can compete in our global economy; has the skills, knowledge, and inclinations to make well-informed choices; and exercises the rights and responsibilities of members of a community. (2018, p. 1)

Defining literacy of an environment or ecosystem community allows scientists and educators a way to answer whether or not a citizen could be considered proficient and able to function within a like-group (McBride, Brewer, Berkowitz, & Borrie, 2013, p. 4). It also allows educators to build curriculum and experiences that help bridge knowledge and emotion to build a sense of belonging and responsibility.

According to Goleman et al. (2012), the term Ecoliterate (or to be Ecoliterate) is the anticipated outcome of practice and “socially and emotionally engaged Ecoliteracy” is the path to follow (p. 2). In education, the goal is to develop learners who find common ground with others, engage in positive actions to find success, reflect on their own and

the group's choices, and understand sustainable practices over the long term (Goleman, Bennett, & Barlow, 2012, p. 2).

With the emphasis on community, it can be a struggle to support this goal in settings that are more isolated. Both rural and urban settings can experience the same sense of being apart from the rest of the world. In a city, there may be limited access to natural environments so that human impacts, like obtaining food or getting rid of waste, loses where things come from or go to. In a rural setting where there is a lot of open space, the availability of resources and access may lead to taking for granted that conditions will always remain the same or that choices do not matter to anyone else. It is that true understanding of how the choices made every day affect every other living and non-living thing that needs to be developed by understanding the rhythms and cycles of the planet (Goleman, Bennett, & Barlow, 2012, p. 4). Sigurd Olson (1976), who wrote extensively about nature experiences, noted "We cannot all live in the wilderness, or even close to it, but we can, no matter where we spend our lives, remember the background which shaped this sense of the eternal rhythm" (p. 30).

The Center for Ecoliteracy has developed five practices to encourage and support ecoliterate citizenship: developing empathy for all forms of life, embracing sustainability as a community practice, making the invisible visible, anticipating unintended consequences, and understanding how nature sustains life (Goleman, Bennett, & Barlow, 2012, pp. 10 - 11). When people see and understand how the needs of living things rely on each other, they "can begin to shift perspective" and "move from a view of humans as

separate and superior...to the view of humans as members of the natural world”
(Goleman, Bennett, & Barlow, 2012, p. 12).

With a focus on connections, emotions, and relationships, one concern when working with young people is developing a sense of helplessness.

To embrace our relationship to the natural world fully is to know that although some of our actions have negative impacts, we also have boundless potential to create a positive effect...In the end, it comes down to what caring educators do best: creating the conditions for learning that nurture hands-on hope. (Goleman, Bennett, & Barlow, 2012, p. 134)

Frances Moore Lappe (2013), an author well known for her writing and presentations regarding food and hunger, was reflecting on how audiences seem to perceive her work and message. In an interview, she shared that the emotion behind what she refers to as “the premise of scarcity” drives people to respond fearfully to conditions or needs (Lappe, 2013). After a shift in her own thinking, she now advocates for a shift from looking at and describing situations in terms of their limits to instead approaching problems with the belief that people have the ability to change and adapt to create long-term solutions. She also encourages the use of what she calls the Three C’s: connectedness, continuous change, and co-creation. (Lappe, 2013). Ecoliteracy builds skills to problem solve, humans then need to use those problem-solving skills in positive and healthy ways for lasting change.

One way to help guide students to focus on positive solutions and actions when working through environmental issues is to harness their sense of wonder in the natural

world. Traditional approaches and settings can inhibit wonder in many ways including spending too much of the learning time indoors, requiring excessive memorization, and relying on technology for experiences rather than taking a trip even if just going out onto school or nearby property (Orr, 2004, p. 23). Schools and educational groups cannot replace outdoor experiences with indoor activities and expect engagement to remain high. Orr (2004) stated that “as our sense of wonder in nature diminishes, so does our sense of the sacred, our pleasure in the created world, and the impulse behind a great deal of our best thinking” (p. 24).

Ecoliteracy relies on connections, and connections are developed when feelings and emotions are involved. This can be a challenge to traditional approaches where students are taught, and expected, to be clinical and analytical. Orr (2004) argued that “science, at its best, is driven by passion and emotion. We have emotions for the same reason we have arms and legs; they have proved to be useful over evolutionary time.” (p. 45). Being human means having feelings and opinions about our experiences, responses that can be used to help understand how to make decisions and take action in ways that are positive for all things on the planet. “We cannot protect something we do not love, we cannot love what we do not know, and we cannot know what we do not see. Or hear. Or sense.” (Louv, 2012, p, 104).

Ultimately, the goal for the practice and development of ecoliteracy depends on looking toward the future with compassion, connection, and conviction. Goleman et al. (2012) clarified “The solution, however, does not lie in a return to past ways of doing things, but rather an integration of ecological intelligence into modern ways of living.”

(p. 47). Today's students will be dealing with environmental conditions that have been left to them to repair or find ways to move beyond. Conditions and issues they face will not only impact those nearby, the behaviors of all humans collectively have impacted the planet and will continue to do so. What has been done in the past has not yielded permanent solutions, more will need to be done and no one can do it alone and "It makes far better sense to reshape ourselves to fit a finite planet than to attempt to reshape the planet to fit our infinite wants" (Orr, 2004, p. 9).

Ecoliteracy and the connections fostered in practice allow humans to better understand the role they play in the world. While being a globally responsible citizen is an ultimate goal, connections need to start at home where we can see, feel, hear, smell and sense the world in a direct and real way. Building local connections allows for lasting relationships and bonds.

Place-Based Education

"If you can't be with the land you love, love the land you're with" (Louv, 2012, p. 117). People do not always have choices in where they live or the conditions they experience in the place they call home. What they may have control over is their understanding of, and ability to connect with others in, their shared community to find ways to make change possible. By studying, in depth, where you live and spend your time, you get a deeper understanding of what community means and your own place within that structure.

Place-based education focuses on the locations where students live and experience the world firsthand. It encourages bringing together all content areas and joins not only

the school, but the surrounding community the school is supported by. “Community vitality and environmental quality are improved through the active engagement of local citizens, community organizations, and environmental resources in the life of the school” (Sobel, 2005, p. 11). It includes natural and man-made environments in the work conducted and respects the traditions, economics, culture, and history of a region. (Sobel, 2005, p. 13). By incorporating all aspects of the community into the focus of lessons and work, students learn to make decisions in a way that takes into consideration the direct impact their choices will have not only on them but on all members of where they live. To summarize the connection of place, Orr (2005) stated:

A place has a human history and a geologic past; it is part of an ecosystem with a variety of microsystems, it is a landscape with a particular flora and fauna. Its inhabitants are part of a social, economic, and political order: they import or export energy materials, water, and wastes, they are linked by innumerable bonds to other places. (p. 91)

Sobel (2005) described place-based learning as a “pedagogy of place”, meaning a framework is developed within which all aspects of an area are included, regardless of the type of natural setting, in the context of local needs and wants (p. 17). Environmental education principles and ecoliteracy practices are brought together to form the foundation for decision-making and advocacy with a goal of supporting and maintaining the common good. By understanding past history, current needs, and future goals, learners connect with concepts in a way that can allow them to see results that last and matter.

One method for helping to support place-based learning is the use of Project Based Learning, or PBL, which “prepares students for academic, personal, and career success, and readies young people to rise to the challenges of their lives and the world they will inherit.” (Buck Institute for Education, 2018, p. 1). PBL allows students to work on a sustained project to solve an individual or group-driven problem that results in a product or presentation given to a local audience (Buck Institute for Education, 2018). There are specific guidelines, referred to as “Essential Product Design Elements”, and a framework for ensuring quality in the projects that are produced. While projects are student driven, guidance, mini-lessons, and support are provided by teachers as students work through the process.

When students are working closely with a community, as in place-based education, they will be required to work through ethics within not only their classroom but also those in the community. Aldo Leopold (1970) described a human’s basic ethical reasoning as competing for own needs but being ethically driven to work within what the environmental and ecological conditions allow (p. 239). While humans are able to express their needs and concerns, other living and nonliving things in the shared community do not have a voice and will need representation as decisions are made and actions are taken. Leopold included the non-human parts of the environment in the term “Land Ethic” so that reasoning includes the parts that do not have an obvious voice (Leopold, 1970, p. 239). When working with a broad range of community members, including students, ethical discussions can be difficult to manage and navigate. With care, those discussions can help enrich knowledge about a place and make a community

stronger when able to define core beliefs and values. “No important change in ethics was ever accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions” (Leopold, 1970, p. 246).

One of the hidden benefits to place-based education is the depth and breadth of information communities can compile locally. When groups of citizens are paying attention to and monitoring what is happening around them, they enrich the base of knowledge of their place. They may notice changes or phenomena that had not been documented before, alerting local scientists to problems or success they have observed. Sobel (2013) further added “Drop by drop, teachers and students are making substantial contribution to environmental monitoring, species protection, land preservation, and air quality improvement in place-based education projects” (p. 57).

Place-based Education encourages students, and the greater community, to truly know where they live and what they share that place with. Using resources and connections within the community, students are able to learn how to reason, debate, advocate, and communicate about what their shared values and needs. This knowledge and engagement promotes understanding and compassion, and allows students to develop a voice in what they desire in the health and sustainability of their world.

Connections require identifying and understanding relationships among participants. In Place-based Education, students are relating to tangible parts of the world around them. As humans, we also tend to name and categorize what we observe. In order to support that need, as well as to understand how systems function and change over time we can use a more formal method for collecting and observing data.

Phenology

Phenology, or the study of how seasonal biological changes happen over time, is one of the longest scientific traditions known and dates back to pre-agricultural times (BudBurst, 2018). Seasons have guided human activities and behaviors for as long as they have been on the planet and over time formal and informal data has been collected to track and plan for life and survival. Early journals and notes have paved the way for formal publications, all of which have provided a rich and detailed record of conditions and how they have changed over time.

Often considered an indicator for climate change due to the chronicling of patterns over time, phenology “influences the abundance and distribution of organisms, ecosystem services, food webs, and global cycles of water and carbon” (USA National Phenology Network, 2018, p. 1). The data collected can help manage pests, predict and prepare for seasonal allergens and disease cycles, respond to the needs of crops and flora, and determine where climate changes have impacted the health of a population or ecosystem (USA National Phenology Network, 2018). Weber (2013) referred to phenology as a “first science” as it identifies the initial events of each season to indicate new phases and cycles (p. x).

National and international databases have been established to collect and share phenological data. Scientists use the data to improve the accuracy of predictions around seasonal shifts, response to possible natural disasters, and management of known environmental problems. While much of the data analysis has been done through official networks, there is a strong base of knowledge built by amateurs who have documented

details and information in areas familiar to them and submitted their findings. Though it is a science discipline, phenology relies on communities and individuals to add depth and validity to the data that predicts and manages large-scale environmental conditions and concerns.

The practice of phenology can help support Place-based Learning initiatives by building direct and lasting connections to where students live. “Good inhabitation is an art requiring detailed knowledge of a place, the capacity for observation, and a sense of care and rootedness” (Orr, 2005, p. 92). Through the practice of journaling, sketching, taking photographs, and other active observation activities, students are able to start seeing how connected they are to the rest of the surrounding environment. Louv (2012) described this connection as a “kinship with other species” (p. 53) and suggested that people find “at least one true place, a piece of land or water that calls to them” (p. 91). This can be in a backyard, on school grounds, and in local public lands but students need to be able to access and experience those places firsthand.

By focusing on the plants, animals, and living things in a local system, students can build not only scientific knowledge about systems and environments but community ties to how those systems affect their daily lives. “We use no written textbook. Rather, the seasons became our text. We study whatever was going on in nature at that time of year.” (Weber, 2013, p. xi). Observations can be made from anywhere in a community with a goal of revisiting that same place repeatedly and over time to build a relationship to it. It can be thought of as a ritual or routine that becomes a regular event to look forward to. Although students need basic identification skills to know what they are documenting,

the availability of identification keys made for phone applications or other technology tools allows students to record what they see without needing to be an expert. Students need to expect the unexpected and will end up being surprised many times by the living things they did not realize were there all along.

Phenology can bridge science, passion, ethics, and emotions in a way that standard science practice cannot. Relationships rely on interactions, interactions build connections. To help students build a relationship with the world they live in, they need the ability to explore it and be inquisitive about it. Instead of relying on taking trips off-site to teach about the environment, educators can use resources that exist just outside of the classroom to build skills needed to be global thinkers. By learning how to recognize and document the world they see around them, students will begin the process of seeing change over time in order to understand how the impacts of our choices can affect other parts of a system we are connected to.

Conclusion

The existing literature clarifies the connections between environmental education, eco-literacy, place-based education, and phenology. The overarching goals and principles of environmental education give guidance and structure to the goal of developing citizens who have the ability to make informed, ethical, reasoned decisions about the environment and the role they play within it. Supporting that goal are the practices, rituals, and routines established by developing literacy and connections to the world through direct and repeated contact. The common expectation for all practices is that there will be outdoor experiences on a regular and ongoing basis.

To understand how students develop skills and attitudes that foster environmental awareness, I will develop a website and set of lesson plans to determine how phenology and place-based learning help build ecoliteracy. My hope is that these resources will be a place for students to store data and build their knowledge about the community they live in. Over time, this work would yield data that future classes could use to start to determine changes over time. I also hope to share this work with other educators so that our community can connect with communities that have similarities and differences to spark discussions and build a more global sense of community.

Chapter Three will provide context for the development of my project, identify the target audience, and describe the components of the work. Also included will be a rationale for my chosen work and a description of the curriculum developed.

CHAPTER THREE

Project Description

Introduction

This chapter will describe my project for the research question: *How does knowledge of local phenology impact the development of ecoliteracy?* My project seeks to build a link between local environmental phenomena and the development of eco-literacy skills through engagement and personal connection. Chapter one detailed the context of my research question based on my own experiences in nature and in a classroom. Chapter two provided a history of environmental education and how it is implemented in today's science teaching, explained ecoliteracy and how it supports environmental awareness, and clarified how place-based education and phenology allow learners to connect to the ecosystem they live in. In this chapter, I will provide a context for the work being done, a description of the activities that will be used, identify the target audience, indicate the curriculum framework supported by the chosen work, provide a timeline for activities, and clarify the relevance of ecoliteracy.

Context

This project will serve to bridge personal connections to a broader understanding of global environmental issues and concerns. Environmental education, as a discipline, first began to formalize in the early 1970's. With increasing awareness of the conditions of water systems and ground pollutants came landmark legislations including the Clean Air, Wilderness, Species Conservation, and Wild and Scenic River Acts (Carter &

Simmons, 2010). Those landmark legislative actions helped spur the development of educational curriculum supporting environmental awareness. Over time Environmental Education has evolved but there is still a lack of agreement on what is most important or how it can and should be implemented. In some cases, opportunity or safety are limiting factors in being able to incorporate outdoor studies into a curriculum. In others, content and time drive what can be taught and, because environmental education is not a formal or specific part of most standards, it is often added as extra activities if all other content is covered for the school year. Orr (2005) believed that environmental education needs to be taught not by “cramming it into” existing curriculum but, instead, “by reconceptualizing the purposes of education in order to promote diversity of thought and a wider understanding of interrelatedness” (p .91).

What is emerging in environmental studies is the belief that local connections to things that directly impact us are more likely to support changes in attitudes and engagement in the broader world around us. That connection includes not only knowledge, but emotions and opinions - the ability to “love” a place. While my goal is to increase connection to and awareness of environmental issues on a large scale, my hope is to start with our school community and this will include working directly on school grounds as well as in the neighborhoods where our students live. Weber (2013) described this by saying students “see that nature is alive and active here and now, not always somewhere else at another time” (p. xi). By learning to identify and track events and changes in our local area, students will be able to build an understanding of how humans interact with and impact the environment. Connections and experience build engagement

and encourage action. Building those opportunities to engage in the world around them will allow students to understand how and why their actions matter.

On a local level, the school and community where I teach are impacted by damages to the water table resulting in contaminated wells and bans on eating fish in a nearby lake. In addition, housing developments are rapidly expanding and our population is seeing big shifts in demographics. Our students are living with and experiencing high levels of change and they need the knowledge and skills necessary to making thoughtful, well-informed choices as members of their community.

Intended Audience

The intended audience of this project is sixth-grade students, which is the grade level I will be teaching when running the project, but lessons and work could be adapted to other grade levels. According to data from the Minnesota Report Card (2018, p. 1), there are 930 students in our middle school in grades six, seven, and eight. Ethnic backgrounds represented in our building, by percents, are 5.8% Hispanic/Latino, 0.5% American Indian/Alaskan Native, 7.0% Asian, 7.7%, Black/African American, 74.7% White, and 4.2% identifying as Two or More Races. English Language Learners account for 2.4% of our population, 14.1% of our students qualify for Special Education Services, and 20.2% of our population receive free or reduced lunch support.

Standards used in the lessons will use both Minnesota State Science Standards for sixth grade and Next Generation Science Standards (NGSS) using middle school standards. The current version of the Minnesota standards were last updated in 2009, the first draft of the new state standards based on NGSS were released in November, 2018,

and a final version will be released in May, 2019. My current district has decided to adopt the NGSS standards after discussions with state officials and we are in the process of implementing the new standards in our two middle schools. This project will be completed during the course of a school year.

Project Components

There will be two parts to this project: a unit of lesson plans that will support skills needed for data collection, and a companion website to support students as they collect data and provide additional information and resources for the area. The project is designed to start in the fall and continue at least through winter, with the option of continuing into spring if there is time. This project will run concurrently with regular classroom instruction with time taken for projects and analysis as needed. Work on building the website and writing lesson plans for this project began in June, 2018, and was completed by the last week of November, 2018.

Lessons in the unit, which were written to cover a total of at least ten instructional days with additional revisits for ongoing activities, are:

1. Similarities and Differences
2. Observations vs Inferences
3. Nature/Observation Journals
4. My Tree
5. Dichotomous Keys
6. Minnesota Tree Identification
7. Field Guides/Minnesota Birds

8. Phenology
9. Collecting and Reporting Data

Once students have learned to collect data, they will be required to make at least two observations per week and record their findings in an online document that is shared with the teacher. When enough data has been collected from observations, and time has been spent learning about what is common or has been observed in our region in the past, students will work to analyze the information collected and posted. We will look for common trends, surprises, and summarize our work.

Rationale

My decision to create a website came about as a way to support the core basis for Phenology - to document changes in a region over time. I chose two sites to make observations in, Lake Elmo Park Reserve and Oak-Land Middle school. The sites are just over two miles apart and are located in Washington County, Minnesota. They share the same geographic features and natural history and allow for a direct comparison to native vegetation. The same observation format used in the last lesson of the unit is followed for observations on the website so that students have examples of how data was collected and I also include pictures from each visit to document changes or note points of interest. Also included on the site are links to local and national phenology groups, online identification support, and background information for common organisms students might encounter during observations.

Lessons used in my teaching unit will support specific content knowledge, research and synthesis of information, critical analysis, and application of learning. The

use of a district-approved lesson framework will support both the Minnesota state standards and the NGSS middle school standards while maintaining a common and recognizable format for staff.

Curriculum Framework

The lessons in this unit follow a structure developed and used by the school district where I work. The format was originally used for a Science, Technology, Engineering, and Math (STEM) certification cohort I was a part of and used to develop curriculum that would be shared within our district. As this unit is intended to be used in our district, I wanted to use a format that was consistent with previous work. I anticipate that the format of these lessons will be changed to fit updated expectations and approaches once standards at the state level are formalized in May, 2019.

The website, called Phenowatch and found at www.phenowatch.com, was built using the Weebly Website Builder. I chose to pay for the basic website package which has a yearly charge and will continue to maintain the site and remain the owner of the content.

Summary

The project described in this chapter will serve as a central location to collect and analyze data gathered over time in a shared community. Students will be learning and applying skills to understand the environmental conditions and health of the area where they live and go to school, allowing them to find connections to changes in seasons and how living things respond to those changes.

In Chapter Four, I will review and reflect on my project. The development of my unit plan and website will be discussed, my research question will be clarified and addressed, future use of the project and possible modifications will be discussed, and I will reflect on the impacts of my project on my teaching in the future.

CHAPTER FOUR

Reflection

This capstone project was developed to answer the question *How does knowledge of local phenology impact the development of ecoliteracy?* The goal for students and educators is to build connections to the natural world in order to better understand how human impact can be managed in positive and meaningful ways. The lessons in the unit were developed to build observation and identification skills in order to track changes and cycles of local ecosystems over time and sixth grade students are initially the target audience. The companion website was built to provide examples of the format used to make observations, share details and history of the region, and provide context for the organisms students are likely to encounter. Together, the lessons and website make local ecosystems relatable and more accessible for students as they learn about the natural world most directly tied to their lives.

Chapter Four will reflect on the work done for this project and how the process allowed me to grow as an educator and researcher. Included in this reflection will be the learning that took place, the connections made to the research, the implications of the project in a professional setting, and the limitations that may exist in implementation. I also suggest future units of study and connections, share how this work will be communicated with colleagues, and explain how this work will benefit science educators.

What Was Learned

Researching and writing are not new processes for me, but this project has been the most in-depth work I have completed professionally. While challenging, the process allowed me to develop deeper and more effective communication skills using a standardized format that will benefit my work as both a teacher and a collaborator. I also grew in my ability to understand intent and purpose in an author's work and how to determine when valid, supported research is being presented.

I found during this process that I have become a much more analytical reader when working with informational texts. While I believe I have always used a healthy measure of questioning of sources and analyzing writing evidence supported claims, the research process for this project helped to clarify what I was looking for in a written piece and why. One of the surprises I experienced occurred when I read two books that came highly recommended by professors and colleagues during my coursework in the Natural Sciences and Environmental Education program through Hamline University. The books have been cornerstones for the most recent efforts supporting environmental education and ecoliteracy, and the authors are well known and highly regarded. I enjoyed reading their work and agreed with the core beliefs they stated, but I found that the books were not very useful from a research standpoint and, though lengthy, there was not much content I could use directly to cite in my own writing. The author's writing heavily quoted many other sources, relied heavily on stories and anecdotes, and often referred to returning to assertions later in the book rather than clarifying statements within the chapters as they progressed. I could not find specific citations or support for some of their

conclusions and I found myself seeking out the authors they quoted instead of being able to use their work in my writing which was not what I expected. I respected what their work was attempting to support and can understand what may make their statements valid, but I was left with the impression that I could not be sure I could validate the use of quotes from their works.

Completing this project introduced me to many authors and topics related to environmental education and ecoliteracy that I had not read before. This has opened up my thinking, supported many of my core beliefs, and challenged me to find support and substance in what I share with students and peers in the science world.

Literature Connection

The literature review allowed me to understand the background and historical development of environmental education and ecoliteracy and helped to reinforce what I have long valued regarding the natural world and experiences I would like to be offering students in my own science classroom.

Growing up, my elementary school experiences in science were directly tied to nature and living things. We spent hours outside, in all seasons, exploring and learning. My classroom, the same one for three years since there was one teacher per discipline for grades four, five, and six, was alive with plants and animals. I also spent time outside at home and took it for granted that it was a normal, regular approach.

Once I started junior high school, my time to explore outside began to shorten and the topics we studied were relegated to indoor activities and reading textbooks or hearing lectures. My school was in the middle of a city block in our downtown area and access to

outdoor spaces was limited to what was available at home, some of my peers who lived downtown had few interactions with outdoor activities on a regular basis. My only memory of being outside over the course of my secondary education experience was for gym class.

After researching and learning more about the development, and subsequent removal of, environmental education from the nineteen seventies and eighties up to today, I am now understanding how this shift in focus may have happened. What I assumed to have been a natural transition into secondary learning expectations may, in fact, have reflected the shift in focus and support for environmental education theory and practice.

As a result, the research that was most compelling to me as I worked through my project was focused on the Next Generation Science Standards (NGSS) and how the National Science Teachers Association has been working to bring environmental education back into the practice of teaching science to all students. Coyle (2014) noted that NGSS has been written in a way that allows for adoption in all settings rather than teaching environmental education content in isolated units or only in specific settings like camps or environmental learning centers (p. 6). NGSS practices support the development of sequenced, well-developed units of study that include environmental studies throughout the school year (Coyle, 2014, p. 7) which is not included in current standards. This supports my own belief that environmental concerns and connections should be a regular and ongoing study in science and I am looking forward to being able to provide documented and detailed reasons for inclusion in classrooms.

My deeper understanding of where environmental education started and where we are now in the adoption process, both by the state of Minnesota and my own district, of NGSS standards will allow me to be a better advocate for the need to include human interactions and responsibilities into our curriculum. With the inclusion of human involvement and roles will come some conflicts and larger discussions about how we interpret data and respond to the results we observe.

Implications

Environmental issues and connections to human choices and behaviors are current and timely topics that can bring impassioned debate and disagreement. While this project is building the foundation for collecting data, there will eventually be a time when that data needs to be analyzed and discussed. Care will need to be taken to make ensure that discussions are done with integrity and respect.

As a science department, we will need to plan for how discussions will be managed with students and how we will respond to questions from parents and community members as they arise. This is particularly important in our district as there are critical pollution issues impacting a community with a diverse range of political and philosophical beliefs. We will need to make sure we have a strong foundation in our science content so that when questioned, we will be able to support environmental education activities. NGSS and district standards will be our strongest support in any discussion and help us communicate why we are exploring the human role in the natural world. My own research in this project will also be useful in these discussions as will the use of data collected by students to show how and why impacts have become more

personal and related to daily life in the area. Debate and considering other viewpoints is central to the new science standards and curriculum being developed. Students will need guidance in learning how to communicate and advocate for what they believe in regardless of what side of an issue they are on while still respecting the perspective of others including the non-human parts of the natural world.

Along with personal beliefs and opinions held by our community and resulting dialogs that may be challenging, there are possible departmental limitations to what may be accomplished with this project. How our grade level content is being developed and what our district ultimately decides to include in curriculum will shape how this project will be used in the future.

Limitations

Implementing this project and the work that would follow will require our science department to make some changes in what, how, and when we teach some of our content. The challenges will come both in time and in the focus that each grade has regarding content.

This project will require repeated visits outside in order to get to know the region being studied. In addition to the introduction and practice, students will need to be provided time to collect data on a regular and ongoing basis. This could impact instructional time if not managed well. Once students have the routine and practice in place, they should be able to efficiently collect data on an ongoing basis but this will have to be a routine activity for it to be used and built upon by all grade levels.

There will also need to be discussions about what is being taught as content at each grade level. My one reservation about the adoption process of NGSS being completed by the state of Minnesota is that grade level standards are still being written with a focus on specific skills. For example, sixth grade will still focus on physical science topics that includes gravity, matter, energy, and chemical reactions. The term “human interaction” does not explicitly appear in the proposed standards until seventh grade. Though there are supports written into NGSS to allow for breaking content into grade level strands, the original intent of the new standards was to include multiple areas of focus at all middle school levels that looped back on each other to support the idea of interconnected science disciplines that would include concepts in biology, chemistry, physics, and geology each year of a student’s science instruction.

The separating out of grade level focus areas reflects previous standards and, from a practical standpoint, makes sense as districts have developed curriculum and purchased needed materials for instruction for past standards already. It would possibly require significant time and money to adopt NGSS in the way that the standards were created, but it is also disappointing to realize that in some ways we are back to only teaching science as a laser focused set of topics from year to year and I worry that the human interactions piece could easily get lost after finally being brought back into the conversation. The lack of inclusion of human interactions in sixth grade as a stated objective could leave room to argue that this project should not be taught, at least in sixth grade, because biology and systems are not taught until seventh grade. There will need to be agreement within our teams in order for this project to have the support and impact I am working to build.

There are many opportunities for this project to have a positive and lasting impact on students and I am confident that our team can find the best ways to fit it into our teaching and routines. The foundations for all other science learning are present in the skills students would learn in sixth grade that would support the development of ecoliteracy skills in future years.

Future projects and recommendations

This project is a foundation for many other areas of study in science at the middle school level. While other skills are being developed, there also needs to be a way to understand where students are in their development of ecoliteracy skills and what they have learned once this project has been underway and students have had time to reflect on their work.

In order to determine whether or not phenology engages students and helps them develop a deeper connection to ecoliteracy concepts, there needs to be an understanding of where their beliefs, values, and connections are when this project begins. This evaluation would also be necessary in order to answer the question *How does knowledge of local phenology impact the development of ecoliteracy?* An evaluation tool would need to be developed to find out student attitudes towards environmental conditions and behaviors like recycling and conservation. There are some evaluations referenced online but I was not able to find a readily available and agreed upon set of questions in my research. More time would need to be spent evaluating what types of questions should be asked and how the results would be interpreted. Once students have completed units of

study, there would also need to be follow-up evaluations in order to track changes in attitudes and opinions.

One of the next steps in unit plans would be learning about the past history of the area students are studying in order to understand changes that have already been documented. Geological changes that have shaped Minnesota resulted in the lakes, streams, and formations we now have, and there have also been changes to the types and numbers of plants, trees, mosses, lichens, and fungi in the area. Those changes have occurred both naturally due to seasons and dynamics within systems, and by humans as they have lived and changed the landscape in the areas they inhabit. Lessons for this unit would include geologic history, landforms, types of forests that once covered the area, and human impacts from native and non-native populations in the region. For sixth grade, this would directly tie well to social studies units that focus on Minnesota history and would allow for larger scale, cross-curricular projects.

Students would also need to understand ecosystems, interactions among and between species, and how organisms adapt and change in response to the conditions they are exposed to. Food chains, nutrient cycles, competition, and basic needs of living things would be included in another unit of study and would fit into seventh grade science standards with phenology collection continuing at that grade level.

Many possible avenues exist for extending and building onto this project. Once basic identification skills have been mastered, students would be able to shift their focus from specific and detailed observation work to more broad analysis of systems and connections.

Communication of Results

My colleagues and I are in the process of developing curriculum for secondary science in our school district. We have three days set for the spring of 2019 to meet and write together and I will be sharing this project with the team during one of our planning sessions. This project would fit with planning for all three grades in our middle school science department, connect with Minnesota Science Standards being developed and implemented, and allow our building teams to have a comprehensive and long term plan to support students in learning about the human interactions of a living system.

I also plan to work with my building team of teachers, who teach the same grade level, to determine how we can collaborate across grade levels. Our district has trained many of us in the use of Project Based Learning techniques and this project would allow us to collaborate as a grade level team to build projects that would support our core subjects in addition to art, technology, and human health and wellness.

Benefit to Profession

The absence of environmental education guidelines written explicitly into science standards is starting to change with national adoption of Next Generation Science Standards. As states begin the process of incorporating standards that address human interactions and the environment, this project will support students in learning how to recognize parts of a natural population and collect data that can be used to analyze change over time.

In addition to science standards, this project addresses and helps build competency in reading, math, and social studies skills. Sixth grade students in Minnesota

are learning about the state and how it has changed due to people migrating to the state, but there is also a focus on native populations that lived in the region. By understanding and developing a relationship to all of the parts that make up the local system, students will be better able to understand not only their own actions, but the actions of those who lived here long ago. Understanding what was once here, how it has changed, and what role humans played will help to bring the past alive and help students understand how their actions will affect future generations. Using multiple disciplines, students will better understand how to collect, track, document, and communicate what they observe and how they feel within a context of home.

Summary

This capstone project has allowed me to explore my research question *How does knowledge of local phenology impact the development of ecoliteracy?* I have created a process, through my lesson plans, to help students master skills to allow them to accurately identify what they are observing in the world around them. Using the website connected to this project, students will be able to reference the format and examples of how to collect and report data, learn more about our local ecosystem, and find support in the identification process. Through the process of identifying and documenting the world around them, students will experience and connect with the natural world and develop a deeper understanding of what it is to be a part of a dynamic system.

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