Summer 2023

Creating An Engaging And Ecocritical Project Based Curriculum For High School Environmental Science

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CREATING AN ENGAGING AND ECOCRITICAL PROJECT BASED CURRICULUM FOR HIGH SCHOOL ENVIRONMENTAL SCIENCE

by

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

Hamline University

Saint Paul, Minnesota

August 2023

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CHAPTER ONE

Introduction

Overview

The goal of this capstone project is to answer the question, *How can educators create an engaging and ecocritical project based curriculum for high school environmental science?* In order to answer this question, the first semester of curriculum for a high school Life Science course was created. The hope is for this curriculum to provide a practical and easily-adaptable example of how educators might create an engaging project based learning experience rooted in principles of critical ecology for high school environmental science students.

The setting in which this project is intended to be implemented is a new public charter which became operational in September of 2021, and just wrapped up its second operating year as of June 2023. As the founding and only member of the school's science department, I have been required to create a brand new curriculum for several science classes from scratch. While I am grateful to have so much freedom in my teaching, it can also be overwhelming at times to know whether or not I am going in the right direction. I have found it challenging to find examples of existing curriculum that matches the values and mission of my school, which focuses on project based learning (PBL) with an emphasis on community action, social justice, and student leadership. This capstone provided me with the opportunity to create a more cohesive curriculum for my school, which I plan to use in the upcoming 2023-2024 school year. This curriculum could potentially be a template for PBL that helps our staff further align our curriculum goals across content areas as well as in the science department. I also hope it can be used to

help teachers who may wish to incorporate PBL and/or critical ecology into their curriculum but are not sure where to start.

Following this introduction, I address my personal journey to becoming an environmental educator and how that journey has played a role in my educational philosophy and positionality. Then, I explain how my professional background ties in with the context of this project. Finally, I review the goals of the capstone project and provide an outline of the remaining chapters.

Personal Background

Perhaps surprisingly for an environmental educator, as a child I did not consider myself to be very outdoorsy or nature-loving. However, upon reflection, I realize I had many childhood experiences that likely contributed to my current environmental ethic. One memory that stands out in my mind is when my mother set up a squirrel feeder on the deck during my elementary school years. I remember wondering, why squirrels instead of birds? Everyone else seemed to have bird feeders in their yard, but I had never heard of a squirrel feeder. She felt that people were often too focused on the birds, and that the squirrels were just as deserving of food as anything else.

I cannot think of a definitive turning point when I started considering myself an environmentalist, but perhaps it is a culmination of smaller experiences with nature which helped me see that the environment - both the natural *and* the social - is something inherently valuable and worthy of caring for. The backyard squirrel viewings (and other similar appreciations and experiences with the environment) helped me see that nature is not something far removed from us, but rather it exists everywhere and is something we are always experiencing. Today, I still find the most joy in the nature that I encounter in

my own yard. A few things that come to mind right away are feeding the birds and squirrels, visiting the bumblebees in my pollinator garden, and watching in awe at the occasional coyote, fox, possum, or deer strolling along the creek that runs through my backyard. I am fortunate to have had many opportunities to experience nature throughout my early life, and know it has been foundational to my environmental philosophies today.

Because I was not always fully aware of my connection to nature, I surprised myself and those who knew me when I decided to become a science teacher. For most of my K-12 experience, I was heavily involved in music, such as piano lessons, orchestra, and a variety of other ensembles. My plan was to go to school to become a music educator. Science was never really something I felt passionate about. This changed for me when I took a Human Geography course at the college level. It was the first time I realized that there were so many connections between scientific knowledge, the human experience, and the way our societal systems function today. For example, I learned about the impact that rivers have had on the way the Twin Cities has developed and how they continue to influence our lived experiences in different ways today. From there, I became particularly interested in geography, geology, meteorology, and more, especially when there was a social or cultural element to the topic. I realized that what had been missing from my science education in the past was the *human* element, which is why it is so important to me to include it in my own science teaching. When this comes up in my classroom, my students are used to hearing me say: “we can’t talk about science without talking about the humans that are doing the science”. This is one reason why it is important to me to incorporate principles of critical ecology into my teaching, which is the critical analysis of how human ideologies and actions influence our perceptions and

treatment of the environment *and* each other. (The study of critical ecology will be explored further in Chapter Two.)

After discovering my passion for the Earth sciences, I decided to change my major and become an Earth Science Educator. During my time in college, I spent many hours observing and assisting teachers and other staff in local classrooms. One thing I learned from conversations with my advisors and mentor teachers at the time is that Earth Science is often less prioritized than other sciences at most high schools in the state, despite the fact that Earth Science standards have been required at the high school level since 2009 (Minnesota Department of Education, 2023). These standards are often squeezed into biology classes, or neglected altogether. While it is difficult to find statistics around why this is so, I suspect part of the reason is a lack of educators with 9-12 Earth Science teaching licenses, who feel confident in teaching climate science. For instance, when I graduated with my bachelor's degree, I was one of two students in the whole class that graduated with an Earth Science Education degree. At my previous workplace (a relatively large suburban school district), I was one of only two science teachers in the entire district that had this credential. Living in a world increasingly affected by climate change, pollution, loss of biodiversity, and other environmental crises, I am passionate about ensuring that we are addressing Earth Science standards at the high school level, and helping provide other teachers with the tools they need to do this as well. While this capstone project is designed to meet primarily Life Science standards as this is what I am teaching in the Fall of 2023, I plan to use this project and a similar scope and sequence as a template for the Earth Science course that I will teach the following school year (2024-2025). Additionally, the ecocritical principles highlighted in this

project help to reinforce the connections students make between the Earth and the life that inhabits it, furthering the goals of environmental education (which are described in more detail in Chapter Two).

The Natural Science and Environmental Education program at Hamline University has been pivotal in helping me further develop my passion for teaching about the Earth. This is where I first encountered the idea of critical ecology and related *ecojustice*. When I first started reading *EcoJustice Education: Toward Diverse, Democratic, and Sustainable Communities* (Martusewicz et al., 2021) in my Hamline coursework, it struck me as being something so crucially important to incorporate not only in my curriculum, but also as a general philosophy in life. The ideas in this book have helped me feel connected to the Earth in a way I never imagined was possible before. Since then, I have spent a lot of time learning more about the philosophies, concepts, and scientific principles of critical ecology. I hope to similarly inspire my students by incorporating this into my own teaching.

As a white woman who grew up in a predominantly white, upper-middle class suburb of the Twin Cities, I acknowledge that the way I experience the world, especially within the field of education, is different than what others with different backgrounds may experience. I had the privilege of attending a four-year university right after graduating high school, and have been a teacher ever since. Because I have been in a typical K-12 environment for both my own schooling *and* career, my experiences in other career and workplace settings are limited. I am continually working to understand my own biases, and to learn from as many other perspectives as possible when it comes to my personal life as well as improving my practices as an educator.

Professional Background

After earning my undergraduate degree, I began my career as a seventh grade Life Science and eighth grade Earth Science teacher at a suburban, traditional public middle school in the Twin Cities area, very similar to where I grew up. I had wonderful colleagues in the science department who shared lessons, materials, ideas, and helped me figure out how to navigate the world of education as a new teacher. As a new teacher, it was a great feeling to know I could lean on them when I needed help finding resources or thinking through a unit.

In March 2020 (my second year of teaching), the COVID pandemic suddenly hit. We had a day's notice before we shut our doors and switched to distance learning for the remainder of the year. The following school year, we fluctuated between a hybrid classroom model (with half the students in the room, and half streaming in virtually from home) and a distance learning model where all students worked from home. Collaboration and communication with my colleagues was critically important during this time, as we were constantly adjusting our plans and brainstorming how to teach science remotely. I found that student absences and missing work had skyrocketed compared to the experience I had during my first year of teaching. Student engagement was on the decline as a whole before the pandemic, but has only grown worse since (Botella Nicolas & Ramos, 2022; Reeves et al., 2023). My colleagues and I all recognized that student learning loss was going to be a major consequence of this pandemic - not only academically, but socially and emotionally as well. The pandemic changed education in many ways, and these changes have also led to an increased need for curriculum that

addresses skills needed for a “post” pandemic world. This is the main reason why *student engagement* is a key theme in this capstone project.

Due to pandemic-related student enrollment changes, I found myself seeking new employment for the 2021-2022 school year. This is when I began working in my current setting as the founding science teacher at a project based public charter high school in an urban area. Because I have been employed with the school since before its doors opened in September of 2021, I have had a unique opportunity to learn first-hand what it takes to start a school and all that entails. The mission of the school is to empower students through PBL to make positive, justice-oriented change in their own communities.

While I am passionate about my school’s mission and values, it has certainly not been easy to start a school. In our first year, we had 7 total staff and 50 students. Our team grew close very quickly as we struggled through that year together. Despite the close connections I have here, as the only science teacher there were many times I found myself making decisions alone when it comes to curriculum and instructional choices. Additionally, while PBL continues to grow as a teaching methodology, it is still a struggle to find affordable lessons and units that match the unique values of my school. Therefore, most of the lessons and units I have taught so far were created by me from scratch. Since beginning my work at this school, I have learned so much about how to structure a PBL unit, mostly through trial and error. This capstone project has allowed me to delve deeper into research-based practices that ensure a more cohesive, meaningful, and engaging PBL experience for my own students, and I am excited to share my project work with my colleagues as well.

The project I have created for this capstone is a series of lessons and project based unit outlines for a semester of high school Life Science that are designed with principles of critical ecology and with student engagement in mind. My hope is that others find this curriculum easily adaptable to a variety of student needs, settings, and curricular requirements, especially teachers who are new to PBL and/or the environmental sciences.

Summary

In this chapter, I provide an introduction to the purpose of the capstone project and research question, which is *How can educators create an engaging and ecocritical project based curriculum for high school environmental science?* I explain how my personal and professional background have shaped my environmental and educational philosophies in order to provide context and rationale for the chosen question. In the next chapter, a review of related literature is provided related to high school environmental education, critical ecology, student engagement, and project based learning. Chapter Three describes the methodology and rationale for choices made in the project curriculum, as well as an explanation of the intended audience and timeline for implementation. Chapter Four will include a reflection on the creation of the project itself, important takeaways, limitations, implications, and potential areas of further study related to this work.

CHAPTER TWO

Review of the Literature

Overview

This literature review is aimed at addressing the question, *How can educators create an engaging and ecocritical project based curriculum for high school environmental science?* In order to answer this question, literature was selected that helps to examine four major themes: high school environmental science education, student engagement, critical ecology, and project based learning (PBL). First, an examination of the current state of education, its purpose, and the purpose of environmental education (EE) is provided, as well as challenges within the field of EE, and a brief overview of the new 2019 Minnesota State Standards in Science Education. This section is followed by a synthesis of research-based factors that can influence student engagement, including common barriers to fostering student engagement in the classroom. Next, an overview of critical ecology is given, followed by its implications for high school science education and potential challenges of implementation. Finally, the benefits, limitations, and best practices for project based learning (PBL) are discussed, followed by a chapter summary.

High School Environmental Education

The Purpose of School

Multiple sources state that schools are meant to provide everyone with equal access to the tools and skills which are necessary for increasing quality of life and work in the world; however, it is clear that most schools are missing the mark when it comes to meeting that purpose, and in fact often perpetuate the problems which schools are supposedly meant to solve (Aldhafeeri & Alotaibi, 2022; Cook, 2019; Finn & Phillips

2023; Martusewicz et al., 2021; Martusewicz & Johnson, 2016; Montgomery & Kehoe, 2016; Walker, 2022). Public school systems in the United States became common beginning in the 1850s. At this time, many viewed school through what Cook (2019) refers to as an *industrial model of education*. Essentially, this means that schools were designed to prepare students for an industrialized economy: to work in factories, follow a bell schedule, and listen to authority without question. (Cook, 2019; Fast, 2016; Martusewicz et al., 2021). Over time, that purpose has certainly shifted, yet remains unclear to many even today (Fast, 2016; Finn & Phillips, 2023).

As the function of education changed, schools found themselves able to teach more outside of the traditional reading, writing, and arithmetic. Because their purpose is unclear to many, there has been increased controversy over what students ought to spend their time learning. For example, politicians, radio hosts, and other public figures have recently expressed increased concern over critical race theory being taught in schools (Sawchuk, 2021; Walker, 2022). This issue has reached such a critical point that bills are being proposed in states such as Iowa, Oklahoma, and Tennessee that ban curriculum which includes any vague mention of race, which has made it especially difficult for educators in those regions to focus on meaningful learning goals (Sawchuk, 2021).

While *what* students are learning may be under scrutiny by many outside the field of education, those within the field often find themselves more concerned with how that learning is assessed. National initiatives, such as the No Child Left Behind Act and the Every Student Succeeds Act which followed (U.S. Department of Education, n.d.), are tied to funding and distribution of resources to schools. This has led to an increased emphasis on standardized testing and formal assessment. This focus on such limited

quantitative data paints an incomplete picture at best (Cook, 2019; Finn & Phillips, 2023; Jensen & Schnack, 1997; Martusewicz & Johnson, 2016, Montgomery & Kehoe, 2016). At worst, it can increase negative outcomes for students due to biased testing and interpretation of results, or loss of class time due to test preparation and other curricular mandates (Fast, 2016; National Academy of Education, 2021).

Education has also dramatically changed in the wake of the COVID-19 pandemic. Some of the most direct impacts include significant learning loss (Aldhafeeri & Alotaibi, 2022; Reeves et al., 2023) and increased absenteeism (Dernbach, 2022; Lynch, 2021; Reeves et al., 2023). Educators have needed to adapt quickly to account for new instructional technology and increased student mental health issues that are a result of pandemic-related life circumstances.

Given these conflicts, this literature review attempts to synthesize works from multiple perspectives in an attempt to find key overarching themes for what the purpose of school *ought* to be, with a particular focus on environmental education. In addition, ideas about how ecocritical thinking and project based learning could help us meet this purpose is explored. The consequences we see as a result of the pandemic may provide the perfect opportunity to make the educational reform that is needed to create a new, unified purpose for education, from an individual scale to a societal one (Aldhafeeri & Alotaibi, 2022; Cook, 2019; Sawchuk, 2021). Public education is critical in helping students understand their own identity, values, and their place in society at large. It is the first organization that we experience, and is formative in our cultural views on power, leadership, group dynamics, and self-esteem (Montgomery & Kehoe, 2016). In addition to the development that happens within the classroom, students learn much about

themselves and how they are perceived through the *hidden curriculum*: the unconscious thoughts and biases that we carry with us and perpetuate as educators, and which appear in our institutionalized systems (Montgomery & Kehoe, 2016). Questions about how we might disrupt the current status quo in education (and environmental education) are part of the inspiration for this capstone project and the reason for the incorporation of ecocritical thinking into the curriculum. The work toward this reform can begin once we agree on a unified purpose.

The purpose of school is not well studied, and unclear to most (Cook, 2019; Fast, 2016; Finn & Phillips, 2023). Some argue that emotional intelligence should be prioritized over cognitive ability (Fast, 2016; Montgomery & Kehoe, 2016). Cook (2019) says both are necessary if we care about human wellbeing in addition to preparing humanity to think critically in the future. According to the Pew Research Center, two thirds of parents in the U.S. agree that social emotional skills should be taught in schools (2022). John Dewey, one of the leading educational theorists and philosophers of the 20th century, believed that education was necessary to connect individual voices to the public sphere, to create understanding of greater social contexts, and to prepare our students to take action in a democratic society (Lowery & Jenlink, 2019). Others have built on these ideas over the years, recognizing that by helping our students see the importance of questioning the status quo and thinking critically to find answers to those questions, they will be better prepared to identify their own values, and to therefore find meaningful work toward improving our political, economic, and educational systems in a democratic society (Smith, 2007; Walker, 2022). Although there are disagreements about the approach, it seems that the most common themes are around generating both cognitive

and emotional intelligence, as well as providing students opportunities to practice the skills they need in order to take action in their communities. These themes align well with the goals of environmental education, which will be explored in the next section.

The Purpose of Environmental Education

It is well established by research that carbon dioxide levels higher than 350 parts per million (ppm) will cause significant environmental damage (Martusewicz et al., 2021). That number today is closer to 420 ppm (NOAA, 2023). At the current rate of global carbon consumption, temperatures could increase anywhere between 0.5℉ to 8.6℉ by 2100, average sea levels are expected to rise between one and six feet, and half of all animals and plants are at risk of extinction in the near future (Martusewicz et al., 2021). What could be more important than teaching students about our impact on the environment, all the life that supports it, and the possible futures of Earth itself?

Awareness of our harmful impact on the environment was popularized during the environmental movement of the 70s, and the Tbilisi Declaration was a result of this progress. The Tbilisi Declaration (1978) was one of the earliest documents to spell out exactly what the purpose of environmental education (EE) ought to be. It stated:

> [Environmental education] should prepare the individual for life through an understanding of the major problems of the contemporary world, and the provisions of skills and attributes needed to play a productive role towards improving life and protecting the environment, with due regard given to ethical values. By adopting a holistic approach, rooted in a broad, inter-disciplinary base, it recreates an overall perspective which acknowledges the fact that natural environment and man-made environments are profoundly inter-dependent. It

> helps reveal the enduring continuity which links the acts of today and the consequences for tomorrow. It demonstrates the inter-dependencies among national communities and the need for solidarity among all mankind. (The Tbilisi Declaration, 1978).

This influential work, put together by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in collaboration with the United Nations Environmental Programme (UNEP), laid the groundwork for the purposes of EE and what it means to be environmentally literate: to *understand* the environment holistically as one interdependent whole rather than several disconnected parts, and to have the skills to *take environmental action* in our own communities to create a better tomorrow.

Understand the Environment. It seems scholars are in agreement that one essential component of environmental education should be to help students feel a sense of connection to nature and understand how it is interconnected. Some environmental educators try to facilitate this connection through the use of perceptual learning theory and perception-action cycles (Finn & Phillips, 2023). According to Finn and Phillips, a perception-action cycle is a pedagogical tool in which educators use *shared attention* to focus student observations on things they can see, do, make, feel, hear, etc. This practice is intended to help students start seeing the interconnectedness between things in their own environment. To complete the perception-action cycle, these shared perceptions are then followed by an opportunity to take action, which helps to position students as active and thus keep them engaged in learning (Finn & Phillips, 2023). By using perception-action cycles, educators can create more opportunities for students to change

their perceptions of the environment, experience a sense of awe, and ultimately create positive environmental change (Finn & Phillips, 2023; Jensen & Schnack, 1997).

Experiencing a sense of awe can also be a powerful tool for building understanding in EE. Research shows that people who have experienced a sense of awe related to nature experience a strong connection to it, which leads to more sustainable actions later in life (Smith, 2007; Walsh et al., 2020). This experience could happen in a variety of places - zoos, a nature experience, through local activities, field studies, etc. and differs for everyone (Smith, 2007; Walsh et al., 2020). Research shows many other benefits related to this sense of awe and exposure to nature, such as improvement of physical and mental health, increased concentration and academic performance, reduced stress, increased empathy and connectedness to humans and other life, more sense of belongingness, and increased ability to see many possibilities for action (Walsh et al., 2020).

Take Environmental Action. By teaching students to perceive and see environmental connections and encouraging them to ask *why?*, educators can provide students with the tools needed to contribute productively to environmental causes (Finn & Phillips, 2023; Jensen and Schnack, 1997; Martusewicz et al., 2021; Smith, 2007; The Tbilisi Declaration, 1978; Walker, 2022; Walsh et al., 2020). Many of these authors agree that the highest level of learning is the ability to take action, and that actions ought to be at the forefront when educators assess environmental literacy (Finn & Phillips, 2023; Jensen & Schnack, 1997; Walker, 2022). Jensen & Schnack (1997) refer to this concept as *action competence:* not only the ability, but the confidence and willingness to do so as well. They emphasize that an action must be intentional and aimed at the root of the

problem in order to count as an action, rather than just an activity. For example, picking up trash on the sidewalk is a helpful activity, but not considered an action because it does not address why people litter in the first place. We also need to make sure we are encouraging action on multiple levels - individual, communal, and societal scales, and that the student decides for themselves that the action is warranted, rather than acting because they are told to do so (Jensen & Schnack, 1997). The more actively students engage in local and regional action as youth, the more likely they are to be active in the future as well (Finn & Phillips, 2023). This emphasis on action in EE is aligned with the goal of education at large: to prepare students for work and action in a democratic society.

It is important to note the true outcome of *action* for students in the context of EE. Jensen & Schnack (1997) put it succinctly: "A school does not become 'green' by conserving energy, collecting batteries, or sorting waste. The crucial factor must be what the students learn from participating in such activities" (p. 473). In other words, the thing that matters most is not how effective the action was, but rather what the student takes away from it. Thus, students must be engaged in the action they are taking in order for them to learn meaningfully and to sustain the behavior in the future.

Challenges in Environmental Education

One major challenge in EE is access to green space, especially in urban environments. With the constraints of time and resources at most schools, it can be difficult to provide this access. This can make it difficult to foster a sense of awe or connectedness to the environment, and can create the sense that nature is something one has to travel to in order to experience. Research shows that most people generally feel

indifferent towards the environment (Walsh et al., 2020). Some students have aversions to the outdoors, such as allergies, limited ability to walk, or just thinking of themselves as an "indoor" person, which can be a barrier to experiencing nature.

Environmental educators must also be careful not to focus too much on the negative. The climate crisis, environmental racism, the extinction of life - such topics can be anxiety-provoking for students, and focusing only on the negative is not an effective way to create behavior change anyway (Antonovsky, 1987; Jensen & Schnack, 1997; Finn & Phillips, 2023; Martusewicz et al., 2021; Walsh et al., 2020). Rather, the focus should stay on how we deal with that anxiety and how to stay action-oriented (Jensen & Schnack, Finn & Phillips, 2023).

Minnesota Standards in 9-12 Science Education

An important component of any formal education is the standards educators are required to implement in their curriculum. The most recent iteration of Minnesota State Standards (2019) is quite different from the previous (2009). While the 2009 document was limited by lower-level thinking questions (e.g. describe, explain, etc.) and a focus on memorization of scientific content, the new standards take a unique three-dimensional approach. A three dimensional approach means that in addition to a focus on content knowledge (disciplinary core ideas), educators also need to work toward helping students learn scientific practices (skills which are necessary to understand the world in a scientific way) as well as cross-cutting concepts (concepts which appear in multiple scientific disciplines, such as energy). Table 1 provides an example comparing the 2009 to the 2019 benchmarks.

Table 1

Comparison of 2009 to 2019 MN Science Benchmarks

2009 Benchmark	9.3.1.1.3 Describe how the pattern of magnetic reversals and rock ages on both sides of a mid-ocean ridge provides evidence of sea-floor spreading.
2019 Benchmark	9E.3.1.1.2 Develop and use a model based on evidence to explain how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. *(Practice: Develop and use models, Cross-Cutting Concept: Stability and change)*

The newer standards lend themselves better to the goals of EE in that they involve a higher level of critical thought, more connections between different disciplines, an emphasis on human influences on the environment, and placing a higher priority on solutions. However, there will be a steep learning curve for teachers as they learn to interpret and implement the new standards. The curriculum in this project can hopefully serve as an example of how educators might incorporate these new standards into their teaching more effectively.

Student Engagement

Overview

Engagement is defined in various ways. According to Reeves et al. (2023), it occurs when students and teachers have shared attention on curiosity and a learning challenge. Others refer to it as a measure of active academic and social participation, including behavior (appropriate conduct and effort), emotions (having a generally good attitude about school), and cognitive work (Griffin et al., 2020; Parker et al., 2021; Wang et al., 2017). Wolpert-Gawron (2018) says it is about having a willingness to learn and getting students to think critically. At the end of the day, what most teachers probably want to know about engagement is how to help their students see the value in participating in learning activities. When students are engaged and have enjoyable

experiences with learning (i.e. experience a burst of dopamine), they are more likely to retain the knowledge and increase their focused attention. (Wolpert-Gawron, 2018). Motivation and engagement decline as students get older, as well as later in the school year (Botella Nicolas & Ramos, 2022). There was a decline in school engagement before the pandemic, but it has become increasingly worse since the COVID pandemic began (Botella Nicolas & Ramos, 2022; Reeves et al., 2023). This makes the question of how to engage students even more urgent than before.

Factors that Influence Engagement

Classroom Climate and Teacher Expectations. The climate and expectations set by the classroom teacher and school can have a big impact on student engagement (Griffin et al., 2020; Reeves et al., 2023). Climate is determined by warm classroom environments, a sense of safety, academic achievement, and relationships between staff, students, and families (Griffin et al., 2020). Schools with a more positive climate are correlated with fewer disciplinary issues, better mental and emotional student health, and increased student motivation and engagement (Griffin et al., 2020). When teachers have positive relationships with students as well as other teachers, it can lead to increased feelings of belongingness for the student, leading to higher engagement (Aldhafeeri & Alotaibi, 2022; Conner et al., 2022; Griffin et al., 2020; Reeves et al., 2023; Wolpert-Gawron, 2018).

Studies show that one main driver of engagement and student success is teachers who set high expectations for *all* their students (Reeves et al., 2020; Rubie-Davies, 2007; Rubie-Davies et al., 2020). It is suggested that the best ways to hold our students to high expectations are to use mixed ability groupings and change them frequently, allow all

learners to engage in advanced activities, and establish routines and procedures at the beginning of the year (Reeves et al., 2020; Rubie-Davies, 2007; Rubie-Davies et al., 2020).

Self-Assessment and Competence. Students often struggle to articulate what they are learning (Reeves et al., 2023). When students know what, how, and why they are supposed to learn, they are three times more likely to actually learn it (Reeves et al., 2023). While we should still allow students some ownership over their learning, it is important that teachers (and students) provide frequent feedback that is clear and received by students (Reeves et al., 2023). This helps them to better understand whether they have met the learning target or not, thus building their competence and belief in their own abilities, which can further student engagement even more (Conner et al., 2022; Reeves et al., 2023).

Student Choice and Voice. Students who feel more autonomy, or ownership, over the learning experiences available to them tend to show an increase in engagement (Botella Nicolas & Ramos, 2022; Conner et al., 2022; Parker et al., 2021; Reeves et al., 2023; Tirado-Morueta et al., 2022). It is important that teachers do not impose what they think is relevant, but rather to let students lead the way so they can immediately see the relevance and connection to their futures and/or passions (Reeves et al., 2023; Walsh, 2021; Wolpert-Gawron, 2018). Student voice is shown to be a factor that can positively influence engagement and academic success (Conner et al., 2022). Not only that, but schools have a lot to learn from their students about what is working and what is not within our school systems (Conner et al., 2022).

Collaboration and Participation. Evidence shows that when students have more opportunities to collaborate with each other, motivation and engagement are significantly increased (Reeves et al., 2023; Wolpert-Gawron, 2018). Participation is just as important (Reeves, et al., 2023). While participation does not necessarily equate to engagement, it is a condition that must be met in order for engagement to happen (Reeves et al., 2023). Studies have shown that when teachers provide students with multiple ways to participate, students engage more and disrupt less compared to traditional, individual hand-raising (Reeves et al., 2023). For instance, having students provide verbal or written responses simultaneously (referred to as *universal response*) allows for students to practice self-assessment without the judgment of their peers, and for teachers to better focus instruction on what students don't already know (Reeves et al., 2023).

Barriers to Student Engagement

Although most of the time it is outside the educator's control, poor attendance is a factor that can get in the way of engagement (Reeves, 2022). Being at school is arguably the most important condition which must be met in order to eventually have student engagement. Chronic absenteeism was a problem before the pandemic, but increased during, and has only grown worse since (Attendance Works, n.d.). Schools are still figuring out how to address these unprecedented levels of absenteeism.

Teachers may also be reluctant to put students under too much stress, given the situations many families are in due to the pandemic and recently increased attention on social and emotional learning (Reeves et al., 2023). Time at school is often now dedicated to "triage" - discipline, mental health, stress and anxiety, all of which get in the way of instructional time (Reeves et al., 2023). With decreased instructional time and

curriculums that are frequently mandated, teachers may find themselves covering content as quickly as possible so they can demonstrate that district goals were met, despite what student test scores may show (Reeves et al., 2023). With limited and rushed instruction, engagement becomes less attainable.

Sometimes, teachers rely too much on entertainment rather than true engagement (Wolpert-Gawron, 2018). Hands-on activities do not necessarily equate to critical thinking, and can lead to student confusion if not purposeful (Jensen & Schnack, 1997; Wiggins & McTighe, 2011). Extrinsic motivation, such as candy and other rewards, is also not recommended as a way to boost engagement (Reeves et al., 2023).

One primary reason why students may be unwilling to participate is a fear of failure (Reeves et al., 2023). This sense of shame can stem from previous teacher interactions that were negative (Reeves et al., 2023). A one-time mistake may cause a student to lose their feeling of competence, and avoid future participation (Reeves et al., 2023).

In spite of these barriers, the curriculum developed in this project will attempt to utilize as many positive factors that influence engagement as possible, especially those that align with the principles of critical ecology and project based learning, such as collaboration and student choice.

Critical Ecology

Overview

According to the Critical Ecology Lab (2020), *critical ecology* is the study of the relationship between the cultural norms of the industrialized world and how they perpetuate problems of injustice, such as the racial disparities within our school systems,

poverty, or the destruction of ecosystems. An ecocritical approach differs from the traditional study of environmental justice because rather than only examining the ways that different people are disproportionately impacted by environmental crises, critical ecology recognizes that these issues stem from the same cultural ways of thinking. Instead of only addressing the environmental injustice itself, critical ecology asks us to consider the power structures that allowed for the environmental injustice to happen in the first place. There are many other terms to define similar studies, such as *deep ecology* and *ecojustice*. Deep ecology refers to the idea that humans must redefine our relationship with nature from one that values it only for its usefulness, to one that values nature as it is (Madsen, 2023). Ecojustice is a similar framework, proposing that the way we place value on nature stems from the same roots as how we place value on other humans - in other words, the same cultural norms that perpetuate things like ethnocentrism and sexism are the same cultural norms that contribute to the ecological crisis we face today (Martusewicz et al., 2021, Martusewicz & Johnson, 2016). For the sake of simplicity, this project will refer to the concept as critical ecology or ecocritical studies, but draws on ideas from deep ecology and ecojustice as well.

Critical Ecology in Education

According to Martusewicz et al. (2021), one primary goal of critical ecological educators should be to help students develop an ethic of care through a pedagogy of responsibility. An *ethic of care* refers to the idea that human health and ecological health are interdependent on one another (Martusewicz et al., 2021; Martusewicz & Johnson, 2016). It involves recognizing the limitations of individual knowledge, listening to those who came before, and seeing things as a whole rather than just their individual parts

(Martusewicz & Johnson, 2016). A pedagogy of responsibility means to reclaim and revitalize the commons we share with each other and other life, and to aim for practices that benefit and support relationships between and among that life (Edmundson & Martusewicz, 2013; Martusewicz et al., 2021). Driven by an ethic of care, a pedagogy of responsibility encourages action on all levels, from students, teachers, school leaders, and more to work toward a democratic, diverse, and sustainable society (Edmundson & Martusewicz, 2013; Martusewicz et al., 2021, Martusewicz & Johnson, 2016). As Martusewicz et al. (2021) put it, ecocritical educators believe and instill in their students that "to recognize that we have a fundamentally unsustainable culture is to say that we have an obligation to try to change it" (p. 8). These ecojustice scholars argue that the purpose of education should be to prepare students to contribute positively to a *democratic* and *diverse* society, for without these we will not be able to create a more *sustainable* society.

Democracy, as defined by Martusewicz et al. (2021), is a system in which people are involved in the decision-making around issues that affect them. It stems from the need to resolve conflict among groups with differing perspectives, and functions best when people work together to solve problems by learning from each other, because no one person can have *all* the answers (Martusewicz et al., 2021). Everyone who is affected by the issue should participate, if the decision-making is to be as just as possible (Jensen & Schnack, 1997; Martusewicz et al., 2021). An ecocritical approach recognizes that the decision-making process should always consider impacts on life other than humans as well.

Diversity is key to the health of human society, as well as ecological health. In the world of critical ecology, it can refer to cultural, linguistic, or biological diversity (Martusewicz et al., 2021). Martusewicz et al. (2021) defines diversity as "the condition of difference necessary to all life and creativity" (p. 22). These differences are crucial to sustaining the interdependence between all forms of life. By encouraging students to appreciate differences and learn from multiple perspectives, students can better understand how necessary diversity is to environmental sustainability as well as how it improves the democratic process (Martusewicz et al., 2021; Walker, 2022). If we do not include diverse voices in our decision-making processes, it is not only unjust, but also undervalues the wisdom that diversity brings to the table (Martusewicz et al., 2021).

Martusewicz et al. (2021) defines a sustainable community as one which supports the ability of the environment (social and natural) to renew itself. This means being able to understand the impact our decisions could have on the generations that will come in the future, and that we must consider these long-term impacts (and how they might affect diverse groups of humans and other forms of life for generations to come) in our democratic decision making.

What does all this mean for science educators? Critical ecology in high school science education means to provide students with opportunities and tools to recognize and understand the impact of the cultural ways of thinking that are ingrained in us from a young age. It also means working with students to interrupt the unsustainable patterns and to replace them with democratic and diverse alternatives that contribute to a more sustainable world (Martusewicz & Johnson, 2016). Ecocritical work is meant to take place on every level and within every context - from elementary through high school and

beyond, at businesses and nonprofits, and within communities (Martusewicz & Johnson, 2016). To prepare students for this work, they need to understand the principles of democracy and sustainability, and to understand how they can play a role in creating communal and societal change (Martusewicz et al., 2021).

Walsh et al. (2020) studied how engaged students felt while enrolled in an ecojustice course. The things students appreciated most were embodied/multimodal learning experiences (such as arts integration), and the variation in the knowledge taught (from sustainability science to psychology and more). After the course, students reported that the experience helped them feel a sense of awe related to the environment, and an associated increase in connection and compassion for self and others, including other life (Walsh et al., 2020).

Challenges in Critical Ecology

The interdisciplinary, holistic approach necessary for an ecocritical pedagogy is not necessarily realistic for most educators and classrooms around the country, particularly in schools where traditional testing is overvalued (Martusewicz & Johnson, 2016). The emphasis on empathy, values, and collaboration involved in ecojustice coursework can be unfamiliar for students and teachers, who may be reluctant to engage with it (Finn & Phillips, 2023; Walsh et al., 2020). The time and collaboration needed to overhaul existing curriculum could be intimidating for educators who may not have the time or resources to do so in their current settings.

There is little research on how effective an ecojustice approach truly is. While Walsh et al. (2020) observed several positive outcomes as noted earlier, the same study also found that despite a course emphasis on how language has been historically used to

separate humans from nature, students continued using a language of separation after the course (Walsh et al., 2020). This project aims to fill a gap in the literature by examining how useful an ecocritical approach may or may not be in a high school science classroom when it comes to increasing student engagement as well as environmental literacy.

Project Based Learning

Overview

Project based learning (PBL) is a form of learning that provides students with an authentic and complex problem or question, which students investigate in differentiated ways over an extended period toward the goal of finding solutions (MacLeod & van der Veen, 2020; Wolk, 2022; Wolpert-Gawron, 2018). Throughout the process, students acquire skills which are thought to have more real-world applications, along with the typical content learning that takes place in school (MacLeod & van der Veen, 2020). Essential elements of PBL include student inquiry, real-world application and assessment, student choice and voice, collaboration, creativity, and an interdisciplinary approach (Wolk, 2022; Wolpert-Gawron, 2018). While PBL has gained traction in the last few years, it is still fairly new for most educators and there are many misconceptions about it (Wolk, 2022). Because of these misconceptions and different opinions about what makes a project “high quality”, many educational leaders and experts in PBL came together in 2018 to codesign A Framework for High Quality Project Based Learning (2018). This framework defines six elements that must be met within a project in order to be considered high quality: intellectual challenge and accomplishment, authenticity, public product, collaboration, project management, and reflection. This framework was used to create the curriculum in this project, and the methodology will be explained further in

Chapter Three. Next, the benefits and limitations of PBL are discussed.

Benefits

It is suggested that PBL be utilized at all grade levels and for all students (Wolk, 2022). There is substantial research on how PBL can be used to increase student engagement and academic success (Wolpert-Gawron, 2018). When students learn knowledge as-needed and can self-direct their learning, that knowledge is far more likely to be retained (Smith, 2007; Wolk, 2022). In line with findings around student engagement, students who have a greater sense of autonomy in their learning are likely to feel more motivated, which is enhanced further by the emphasis on collaboration in PBL (Botella Nicolas & Ramos, 2022; Wolpert-Gawron, 2018). Skills that students could learn through PBL include (but are not limited to) collecting and analyzing data, collaboration with peers and community members, organization, reading, writing, and probably most importantly, how to apply their classroom learning in real-world situations (Smith, 2007). Providing students with opportunities to learn about the problems they feel are most relevant to them gives them the skills and competence they need when it comes to improving their own communities (Smith, 2007, Walker, 2022).

One reason why PBL may work so well is because it can make learning *and* teaching a lot more engaging. The enthusiasm demonstrated by a teacher who is passionate about PBL can often be contagious for the students (Wolpert-Gawron, 2018). As a project based educator myself, I can say from personal experience that it is a lot more rewarding and exciting to teach students in this way compared to how I felt when I was really just teaching to prepare them for tests.

Limitations

Project based learning is less effective when it is not implemented in a way that is properly scaffolded for students. Without structure such as project constraints, goals, and feedback, it can leave students unsure of what to do and how to proceed (Botella Nicolas & Ramos, 2022; MacLeod & van der Veen, 2020). It can be especially difficult for students who are chronically absent to jump into long-term projects, especially if they missed the beginning stages and set-up for the project (Lynch, 2022). Without providing students with the necessary scaffolding, they may be unable to self-assess their learning which can lead to disengagement (MacLeod & van der Veen, 2020, Reeves et al., 2022).

Students may be wary of collaboration for a variety of reasons, such as social pressures, habit, or worry that the group will not work well together (MacLeod & van der Veen, 2020; Reeves et al., 2023; Walsh, 2021). The collaborative nature of PBL is time consuming, which can make it challenging to properly implement (Botella Nicolas & Ramos, 2022). Teachers may also not be familiar with the most effective tools to facilitate collaboration between students.

Time may also be a limiting factor for the interdisciplinary work essential to PBL. Traditional teacher preparation programs do not focus on interdisciplinary education, so many teachers may feel ill equipped to teach in this way (MacLeod & van der Veen, 2020). Teachers may also just not have the capacity or decision-making authority to implement PBL. Assessment of PBL learning may not align well with typical school, district, state, or national testing requirements.

Best Practices

Planning

A PBL unit should always begin with an essential or guiding question. Some PBL advocates say that these questions may be posed by the teacher or the student (Wolpert-Gawron, 2018), while others believe students and teachers should co-create these questions (Wolk, 2022). Regardless, it can be challenging to know where to start when developing a high-quality PBL question. Wolpert-Gawron (2018) suggests to imagine students as different characters, professions, experts, etc., and think about what they should be able to accomplish at the end of the unit. From there, work backwards to fill in the spaces between launch and final product with lessons, activities, mini-projects, or assessments. (Wolpert-Gawron, 2018). MacLeod & van der Veen (2020) provide some helpful guidelines for ensuring questions are well-framed for interdisciplinary work. The problem should require contributions from all involved disciplines, which can be distilled and then reintegrated to solve problems using elements from previous course work. (MacLeod & van der Veen, 2020).

One common misconception about PBL is that there should be no direct instruction, but this is not true (Wolk, 2022). Often, a PBL unit is best started with a small series of mini-lessons related to specific content concepts that are necessary to understanding for the project, lasting for about a week or two (Wolk, 2022). This is followed by the project itself, which could last anywhere from two to ten weeks, depending on the scope of the project (Wolk, 2022). The first half of the work usually involves collaborative research, while the second half focuses on design, creation, and solutions (Wolk, 2022). A successful project starts with the teacher providing an

overview of requirements, due dates, and a visual concept map to show the direction and steps that need to be taken to complete the project (Wolk, 2022). There should also be several scaffolds for different levels of learners that are available to all who need them, and are accessed by students independently rather than assigned by the teacher (Wolpert-Gawron, 2018). This scaffolding can be the greatest challenge of the curriculum development process (Walsh et al., 2020).

Instruction

The PBL classroom is a lively one. It might seem somewhat chaotic to someone on the outside, but the chaos is purposeful and often joyful (Wolk, 2022). For students to produce high-quality work, they should be doing the work *in* the classroom, have lots of opportunities to receive feedback from teachers *and* fellow students, and see several examples of high-quality work (Wolk, 2022). When students are collaborating, it is helpful to provide students with specific roles and responsibilities for that collaboration, such as recorder or time-keeper in order to help them be more accountable for their work and contributions to the group (Wolpert-Gawron, 2018).

It is important to note here that assessment *during* instruction is a key component of PBL. When PBL teachers are bouncing around the classroom helping students with their projects, they are assessing as they teach, which helps students stay on track and understand their next steps (Wolk, 2022).

Assessment

Not only is instructional collaboration important, assessment is also collaborative in PBL. Projects should be assessed with the same rubric by multiple stakeholders, including teachers (multiple if possible), students, and community members. In addition,

students should be part of the development of the rubric itself when possible (Wolpert-Gawron, 2018).

In PBL, the process is valued just as much as the product (Wolk, 2022). The process should involve a lot of student collaboration. Collaboration should be used as a way for students to share knowledge, but students should still be responsible for individual pieces of work (which are then individually assessed) (Wolk, 2022; Wolpert-Gawron, 2018).

PBL artifacts of learning should be presented and/or published (in a variety of ways), to an authentic audience where possible (Wolpert-Gawron, 2018). The artifacts should attempt to provide solution-oriented ideas about how we can improve our own lives and especially the lives of those in our communities in some way (Wolpert-Gawron, 2018).

Reflection throughout and at the end of a project is an important part of the PBL process, and can positively impact student engagement by helping students' ability to self-assess and self-direct their own learning (Reeves et al., 2023; Wolpert-Gawron, 2018). Students should always reflect on the successes and places for improvement within their projects, as well as consider what they may do differently next time.

Summary

In this literature review, the purpose and function of schools is discussed, especially as it relates to high school environmental education, which authors argue ought to be focused on preparing students for action (environmental or otherwise) in a democratic society. Next, the concept of critical ecology is defined, which furthers the goal of making progress toward a more sustainable world in the future. Then, the factors

that influence and barriers to student engagement are explored, as one of the goals of this project is to consider how an ecocritical approach might be used to foster increased student engagement. Finally, the benefits, limitations, and best practices for project based learning are explained, many of which are well-aligned with the goals of education, environmental education, ecocritical education, and creating a more engaging classroom environment. These themes were all reviewed here in order to answer the question, *How can educators create an ecocritical and engaging project based curriculum for high school environmental science?* Following, Chapter Three explains how the themes from the literature review played a role in the methodology of creating project curriculum, as well as the setting and timeline in which this curriculum will be implemented.

CHAPTER THREE

Project Description

Overview

The purpose of this chapter is to provide further context for the development of the project curriculum, which attempts to answer the question: *How can educators create an ecocritical and engaging project based curriculum for high school environmental science?* This chapter begins by detailing the guiding principles which drive the project, and how they appear in the curriculum. Then, a description of the project itself and how it will be implemented is provided, including the setting and timeline for implementation. This section also discusses how the project's success will ultimately be measured. Last, a summary of the chapter is provided along with a brief description of Chapter Four.

Guiding Principles

The goal of this project is to further understand whether an ecojustice approach, in conjunction with a project based learning framework, could potentially be utilized to foster increased student engagement.

Critical Ecology

Critical ecology, which is described in more detail in Chapter Two, is an idea that encourages students to identify and analyze the taken-for-granted industrialized and globalized cultural norms which have contributed to society's greatest problems, and aims to help students develop the skills necessary to disrupt these norms and envision healthier and more sustainable solutions. Key themes of critical ecology in education should include democracy, diversity (including biodiversity), and sustainability (Martusewicz et al., 2021).

Critical ecology was chosen as a key element for this project because it goes above and beyond typical environmental education (EE) to foster an ethic of care through a pedagogy of responsibility. In other words, the hope is that students not only gain a greater understanding of environmental problems, but also feel more empathy towards each other and their environment in order to help them see why it is important for diverse individuals to collectively work together in democratic ways, to ultimately create a more sustainable and just future for ourselves. While traditional EE does emphasize environmental understanding and encourages students to take action, critical ecology specifically asks students to make connections between social *and* environmental issues to identify the true root of societal problems, in hopes that students consider action steps that are significantly more meaningful and effective than they might be otherwise.

Ecocritical curriculum, especially in the high school science classroom, is difficult to find, so this project aims to fill a gap by providing educators with concrete examples of units and lessons that work toward the goals of ecocritical education. Turner's (2015) book *Teaching for Ecojustice: Curriculum and Lessons for Secondary and College Classrooms* serves as the only existing example I have been able to find so far, and a tremendous help in thinking about how to structure the curriculum in this project.

Project Based Learning

Project based learning (PBL) is a pedagogical method in which students collaboratively work to answer guiding questions and create products which demonstrate their learning. This project utilizes best practices in PBL (detailed further in Chapter Two), for many reasons. For one, it is a foundational element to the school and setting in which this curriculum is meant to be implemented. Additionally, when PBL best practices

are kept in mind and utilized, it is clear from the research that it can be a powerful tool to increase student engagement and academic success (Botella Nicolas & Ramos, 2022; Smith, 2007; Wolk, 2022; Wolpert-Gawron, 2018). It furthers the goals of EE, critical ecology, and education at large by allowing students opportunities to develop necessary life skills and gain the tools needed to make sustainable change toward a more democratic and diverse society.

Project Framework

This project uniquely combines the central themes of critical ecology with a PBL framework, with the hope that it creates an environment where students not only understand the importance of diversity and develop an ethic of care, but also have the action competence to use that understanding and empathy to create a more sustainable and just world after they leave high school. While these approaches are different from each other in several ways, they are in strong alignment when it comes to instructional practices that are shown to increase student engagement, such as collaborative learning, varied assessment, student choice and voice, and an equal emphasis on process *and* product. I feel strongly, rooted in the research conducted for Chapter Two, that combining these two approaches has the potential to tremendously increase engagement and help students feel more empowered to self-direct their own learning.

The primary framework used to develop this project is A Framework for High Quality Project Based Learning (2018). This framework identifies six key elements that must be met in order for a project to be considered high quality: 1) Intellectual Challenge and Accomplishment, 2) Authenticity, 3) Public Product, 4) Collaboration, 5) Project Management, and 6) Reflection.

Intellectual Challenge and Accomplishment

A high quality project based learning (HQPBL) unit should offer students opportunities to challenge themselves intellectually and feel proud of their work. The best way to ensure this is to have students start with an intellectually challenging guiding question that provides them focus as they work through the project.

Authenticity

HQPBL curriculum should strive to be authentic wherever possible, meaning that the experiences students have as they work should always mirror or relate somehow to the "real world". Projects feel more authentic to students when they have a chance to choose their own guiding question and the methods they use to answer it.

Public Product

Students should always showcase the learning from the project in a public way. This could be simply sharing with a small group of peers, to the whole class, to the whole school or additional community members. What matters is that they have to consider how they will share their work, which can also help with a feeling of accomplishment.

Collaboration

Collaboration is key to learning in HQPBL, in ecocritical studies, and especially when it comes to student engagement. HQPBL units should offer students a variety of ways to collaborate with each other, both in the formative work leading up to and during the project as well as in creating a final artifact to showcase to others. These groups should change frequently and mix students with various abilities and talents.

Project Management

HQPBL units should not only focus on content knowledge and skills, but also project management skills. This means teaching students skills to keep track of deadlines, break down large steps into smaller ones, collect and compile observations in a way that works for them, and consider how they will showcase their artifacts and what it will take to do so.

Reflection

Reflection is a key component of HQPBL, and also extremely important for student engagement as it allows students to self-assess their own learning and where they might be stuck. Reflection should occur throughout a project as a student considers the work they have ahead of them, and also at the end of a project to reflect on the project process and quality of the artifact.

Project Description

This project includes a curriculum that is intended to be used over the course of the first semester of a high school Life Science class. The curriculum contains four units which are designed to meet the standards listed in Table 2 on the next page.

Table 2

MN Science Benchmarks Addressed by Project Curriculum

Unit 1: Atoms to Organisms	9L.3.2.1.2 Construct and revise an explanation based on evidence for how various elements combine with carbon to form molecules that form the basis for life on Earth. (*Practice: Constructing explanations, Cross-Cutting Concept: Energy and matter*)
	9L.1.2.1.1 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (*Practice: Planning and carrying out investigations, Cross-Cutting Concept: Stability and change*)
	9L.3.1.1.4 Use a model to illustrate that cellular respiration is a chemical process in which energy from food is used to create new compounds. (*Practice: Developing and using models, Cross-Cutting Concept: Energy and matter*)
Unit 2: Genetics for Good	9L.3.2.1.1 Construct an explanation based on evidence for how the structure of DNA determines the structure of the proteins that carry out the essential functions of life. (*Practice: Constructing explanations, Cross-Cutting Concept: Structure and function*)
	9L1.1.1.1 Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (*Practice: Asking questions, Cross-Cutting Concept: Cause and effect*)
	9L.4.1.1.2 Make and defend a claim based on evidence that heritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. (*Practice: Engaging in argument from evidence, Cross-Cutting Concept: Cause and effect*)
Unit 3: Anatomy	9L.3.1.1.1 Develop and use a model to illustrate the levels of organization of interacting systems and how that translates into specific functions in multicellular organisms. *(Practice: Develop and use models, Cross-Cutting Concept: Structure and function)*
Unit 4: Life Finds a Way	9L.2.1.1.2 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. *(Practice: Analyze and interpret data, Cross-Cutting Concept: Patterns)* 9L.4.2.1.1 Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. *(Practice: Obtain, evaluate, and communicate information, Cross-Cutting Concept: Patterns)* 9L.3.2.1.4 Construct an explanation based on evidence that the process of evolution results from four factors: reproduction within a species, heritable genetic variation of individuals in that species, competition for limited resources, and increased survival and reproduction of the individuals best suited for the environment. *(Practice: Construction explanations / Design solutions, Cross-Cutting Concept: Cause and effect / Mechanism and explanation)* 9L.3.2.1.5 Construct an explanation based on evidence for how natural selection leads to the adaptation of populations. *(Practice: Construction explanations / Design solutions, Cross-Cutting Concept: Cause and Effect / Mechanism and explanation)* 9L.4.1.1.3 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. *(Practice: Engage in argument from evidence, Cross-Cutting Concept: Cause and effect / Mechanism and explanation)*

Each unit begins with a few lessons of introductory concepts that help students develop the scientific language and concepts associated with each unit. The majority of the lessons in each unit are meant for students to work on each project, developing a

deeper understanding of the content as well as learning collaboration and project management skills throughout. The end of each unit provides time for students to create the final artifacts that they will showcase, and a platform for students to share their final artifacts.

Setting

This project is designed for implementation at a charter high school located in an urban setting in Minnesota. The focus of this school is on PBL, interdisciplinary work, 21st century skills, community connections, and social justice. There are 75 currently enrolled students, with 10 total staff members (content teachers, special educators, and administration), with plans to expand to 105 students and 12 staff in the 23-24 school year. The student body is extremely diverse in demographics such as race, culture, gender, economic status, but also in their abilities, talents, and passions. Students at this school are strongly encouraged to choose project topics and guiding questions related to those passions. One key feature of this school is the Community Asset Projects (CAPs) built into the school year, in which students work to find solutions to problems in the community they are passionate about. Because of this, projects done throughout the year in regular classes also have the goal of preparing students for this type of solution-oriented independent work.

Timeline

The work for this project began in January 2023. Chapters 1, 2, and 3 were written between January and May of 2023. In June, the scope and sequence of the 23-24 school year curriculum was created and initial unit outlines were drafted. Next, essential questions and project rubrics were designed so as to be a guide for the work that would

take place in each lesson. Then, an outline for each lesson was created. Finally, additional unit materials were created as resources for the user of the curriculum.

My plan is to implement this curriculum in the fall of 2023, between September and December, in my 9th and 10th grade Life Science class. These units are meant to be first in a sequence of and serve as a blueprint for a series of more PBL units throughout the school year.

Assessment

The projects themselves will be assessed with a rubric based on best practices in PBL, which is provided in the curriculum itself. The effectiveness of the whole project will be assessed through engagement checks that occur weekly for the duration of each unit, in an attempt to measure how students feel about each stage of the project. This will help for tracking which specific pieces of each unit are most or least effective. At the end of each unit, a summative survey to ask about overall engagement and student understanding of critical ecological concepts will be used. This information can be used to better structure and design the units which will occur throughout the rest of the school year and beyond.

Summary

This chapter is meant to provide further understanding of the connection between the central themes of the project and how these themes are implemented in the project curriculum itself, in order to answer the question: *How can educators create an ecocritical and engaging project based curriculum for high school environmental science?* First, an overview of the guiding principles which form the basis for this project is provided. Then, the framework used to develop the project is explained. Next, a

description of the project itself is provided as well as the setting it will be implemented in, timeline in which it was developed and will be utilized, and how its effectiveness will be assessed during and after implementation. Chapter Four will summarize key findings and reflections from the research question, as well as the limitations and potential future areas of study.

CHAPTER FOUR

Overview

This project was created in order to answer the question: *How can educators create an engaging and ecocritical project based curriculum for high school environmental science?* This chapter includes personal reflections on the project process and examples of how this project could be utilized in the future. First, personal learnings gained from the project process and recommendations based on findings are provided. Then, the values identified and challenges encountered throughout the process of writing the curriculum is explained. A description of the implications, limitations, and implementation of the curriculum project comes next. Finally, potential areas of further work are identified, concluded by a chapter summary.

Personal Learning and Recommendations

I learned so much about myself through this capstone project, not only as a researcher, writer, and learner, but also as an educator and what I value most when it comes to student learning. In the early stages of the process, I learned a lot about gathering extensive amounts of research and information, then compiling it in a way that summarized and made sense to others. I have certainly written evidence-based essays before, but not to this extent. This process was particularly helpful for my work, not only so that I could develop a deeper understanding of the literature, but also so that I can share research strategies with my own students, who are asked to make observations and gather evidence themselves throughout the project curriculum. I also revisited and refreshed my memory of many ideas and instructional strategies that I was introduced to in my undergraduate coursework, which helped to reinforce some of the instructional

strategies I had already been using, and those that I ought to consider changing. Toward the end of the 2022-2023 school year as the research for this project was being conducted, I had a chance to implement and practice some of the collaborative discussion practices used in this curriculum, and there was a noticeable difference in student engagement. Providing students with clear roles and tasks to complete, along with having them complete these tasks in a collaborative way were what I believe to be the biggest factors in the change.

When I started this project, one of my primary goals was to learn more about how to structure a project based learning (PBL) unit. I was expecting to find a "correct" methodology for this, but what I found is that there are so many ways to implement PBL that could all be considered "correct". One recommendation I have for educators and schools looking to increase their use of PBL is to identify their own values around student learning and the purpose of projects, so that they can focus on what is most important and meaningful for them and their students. There are so many other methods of learning that could align with PBL and enhance it, such as problem based learning, community based learning, passion based learning, service based learning, place based learning, and more. I encourage educators and schools to look into these different ways that PBL could be done so that the work students are doing aligns with the mission and values of the school community.

One perpetual struggle educators seem to face is that there never seems to be enough classroom time to get to everything we would like to get to in our curriculum, and I found that to be the case for this project too. This meant I had to decide which standards, concepts, and lesson activities needed to be prioritized. Because of my

research into PBL, I decided to focus on the essential questions for each project as a guide for curriculum topics. As I wrote the outlines for each lesson, I asked myself if the lesson activities helped work toward building students' ability to eventually answer that essential question. If it did not, that material was adjusted or cut out. I would recommend that anyone utilizing PBL also focus on the goals and purpose of the project that students will complete in order to ensure that the lessons leading up to and throughout the project work make sense for the student learning goals.

Another thing PBL educators should keep in mind is that the majority of the student learning should happen *during* the project work through inquiry and exploration. At the beginning of each unit in this curriculum, there are a few lessons designed to teach students introductory concepts, helpful terminology, and practical skills that they will use throughout the project, but the bulk of the knowledge and skill development happens through the project itself. This is different from a traditional teaching style that might include several weeks worth of teacher-led lessons, followed by a project or test to showcase learning. With PBL, the project is meant to deepen content knowledge and work on skills, while the final artifact is how students showcase that learning (and in the process of developing the final artifact, they are working on useful skills too). My recommendation would be for educators to focus less on content knowledge during teacher-led lessons and more so on student skill development, because what students will need the most help with is developing the skills to perform inquiry and exploration of content on their own during more independent, student-led lessons. The content knowledge will happen naturally as students work through the project, as long as they have the skills to find it.

Writing the Curriculum

It was particularly helpful for me to begin my research with the purpose of school and environmental education. If you were to ask any group of people what they think students *should* be learning in school, you would likely get a different response from each person in the group. It was important to me to ground my work in true research around the purpose of school, as well as what it means to have environmental literacy, so that I could make sure my curriculum was in alignment with these goals. This process also helped me to further identify and deepen my own values when it comes to what I want students to walk away with after they leave my classroom. These values play a strong role in the content of the curriculum.

One value that has become clear to me as a result of this project is that students learn how to *take action* related to the problems they are passionate about. Many researchers agree that taking action should be considered one of the highest forms of learning (Finn & Phillips, 2023; Jensen & Schnack, 1997; Walker, 2022). A key component of this action is that students not only have the skills to do so, but also the willingness (Jensen & Schnack, 1997). In order to develop that willingness, students need the ability to ask questions and identify their values. This is why so much of the project work in this curriculum is geared toward helping students generate high-quality questions and consider ethics and values. The hope is that this work will help my students find their passions and figure out what they most want to take action on later in the school year, and most importantly, beyond school itself.

A struggle I encountered during my research was finding examples of other curriculum that incorporated critical ecological concepts. While the idea has been

explored by researchers for a few decades now and implemented in some college settings, it is still very new to K-12 education. This made it difficult for me to know if I was on the right track with critical ecology in my own curriculum. The only example I could find, which turned out to be extremely useful, was *Teaching for Ecojustice: Curriculum and Lessons for Secondary and College Classrooms* by Rita Turner (2015). The way Turner structured her lessons was much more casual and open-ended than a typical lesson planning template, which was a big inspiration for the way I wrote my own lessons. I learned from this example that critical ecology does not need to be explicitly discussed, but can also appear in the hidden curriculum that is always there underlying what we do in the classroom. I hope that my curriculum can be useful in the same way to others as well.

Implications

One of the hopes for this project is that it can serve as an example of high quality PBL for other educators in my school setting. As a school that has only been operational for two years (opened in the Fall of 2021), there was no precedent for how to structure a project, and much of what I learned about PBL was through trial and error until beginning the research for this curriculum. This project has given me new confidence when it comes to knowing what quality PBL is (and what it is not), and I hope that I can share this confidence with other educators and staff at my school, especially newer staff who may not have experience with PBL. I also hope that my project can serve as a conversation starter for how we might incorporate ecocritical concepts into other school subjects outside of science, as well as how we might apply those ideas to our whole

school system - from student, to teacher, to administration, and all the way to the school board and possibly beyond.

Limitations

The focus of this project was primarily on the planning and instruction of an engaging and ecocritical curriculum, and less so on the assessment of student learning. Assessment is an extremely important component of the learning process, and I wish I had more time to delve into this topic. In particular, I think that a critical ecological approach combined with the PBL value of skill based learning could be a place to start as we consider how to improve our existing assessment practices. Assessment is something that can vary so greatly between schools and districts, so it made sense to me as I built the project to leave the assessment and evaluation more open-ended, because most educators would need to make changes to it anyway. Even within my own school setting, each educator has slightly different ideas about the best way to formatively and summatively assess student learning. So, due to time constraints and a lack of existing examples in the literature, assessment is one limitation of this project.

I believe this curriculum could be improved by incorporating more varied instructional options for educators. My lessons can definitely serve as an example of how one might instruct, but every teacher is different and there is a lot of value in trying a variety of different instructional methods to figure out what works best for you and your students, especially if you are newer to the field of teaching. The instructional activities I chose are those that I have found in my own experience work best for me and my teaching style, so I think it would be more helpful to other educators to provide a few other examples of how they might instruct differently.

Project Implementation

I plan to use this curriculum beginning in September of 2023 through December 2023. It is designed to help students build the skills they need to apply an ecocritical lens to the problems they see in their own lives, by using methods of PBL to create engaging learning experiences for students. Throughout the fall and in December 2023 after implementing the curriculum, I plan to evaluate what worked well and what did not as I continue to write curriculum for the remainder of the school year. In order to evaluate this, I plan to survey my students to see how their knowledge, skills, and environmental values have changed from September to December, which will help me identify areas to focus on next. To communicate my results, I will first share my project findings with colleagues during our August professional development session ahead of the 2023-2024 school year, so we can reflect together on what instructional strategies, course content, and student skill development in the curriculum we might focus on during the year. Throughout the school year, I plan to update my colleagues on my continued evaluation of the strategies that are working well so that we can adjust accordingly for our students.

Future Work

I hope that this project can help further the dialogue about the benefits of PBL for K-12 students, as well the benefits of incorporating social justice concepts into the science classroom. I believe this curriculum provides a benefit to the profession by bringing critical ecology into the spotlight, which is an unfamiliar concept for the vast majority of people. There are very few studies or resources for critical ecology in the high school classroom, so this project aims to fill a gap in the existing literature.

Aside from continuing the existing curriculum into the remainder of the 2023-2024 school year, this project has sparked many new ideas for future work. I hope to continue studying assessment in PBL and critical ecology, as this is such a crucial part of education and a limitation of this project. In particular, I want to explore new ways to assess student learning that are more aligned with the values of critical ecology, such as collaborative assessment. I also hope to find ways to incorporate critical ecology into other subject areas, my school's advisory program, and other non-classroom areas (such as lunch time procedures, field trips, or student conferences).

Summary

This chapter provides a reflection on the process of preparing for and creating a curriculum to answer the question, *How can educators create an engaging and ecocritical project based curriculum for high school environmental science?* This chapter includes personal learnings and recommendations based on the findings of the project, a reflection on the writing process of the curriculum, project implications and limitations, a plan for implementation, and some ideas for future work related to the project. Writing this curriculum provided me with a fantastic opportunity to dive deeper into the world of critical ecology and project based learning, and how to implement these into my teaching in a way that will be engaging for my students. I feel confident that my teaching and instruction will improve because of what I have learned throughout this process.

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