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Permaculture Curriculum for Public School Children in the United States

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Permaculture Curriculum for Public School Children in the United States

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

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DEDICATION

To Bill Mollison, who was never afraid to challenge the status quo.

I challenge you to look at human within nature, and that human is part of nature, and that we can use the better parts of our human nature to really heal the world.

—Professor Malia Akutagawa, *Aloha ʻĀina Molokai*

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CHAPTER ONE: INTRODUCTION

Introduction

The following capstone project, dedicated to natural science and environmental education, asks the question: *How can a permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* Permaculture is a whole-systems, sustainable design science that uses patterns found in nature to create environments that provide for human needs and are beneficial to all life forms. In order to better understand the aims of my capstone project which was the development of a permaculture curriculum for children in public schools, this paper provides an overview of the following topics: nature-based education and curriculum, including outdoor classrooms; sustainability and permaculture; permaculture education and curriculum; and academic standards. The intended audience for the work developed here is educators of children in public schools in the United States. However, this work is applicable to educators of children in any setting.

Rationale

Growing up in a suburb of Detroit, Michigan some of my favorite memories happened at a park just down the street from my house. The park was a big open area with a small playground, surrounded by houses. I spent a lot of time using the playground equipment, by myself or with friends. But, my fondest memories were of hours of unstructured play on a small hill and in a little patch of woods. I visited that park multiple times a week, year-round. It was a site for talent shows, barbies, role playing, sports, talking, singing, and watching animals or bugs. I loved the wooded area most, where my

friends and I built forts in the spring, summer, and fall – and ice skated on the shallow pond in the winter, warmed by thermoses of hot chocolate. I had a great childhood, and that park was one of the reasons why. Sadly, years after I moved away developers destroyed the park and the woods to make room for more houses. Today, there are no signs that the park ever even existed. Unfortunately, this sense of loss is common for many people like me who grew up playing in pockets of nature in urban and suburban neighborhoods.

Nature Deficit Disorder

Today, kids have less wild areas to explore. But, that is not the only thing holding them back from connecting with nature. In the hypnotic age of electronics and the rapidly changing modern world, even when nature is available, many kids would rather stay indoors. This has caused many children to become disconnected from nature. Richard Louv (2008), renowned author of numerous books on the relationships between humans and nature, refers to this new landscape of childhood as 'nature deficit disorder'.

Nature deficit disorder can cause physical, mental, and emotional problems for children, such as higher rates of physical and emotional illnesses, attention difficulties, and dulled senses (Louv, 2008). But, according to Louv, all hope is not lost. After many years of interviewing elementary students, Louv found that while children spend less time in nature, they speak of nature "with a strange mixture of puzzlement, detachment, and yearning" (p. 13), as well as with a sense of curiosity. When asked why they do not go outside more, three common answers from children included lack of time, preference for electronics, and parental worry.

The children of today are the Earth's stewards of tomorrow. Nature deficit disorder leaves them ill-prepared for this role. Our planet is in trouble. American icon William Shatner, in an interview about seeing the Earth from space for the first time in 2021, described with overwhelming sadness what he saw as "the writhing, slow death of Earth" (Rivera, 2022, p.1). It is no secret that the previous and current unsustainable actions of humans living on this planet have caused massive damage to our Earth's climate, environment, and ecosystems. Sadly, our children will inherit the problems that we created and will need to come up with better, more sustainable ways for living into the future. In light of this responsibility, one might wonder how these children can become the Earth's stewards of tomorrow if they aren't connecting with nature today.

Nature-Based Education and Permaculture

One conclusion that I drew from Louv's insights is that, while we cannot force our children to 'want to be' outside, we can provide them with more opportunities to 'be' outside. Schools are in the best position to reach the most children. One way that schools can do this is through nature-based education.

Nature-based education, in the context of this paper, refers to an educational approach that uses nature as an outdoor classroom, paired with a nature-based curriculum. Nature-based education can provide many benefits to a child's health and well-being (Largo-Wight et al., 2018). These benefits can include physical activity, fresh air, play, increased exposure to science, creativity expansion, improved focus, and a much-needed break from screens. Learning outdoors also gives children an outlet for pent up energy. As stated by Fletcher (2018), "If there are no walls, you cannot bounce off the walls" (14:15). Allowing children to move more can help kids focus when needed,

helping teachers get more accomplished in smaller amounts of time (Shockman, 2022). Outdoor learning can also have a positive effect on the brain and lead to better learning outcomes (Gatewood Elementary, 2022). However, while many forms of commonly-used nature-based education and curriculum can certainly help kids to connect with nature and improve their well-being, they do not necessarily teach them about sustainable design. This leaves children unprepared for an uncertain future on this planet. Permaculture is a form of nature-based education that can be used to fulfill this gap.

Permaculture is an interdisciplinary, whole-systems sustainable design science (Mollison, 1997) that can be used to both connect children with nature and prepare them to live sustainably on our changing planet. The future of this planet will require a change of consciousness, from one of short-term exploitation of people and nature to one that cares for and considers the long-term impacts to both (Aderslowe et al, 2018). In order to reach this goal, we need to support children to develop a sensitive, compassionate, and cooperative relationship with each other and the natural world. Permaculture education is based on a set of ethics, principles, and design tools that can be used to create resilient, sustainable relationships between human beings and the natural world. According to Louv, in a testimonial for a book about permaculture education for children, “if incorporated into the lives of enough children and the adults who care for them, this philosophy can change the world” (Aderslowe et al., 2018, p. 4).

Context

I can think of three people who made the biggest impact on my environmental education journey thus far: my grandma, a co-worker named Steve, and Bill Mollison, the co-creator of permaculture. My grandma lived through the Depression and was very

conservation-minded. Because I spent a lot of time with her, I grew up learning to turn off the lights when not in a room and not letting the faucet or hose run longer than necessary. She did not like waste of any kind, including food. Her favorite pastime was sitting on her back porch watching wildlife and talking about pollution. I did not realize how much of an impression she made on me until I was older.

My co-worker and friend Steve said something to me that became a pivotal moment in my life. I was working in public environmental education at the municipal level. A lot of my work was writing publications to educate residents about environmental practices. At the time, I was doing some of these practices at my own home, but not anything close to what I should have been doing. We were casually debating and Steve said something like, “If you are going to talk-the-talk, you have got to walk-the-walk.” I thought long and hard about this, started to feel like a hypocrite, and soon after went to Australia to take a Permaculture Design Course.

I took the internationally-known 72-hour Permaculture Design Certificate Course (PDC) with Bill Mollison and Geoff Lawton in 2007, and it changed my life. I also have a Bachelor of Science degree in Environmental Studies from the University of Minnesota College of Natural Resources. While I learned a lot in that program, I learned so much more in just two weeks in my PDC. Bill Mollison had a big personality that I immediately clicked with. He was so raw and authentic that I felt deep respect for him. A few weeks after the course ended and I returned to the United States, Bill’s co-teacher Geoff Lawton contacted me about starting a United States branch of his permaculture nonprofit organization. I said “Yes”, and used my skills as an attorney to incorporate the

Permaculture Research Institute USA (PRI USA). I worked as administrative director for PRI USA for about five years.

The Permaculture Research Institute USA (PRI USA)'s most important work took place on the island of Moloka'i, Hawai'i, where we provided permaculture training to both local and non-local students. PRI USA formed partnerships with Sust'ainable Moloka'i (a local nonprofit working to create a sustainable island through a blend of Native Hawaiian culture and modern practices) and the Ho'ala Hou Program (an organization that provides support programs for at-risk youth). Through this collaboration, known as the Moloka'i Permaculture Education Initiative, PRI USA trained fifteen key Moloka'i community leaders through a series of four Permaculture courses. After completing the 72-hour Permaculture Design Certificate Course, a Practicum on Incorporating Traditional Hawaiian Plants into a Permaculture Design, Teacher Training, and Water Harvesting Earthworks, these new permaculturists were well-trained in both the theory and practice of permaculture. They have since gone on to incorporate what they learned into their homesteads, schools, community organizations, and island-wide projects.

It has been a little over ten years since my permaculture work in Hawaii. During this time, I chose to focus on raising my kids and working part-time in the legal profession. But, now that they are getting older and I am looking for more meaning in my work, I have decided to return to the field of environmental education. I am in the process of starting a new permaculture organization that will offer permaculture courses in the context of real-world projects to both adults and children. I would love to partner with

public school districts to provide permaculture education opportunities for children. I recently worked on a project in another course where I interviewed education professionals at a local elementary school about the idea of starting an outdoor classroom. Everyone's responses were positive. This could be a great way to help urban kids get outdoors more and an opportunity for the application of a permaculture-based curriculum.

Being a mother, I know first-hand how difficult it can be to get children outside into nature these days. And, my kids have more opportunities than most, as I have been 'dragging' them to Wisconsin's north woods and lakes since they were born. Unfortunately, many kids who live in cities do not always have the same opportunities. Reconnecting kids to nature is key to the future of the earth, as I believe there is a direct correlation between intimacy WITH nature and advocacy FOR nature. In the Hawaiian language, Malama 'Aina means 'to care for and nurture the land'. If kids are not connecting with nature, how will they Malama 'Aina when they become adults?

While I do not have experience as a public school teacher, I do have professional experience in the field of environmental and permaculture education. Plus, in addition to having a bachelor of science in environmental studies, I have a law degree that has given me skills in critical reading, research, and analysis. I believe that my professional and educational experience, together with my child-rearing experience, qualifies me to take on the task of this capstone project. A lot has changed in environmental education since I was last in the field, generally for the good. With the progression of climate change, people are more concerned about the environment and possibly more open to solutions to different ways of living like those that permaculture offers.

Summary

In this chapter, I have discussed the problem of children's disconnect with nature and how this is a major issue for the future caretaking of this planet. I have introduced the concepts of nature-based education and permaculture as potential solutions to these problems. I have also shared the personal and professional journey that has led me to choose this particular capstone topic.

The remaining chapters in this paper focus on my research question: *How can a Permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* In Chapter Two, I review pertinent literature surrounding the topics of nature-based education, outdoor classrooms, nature-based curriculum, sustainability and permaculture, permaculture education and curriculum, and academic standards. In Chapter Three, I discuss my findings and describe the capstone project I developed. In Chapter Four, I share what I learned from the capstone literature review and project development process. Finally, in the References and Appendices sections, I provide a list of resources for development of this capstone research paper and project.

CHAPTER TWO: LITERATURE REVIEW

Introduction

Chapter Two provides a thorough analysis of the literature necessary to answer the research question: *How can a permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?*

Topics reviewed in this chapter include nature-based education and curriculum, including outdoor classrooms, sustainability and permaculture, permaculture education and curriculum, and academic standards. Nature-based education can be used to help connect children to nature when using a nature-based curriculum in an outdoor classroom. One type of nature-based curriculum that can be used in an outdoor classroom is permaculture. Permaculture not only helps children to connect with nature, it can also teach them how to design new, more sustainable ways of living in light of current environmental crises and uncertainty. Permaculture curriculum can be used to meet academic standards in public schools.

Nature-Based Education

Nature-based education has been around for more than two centuries and used for various purposes (Prochner, 2021). Today, it is commonly viewed as an alternative approach to a traditional education that relies on little interaction with the natural world. There are many possible ways to define nature-based education (Ford, 1986). Some definitions might include recreational activities such as hiking, camping, and canoeing. Others require an additional component of active learning, such as observation, problem-solving, and reflection (Meier & Sisk-Hilton, 2013). Nature-based education can

also be defined as a means for curriculum extension to the outdoors or an opportunity for direct learning experiences in nature (Ford, 1986). In the context of this paper, nature-based education is made up of two components: an outdoor classroom and a nature-based curriculum. In order to expand on this, it is necessary to take a deeper look into these components.

Nature-based education is a type of environmental education that uses nature as the organizing concept to promote environmental literacy. Environmental education, as defined by the United States Environmental Protection Agency (2022), is "a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment" (p. 1). The North American Association for Environmental Education (NAAEE) is a United States-based, international nonprofit organization that works to promote excellence in environmental education throughout North America and the world (2022). According to NAAEE, environmental education provides the skills necessary for people to make informed decisions about the environment that lead to lifelong stewardship and a more sustainable society.

The guiding principles of environmental education are grounded in two main documents: the Belgrade Charter, adopted at a United Nations Conference in 1976; and the Tbilisi Declaration, adopted at the world's first intergovernmental conference on environmental education in 1978 (NAAEE, 2021). Simply stated, the goal of environmental education is to provide experiences and learning that will foster environmental literacy. An environmentally literate person, as defined by NAAEE in *Developing a Framework for Assessing Environmental Literacy* (2011), is "someone who both individually, and together with others, makes informed decisions concerning the

environment; is willing to act on these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life" (pp. 2-3).

While nature-based education is a type of environmental education, there is one key difference that sets it apart. Environmental education can take place anywhere, but nature-based education takes place where nature is present, generally outdoors (Prochner, 2021). However, some scholars state that it can also take place indoors if nature is present, such as via plants, animals, and water (Jordan & Chawla, 2019).

Jordan and Chawla (2019) referred to nature-based education as "learning through exposure to nature and nature-based activities" (p. 2). This can include learning via direct experience with nature or learning with nature as a background. Prochner (2021) stated that nature-based education models generally prioritize three types of child-nature experiences: 1) direct experiences in natural settings; 2) indirect experiences in structural contexts; and 3) symbolic experiences with representations of nature. This wide variation in the approaches to nature-based learning allows it to not only be used to learn about the natural world, but also can include learning about any subject, skill, or interest while in natural surroundings (Jordan & Chawla, 2019). Nature-based learning can also be used in informal (such as children's freeplay in their yards), non-formal (such as family visits to nature centers), or formal (such as nature-based learning in outdoor classrooms) settings.

This background on nature-based education helps to demonstrate to the reader how and why it can be used as a tool to help connect children to nature. Nature-based education, with respect to this project, can be further defined through the following overview of its two components: outdoor classrooms and nature-based curriculum.

Outdoor Classrooms

While the schoolyard is generally used as a space for activities such as sports or recess, it can also be used as a space for learning known as an outdoor classroom (Nuttall & Millington, 2008). An outdoor classroom can be used to teach science or any subject area.. The outdoors is an important learning environment because there is a level of learning that takes place there that does not happen indoors (Nelson, 2012).

An outdoor classroom can take many forms and generally includes both natural and built elements (Nuttall & Millington, 2008). It can be a small patch of land or a vast area. It can be natural, landscaped, and/or include a permanent structure for teaching. Spaces can also be expanded to include designs for specific learnscapes.. These are places in the school landscape that provide additional teaching resources, such as specialized gardens, compost piles or worm bins, water catchment features, weather and wind stations, bird feeders, natural playgrounds, or calming spaces.

Starting an outdoor classroom can seem like an overwhelming task for schools. But, it does not have to be if you start small. It can be done on a shoestring budget or with the help of grants such as the No Child Left Behind Grant (Minnesota Department of Education, n.d.a). Hackett (2022) suggested starting an outdoor classroom in five phases: 1) Establish infrastructure, 2) Make the transition outdoors, 3) Integrate curriculum, 4) Prepare for the weather, and 5) Create sustainable systems for managing your spaces.

Interest in outdoor classrooms and nature-based education has increased over the last few years in response to the COVID-19 pandemic (Green Schoolyards America, 2022). As kids moved from school grounds to distance learning, they lost opportunities for directly connecting with the outdoors, and one another (Prochner, 2021). Outdoor

classrooms offered a promising solution during this trying time. A few schools in Minnesota that have incorporated outdoor classrooms into their programs include Gateway Elementary in the Hopkins School District (Gatewood Elementary, 2022; Shockman, 2022), Deephaven Elementary in the Minnetonka School District (Minnetonka Public Schools, 2022), and Golden Lake Elementary in the Centennial School District 12 (Centennial School District 12, 2022).

This introduction to outdoor classrooms is important because outdoor teaching spaces are necessary for nature-based education. While it might be true that some schools already have natural spaces nearby that they can explore, such as trails or parks, many urban schools do not. An outdoor classroom is a space that can be created and used by any school with any amount of space or resources.

Nature-Based Curriculum

Nature-based curriculum is a course of study that can be used by educators when teaching in outdoor classrooms to help children connect with nature. There are sources of nature-based curriculum available for children from early childhood education through high school (Minnesota Department of Education, n.d.a.; Leopold Education Project, 2016; Project Learning Tree, 2022; Project WET, 2020; Project WILD, 2018).

Lessons in a Land Ethic is a curriculum for all ages created as part of the Leopold Education Project (2016). It is an outdoor, interdisciplinary conservation and environmental education curriculum based on the essays found in *A Sand County Almanac*. It was created for teachers but can also be used by other educators. The purpose of the curriculum is to promote responsible decision-making regarding the impact of humans on ecosystems.

Project Learning Tree (PLT) is a curriculum developed by the Minnesota Department of Natural Resources that focuses on advancing student understanding and knowledge of forestry and natural resources (Project Learning Tree, 2022). PLT uses forests as a context for teaching kids of all ages about reading, writing, math, science, and social studies.

Project Water Education for Today (WET) is an international, interdisciplinary curriculum and program that provides water science education (Project WET, 2020). It is appropriate for all ages and correlated to Common Core and Next Generation academic standards.

Project WILD is an interdisciplinary conservation and environmental education curriculum and program that uses the subject of wildlife as a teaching tool (Project WILD, 2018). Lessons are appropriate for all ages and correlated to Common Core, Next Generation Science Standards, and Head Start Early Outcomes Framework. Project WILD lessons are also linked to STEM (Science, Technology, Engineering, Math) via activity extensions that use a variety of tools for deeper investigation and problem solving.

This introduction to some of the sources of nature-based curriculum is necessary to show the reader what types of content they are commonly based on. All of these sources are tied to science and environmental education and can help children learn more about and connect nature. However, they do not necessarily teach them how to design for sustainability. In contrast, permaculture curriculum can be used to not only teach children about and help them connect to nature, but also teach them about sustainability.

This section introduced some of the literature related to the topic of nature-based education, including the topics of outdoor classrooms and nature-based curriculum. It is necessary for the reader to understand these components and aims of nature-based education in order to be able to see how it can be used as a tool to help connect children to nature and reverse the effects of nature deficit disorder. It is important to note, however, that many types of nature-based education and curriculum do not teach children about sustainability and sustainable design. Children need to obtain sustainable design skills in order to prepare for future living on this planet. The next section discusses sustainability in more depth and how it relates to permaculture.

Sustainability and Permaculture

Sustainability and permaculture are intrinsically connected. In order to understand this connection, it is necessary to take a look at the definitions of both. The most widely-accepted definition of sustainability comes from the United Nations' *Report of the World Commission on Environmental Development* (United Nations Brundtland Commission, 1987). This report was created to become a global agenda for change in response to the environmental, development, and energy crises at that time. It defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (p. 16).

The Hannover Principles (McDonough, 1992), created by architects for the World's Fair Expo in Hannover, Germany in 2000, further expanded the United Nations Brundtland (1987) definition of sustainability. These were nine recommended principles created as a platform for architects and designers to consider when designing for sustainability. The Hannover Principles prioritized concepts such as the rights of

humanity and nature to coexist, interdependence, accepting responsibility for the consequences of design decisions, creation of safe products that have long term value, the elimination of waste, and reliance on natural energy flows. The principles also acknowledge the limitations of design for sustainability and accept the idea that there is always room for improvement through open sharing of knowledge.

Permaculture is a design system for sustainable land use and living (Holmgren, 2003). David Holmgren, co-creator of permaculture, talked about sustainability and how it relates to permaculture in a speech given to university students at a 2003 sustainability conference (Holmgren, 2003). Holmgren defined sustainability, in the most general sense, as "the ability to continually provide the necessities of life" (p. 3). However, in his book *Permaculture: Principles and Pathways Beyond Sustainability* (2002), Holmgren argued that any basic definition of sustainability leaves it open "to inevitable appropriation by corporate spin doctors" (p. xxx). He went on to point out that, because a "high energy human society" like ours is nothing more than "a pulse in the long run of human history", attaining a simplistic definition of sustainability is impossible (p. xxx). Instead, we need to think of it in terms of adaptation to our continuously changing environment and energy descent. Holgren (2003) stated that permaculture, on the other hand, focuses on "creative and positive actions that are practical and appropriate, without necessarily attempting to understand how it all adds up" (p. 3). Holmgren argued that, given the rapid change of society and uncertainty about the future, this is a reasonable response.

This section introduced some of the literature surrounding the topic of sustainability and how it relates to permaculture. Sustainability is an important concept to understand in order to help prepare our children to tackle environmental problems and

plan for a sustainable future on this planet. The next section discusses how permaculture education is a key tool we can use to help reach this goal.

Permaculture Education

"What is permaculture?" is a common response from people when they hear the word for the first time. Permaculture is not as well known in the United States as it is in other countries. This paper attempts to change this through a review of the literature surrounding permaculture definitions; descriptions of ethics and design principles; and existing permaculture curriculum.

Permaculture is a word coined by Bill Mollison and David Holmgren to describe a whole-systems sustainable design science that they created in the mid 1970's in response to global environmental problems (Holmgren, 2002; Mollison, 1988). It is based on a prime directive, a set of ethics, design principles, and strategies that are heavily grounded in the theory and practice of indigenous and traditional cultures (Holmgren, 2020). The prime directive of permaculture states that "the only ethical decision is to take responsibility for our own existence and that of our children" (Mollison, 1988, p. 1).

Permaculture: A Designer's Manual (Mollison, 1988) is the textbook that outlines the curriculum for the field of permaculture, including definitions, ethics, design principles and strategies (Mollison, 1997). It is also the basis for the 72-hour Permaculture Design Certificate Course (PDC).

The Definition of Permaculture

There is a joke among practitioners in the field that there is no single definition of permaculture. Some critics say that this leads to confusion and misunderstanding of the

discipline (Harper, 2003). While it is true that people tend to explain permaculture in many ways, the descriptions generally all have a similar meaning. Bill Mollison (1988) defined permaculture (permanent agriculture) as:

> the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems. It is the harmonious integration of landscape and people providing their food, energy, shelter, and other material and non-material needs in a sustainable way. (p. ix)

In *The Essence of Permaculture* (2020), David Holmgren stated a more current definition of permaculture as a system that creates "consciously-designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fiber, and energy for provision of local needs" (p. 3) .

Permaculture design is "a system of assembling conceptual, material, and strategic components in a pattern which functions to benefit life in all its forms" (Mollison, 1988, p. ix). It is a process for providing for people's needs within ecological limits (Holmgren, 2020). Permaculture is a design system that uses lessons from nature to create sustainable human environments.

Becoming familiar with some of the definitions of permaculture is one way to help the reader to understand the concept. Permaculture is also based on a set of ingrained ethics. Learning about these ethics provides another piece of the puzzle.

Permaculture Ethics

The Ethics of permaculture are based on three universal principles: 1) Care of the Earth, 2) Care of People, and 3) Setting Limits to Population and Consumption (to

conserve resources) (Mollison, 1988). Holmgren (2020) described Care of the Earth as rebuilding nature's capital and Care of the People as nurturing self, family, and community. However, like many definitions of permaculture, there are also different interpretations of the ethics. The third ethic has been subject to the most discussion. Some have rebranded it as "Share the Surplus" or "Fair Shares" (Permaculture Association, 2022). Others have called it "Future Care" (Harland, 2021; IDEP, 2011b; Pittman, 2021). Harland (2021), the editor and cofounder of Permaculture Magazine, described Future Care as a term that combines all of the other definitions: limits to growth (population and consumption); redistribution of surplus; and fair shares. Harland suggested that we view this ethic as a shift towards seven generational thinking and decision-making, modeling the wisdom of the Iroquois and other indigenous and traditional cultures. Regardless of how one describes these three ethics, they are all common to traditional cultures that connect people to nature (Holmgren, 2020).

The three permaculture ethics can be used as a lens through which to view permaculture. Understanding this can help the reader to gain a deeper understanding of what permaculture is all about. A final important piece of the puzzle is the permaculture design principles.

Permaculture Design Principles

Permaculture design principles are a set of simple guiding principles, rooted in systems-thinking and derived from the study of the natural world and pre-industrial sustainable societies (Holmgren, 2020). Permaculture principles provide guidance when choosing appropriate design strategies and techniques for a particular site or context.

They are expressed using brief statements or slogans that can be easily remembered. These principles can be seen as universal, but the way they are expressed can vary greatly according to locality (Holmgren, 2002). Some argue that in order to be more useful, they should be changed "into a collection of specialized sets with specific applicability" (Harper, 2003, p. 10). These principles can also be applied to personal, economic, social, and political matters, which are known in the field of permaculture as invisible structures (Holmgren, 2002)..

There are two primary sets of design principles: the Mollison principles and the Holmgren principles (Mollison, 1988; Mollison, 1997; Holmgren, 2002). See Table 1. The Mollison principles are divided into two categories: attitudinal and ecological (Mollison, 1997).

Table 1

Permaculture Design Principles

Mollison	Holmgren
<u>Attitudinal</u> ● Work with nature, rather than against it. ● The problem is the solution. ● Make the least change for the greatest possible effect. ● The yield of a system is	● Observe and interact. ● Catch and store energy. ● Obtain a yield. ● Apply self-regulation and accept feedback. ● Use and value renewable resources and services.

theoretically unlimited.

- Everything gardens.

Ecological

- Relative location: Every element is placed in relationship to another so that they assist each other.
- Each element performs many functions.
- Each important function is supported by many elements.
- Energy efficient planning for house and settlement (zones and sectors).
- Emphasis on the use of biological resources over the use of fossil fuel resources.
- Energy recycling on site (both fuel and human energy).
- Small-scale intensive systems (stacking in space and time).
- Using and accelerating natural plant succession to establish
- Produce no waste.
- Design from patterns to details.
- Integrate rather than segregate.
- Use small and slow solutions.
- Use and value diversity.
- Use edges and value the marginal.
- Creatively use and respond to change.

Permaculture Design Principles

favorite sites and soils.

- Polyculture and diversity of beneficial species for a productive, interactive system.
- Use of edge and natural patterns for best effect.

Note: Adapted from B. Mollison, "Introduction to Permaculture", Tagari Publications, 1997; and D. Holmgren, "Permaculture Principles and Pathways Beyond Sustainability", Holmgren Design Services, 2002.

Permaculture ethics and design principles form the basis of both an introduction to permaculture course and a full seventy-two hour Permaculture Design Certificate Course (PDC). The PDC, however, goes into much more depth than an introductory course, covering the topics of: methods of design; pattern understanding; climatic factors; trees and their energy transactions; water; soils; earthworking and earth resources; the humid tropics; dryland strategies; humid cool to cold climates; aquaculture; and the strategies of an alternative global nation (Mollison, 1988).

The preceding subsections on permaculture definitions, ethics, and design principles have provided the reader with a comprehensive overview of what permaculture is about. The next subsection on permaculture curriculum reviews some of the literature on how permaculture is taught to both adults and children.

Permaculture-Based Curriculum

The 72-hour Permaculture Design Course (PDC) curriculum is the internationally recognized standard for teaching permaculture to adults (Alderslowe et al, 2018; Permaculture Association, 2020; Permaculture Institute, n.d.; Permaculture Research Institute of Australia, 2015). This curriculum covers all of the subjects found in the *Permaculture Designer's Manual* (Mollison, 1988). Some permaculture educators have also created supplemental materials to support the PDC curriculum, such as teaching and activity guides (Morrow, 2014; IDEP Foundation, 2011a, b, c).

Some educators also teach introductory permaculture courses. These courses are generally a significantly shorter version of the full Permaculture Design Course (PDC) that provide a general overview of permaculture ethics and design principles (Permaculture Association, 2020). Introductory permaculture courses vary widely and can be adapted to a variety of age groups and settings. Because a full PDC is primarily geared towards adults, there has historically been less permaculture curriculum created specifically for children. However, in recent years, more work has been done on this topic (Nuttall & Millington, 2008; Alderslowe et al, 2018; Christopher, 2019).

Outdoor Classrooms: A Handbook for School Gardens, is a book written by experienced Australian primary school teachers and permaculturists Carrolyn Nuttall and Janet Millington (2008), about integrating permaculture into school gardens and outdoor learning spaces. In it, Nuttal and Millington introduced a permaculture-based outdoor education curriculum for ages K-8, as well as a comprehensive plan on how to create a permaculture-based school garden. This curriculum included learning goals for twelve permaculture topics for lower elementary, upper elementary, and middle school students.

These topics include climate, patterns in nature, water, earth resources, landform, living soil, plants, animals, trees, energy, buildings and structures, and permaculture design. This book also contained suggested lessons on each of these topics, as well as tips on teaching permaculture to children. While the book's primary focus was on using a permaculture curriculum in an outdoor garden or outdoor classroom setting, the curriculum could be adapted to other outdoor settings.

Earth Care, People Care and Fair Share in Education: The Children in Permaculture Manual (Alderslowe et al, 2018) is a book for teaching permaculture ethics and principles to children, age three to twelve, in formal and nonformal settings. It was created by the Children in Permaculture Project, which brought together educators and researchers from five European Countries to create permaculture resources. This book introduced a new Children in Permaculture (CiP) pedagogy and curriculum, with lesson plans and strategies for educators. The CiP curriculum is based on Mollison's (1988) original Permaculture Design Course (PDC) curriculum, with current updates by the Permaculture Association of Britain and input from other educators in the field. According to author Devapriya, one of the goals in creating the CiP curriculum was to help children to "feel fully connected with" and "part of nature" rather than seeing themselves as "a destructive add-on" (Children in Permaculture, 2018, 8:35). The CiP approach nurtures sustainability through connection to and respect for the natural world (Alderslowe et al, 2018). Because the CiP curriculum was created in Europe, it does not directly correlate the lessons to United States academic standards. However, it does categorize them according to themes in education which include: mathematics, language,

science (biology, chemistry, physics), social science (geography, history), arts (music), health and well-being, physical education, and home economics (cooking, sewing, etc.).

The School Garden Curriculum: An Integrated k-8 Guide forDiscovering Science, Ecology, and Whole-Systems Thinking is a permaculture-based gardening curriculum for K-8th grade students (Christopher, 2019). The curriculum provides detailed lesson plans, broken down into the four seasons, that incorporate permaculture ethics and design principles into gardening activities. Lesson plans are aligned to Next Generation Science Standards in the United States. The author has an extensive background in both gardening and childhood outdoor education.

This subsection has reviewed some of the literature surrounding permaculture-based curriculum, which included the 72-hour Permaculture Design Course (PDC), an introductory permaculture course, and three examples of permaculture curriculum for children. These sources are important to understand as they can be used as a toolbox to draw from in order to create a permaculture curriculum for public school children in the United States.

In order to provide a comprehensive overview of permaculture education to the reader, this section has reviewed key literature on permaculture definitions, ethics, principles, and existing curriculum. Permaculture is a whole-system sustainable design science. It teaches people how to design systems that provide for human needs, and are beneficial to all life forms, using patterns found in nature. This information is important to help the reader understand how a permaculture-based curriculum can be created and used as a tool to help children connect with nature and one another, while also teaching

them how to plan for a sustainable future. The next section will discuss academic standards and how they relate to public school education.

Academic Standards

The Minnesota Department of Education's publication on *Understanding Minnesota K-12 Academic Standards* provided a basic overview of what academic standards are and how they relate to public schools (2011). Academic standards refer to a state's expectations for student learning in public schools. They are divided into content areas, with benchmarks that must be met within each area. Academic standards and content areas vary by state. States can also develop standards for some content areas and may allow local public schools to develop standards for others. Benchmarks represent a skill that each student must master in order to graduate from each grade level. Local public schools must adopt a curriculum (written plan) for meeting state standards. A curriculum outlines the learning experiences that educators will use to help children meet the state benchmarks for each content area. Instruction refers to the methods that teachers use to provide learning experiences. Choice of curriculum and instruction is generally at the discretion of schools.

Two sets of academic standards adopted by multiple states in the United States are Common Core State Standards (CCSS) (NGA CCSSO, 2010; CCSSI, 2009) and Next Generation Science Standards (NGSS) (NGSS, 2013). Common Core State Standards are composed of two sets of standards that can be adopted together or individually. These are English Language Arts/ Literacy standards and Mathematics standards.

Common Core English Language Arts/Literacy standards were developed to ensure that all students are college and career ready in literacy by the end of high school

(NGA CCSSOI, 2010). These standards not only focus on English and language arts, but also history, social studies, science, and technical subjects. In addition, these content areas are used to meet reading, writing, speaking, listening, and language challenges. Standards are divided into sections, strands, standards, and individual Career College Ready (CCR) anchor standards. English Language Arts/Literacy standards define what students are expected to know and should be able to do, but not how teachers should teach.

Common Core Mathematics standards were developed to improve mathematics achievement in the United States in order to compete with other high-performing countries (CCSSI, 2009). They are divided into standards, clusters, and domains. Mathematics standards define what students should be able to do in their study of mathematics, but do not dictate curriculum or teaching methods.

The Next Generation Science Standards (NGSS) outline what science students should know at each grade level from K-12 (NRC, 2012; NGSS, 2013). These standards were created in a two-part process in response to a states' concern that students were lacking a solid knowledge and background in science. Stage one began with the National Research Council, the staff arm of the National Academy of Sciences, forming a committee to create a document known as the *Framework for K-12 Science Education* (NRC, 2012). The committee found that the primary reason for lack of student proficiency in science was due to three weaknesses in the public school system: 1) science is not organized systematically across grades K-12: 2) a breadth (exposure to many concepts) verses depth (deep exploration into fewer topics) approach; and 3) lack of engaging opportunities to experience how science is actually done. The Committee

addressed these weaknesses by building three key goals into the NGSS framework. These goals were meant to ensure that, by the end of 12th grade, all students:

- have some appreciation of the beauty and wonder of science;
- possess sufficient knowledge of science and engineering to engage in public discussions on related issues;
- are careful consumers of scientific and technological information related to their everyday lives;
- are able to continue to learn about science outside school;
- and have skills to enter the careers of their choice, including (but not limited to) careers in science, engineering, and technology.

After the National Research Council committee completed the final version of the *Framework for K-12 Science Education* (2012), states led a process where state leaders, education professionals, and the science and business community worked together to create a set of standards that were grounded in it (NGSS, 2013). The NGSS are divided into three dimensions: scientific and engineering practices, crosscutting concepts, and disciplinary core ideas. Scientific and engineering practices refer to practices that scientists and engineers use to produce knowledge and develop solutions. Crosscutting concepts are concepts that can be used as an organizational framework to connect knowledge across scientific and other disciplines. The disciplinary core ideas cover basic knowledge in: physical sciences; life sciences; earth and space sciences; and engineering, technology, and applications of science. Performance expectations for each grade level align with the three elements. The last topic that this literature review is STEAM

education. While STEAM is not an academic standard, it is an important approach to learning used by some public schools.

In the book *An Educator's Guide to STEAM: Engaging Students Using Real World Problems*, Quigley and Herro (2019) proposed a conceptual model for STEAM education and outlined implementation strategies for educators using a connected learning theory. STEAM is a transdisciplinary approach to education that combines the disciplines of science, technology, engineering, art, and mathematics and to create learning experiences that relate to the world beyond the classroom. STEAM is an alternative to STEM education, in that it includes the additional subject of arts (and humanities). Proponents of STEAM argue that art helps connect the other subjects and makes them more interesting to more students and also promotes more real-world applications. Unlike content focused learning, in addition to combining multiple disciplines, STEAM education focuses on problem solving and student collaboration. It also prioritizes student interests as topics for project-based learning.

In order to create a permaculture curriculum for public school children in the United States, it is necessary to understand academic standards and common approaches to education used in public schools. This section introduced some of the literature surrounding the topic of academic standards, including a basic overview of what academic standards are and how they relate to content area, benchmarks, curriculum, and instruction. Next, it introduced two common sets of standards that have been adopted by multiple states: Common Core State Standards (CCSS) and Next Generation Science Standards (NGSS). Finally, it presented STEAM as an educational approach to connect multiple subjects and strengthen student learning.

The insights gained from the topics covered in this literature review provide help to answer the question: *How can a permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* Permaculture is a type of nature-based education that can help children reconnect with nature. The prime directive and ethics of permaculture can also help children to connect to one another. Permaculture also teaches sustainable design, which can help children prepare for a sustainable future by learning how to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations Brundtland Commission, 1987, p. 16).

A new permaculture curriculum for public schools needs to be aligned with state academic standards. Public school districts follow the academic standards that their state has adopted. Not all states choose the same types of standards, but several states do follow Common Core State Standards (CCSS) and Next Generation Science Standards (NGSS). As a result, it makes the most sense to align a permaculture curriculum with these standards. The three dimensions of the NGSS Framework are very similar to permaculture concepts and design principles (NRC, 2012). Permaculture education and curriculum could be an effective mode to meet this framework. The ideas of the Crosscutting Concepts Dimension of the NGSS Framework, as well as a STEAM approach, could also connect a permaculture curriculum to other subject areas as included in the CCSS. The next section provides a summary of the key findings within each topic that are important to this research.

Summary

This literature review has provided an introduction to the key topics that are necessary to understand in order to answer the research question: *How can a permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* The key topics covered in this chapter included: nature-based education and curriculum, including outdoor classrooms; sustainability and permaculture; permaculture education and curriculum; and academic standards.

Nature-based education is an approach to environmental education that uses nature as the organizing concept to promote environmental literacy. An environmentally-literate person is one who works individually and/or together with others to make informed decisions about the environment, is willing to act to improve the well-being of all people and the environment, and participates in civic life. Outdoor nature-based education in the context of this research includes two components: an outdoor classroom and a nature-based curriculum. Outdoor classrooms are informal or formal teaching spaces that are outdoors in nature. When teaching in outdoor classrooms, educators can either adapt existing curriculum to the outdoor space(s) or adopt a nature-based curriculum. Existing examples of nature-based curriculum focus on a wide variety of environmental education topics, which are helpful to connect children with nature. However, they do not necessarily teach sustainable design.

Sustainable design is design for sustainability, to meet the needs of the present without compromising the needs of the future. However, a simple definition of

sustainability may not be possible due to the instability of our high-energy, modern society. Instead, it may be beneficial to think of sustainability more in terms of designing to adapt to the change and uncertainty happening in our environment. The Hannover design principles are guidelines to consider when designing. They include considerations such as: the coexistence of humans and nature; the creation of reusable, repairable products instead of those designed for planned obsolescence; the elimination of waste; reliance on natural energy flows; and taking responsibility for what one designs.

Permaculture is a whole-system sustainable design science. It teaches how to design systems that provide for human needs and are beneficial to all life forms, using patterns found in nature. Permaculture is based on a set of ethics and design principles that are rooted in the knowledge of indigenous and traditional sustainable societies. Permaculture ethics include: earth care; people care; and fair share (also known as future care). Permaculture principles are guiding principles for design. They are based on two sets of principles: the Mollison principles and the Holmgren principles.

Permaculture curriculum is based on either a full Permaculture Design Course (PDC) format or some level of an introductory format. Most curriculum in existence was created for adults. There has been less created for children, although this area is expanding. Three examples of permaculture curriculum for children were presented in this paper. The first example was found in the book *Outdoor classrooms: A handbook for school gardens* (Nuttall & Millington, 2008). In this book, Nuttall and Millington introduced a permaculture-based outdoor education curriculum for ages K-8. This curriculum included learning goals for twelve permaculture topics for lower elementary,

upper elementary, and middle school students. The aim of this curriculum was for use in a school garden or outdoor classroom. However, it could be used for any outdoor setting.

The second example of permaculture curriculum was found in the book *Earth Care, People Care and Fair Share in Education: The Children in Permaculture Manual* (Alderslowe et al, 2018). In this book, Alderslowe et al (2018) developed a curriculum based on a new Children in Permaculture (CiP) pedagogy geared toward children ages 3-12. This curriculum was created in Europe and does not provide correlations to United States academic standards. However, it did categorize lessons according to basic subjects in education.

The third example of permaculture curriculum was found in the book *The School Garden Curriculum: An Integrated k-8 Guide for Discovering Science, Ecology, and Whole-Systems Thinking* (Christopher, 2019). In this book, Christopher (2019) incorporates permaculture ethics and principles into a garden-based curriculum for K-8th grade students. This curriculum was aligned with Next Generation Science Standards.

Academic standards are state expectations for student learning in public schools that are divided into content areas with benchmarks that must be met for each area. Schools can choose the type of curriculum they want to use to meet these standards. States can choose to create their own academic standards or adopt standards that are commonly used in other states. Two types of standards that have been adopted by multiple states are Common Core State Standards (CCSS) (NGA CCSSO, 2010; CCSSI, 2009) and Next Generation Science Standards (NGSS) (NGSS, 2013). CCSS includes two sets of standards that can be adopted together or individually: English Language Arts/Literacy Standards and Mathematics Standards. In addition, while not an academic

standard, the education approach of STEAM can be used to connect multiple disciplines to real-world problems that increase student interest and learning,

The findings gained from this research provided valuable information for the creation of this Capstone Project. Permaculture is a type of nature-based education. Like nature-based curriculum, permaculture curriculum, when paired with a formal or informal outdoor classroom, can help children connect to nature. Also, like nature-based curriculum, permaculture curriculum uses nature as the organizing concept to promote environmental literacy. This means helping to educate people to make informed decisions about the environment and act to improve the well-being of both humans and the natural world. Permaculture curriculum also teaches people to participate in civic life in their local communities.

There are two key differences between permaculture curriculum and most nature-based curriculum. First, permaculture curriculum and education is based on a set of ethics that are centered at the core of the discipline: earth care; people care; and future care (also known fair share). Second, permaculture teaches people sustainable design, or as Holmgren described, how to adapt to the changes and uncertainty of the environment. Permaculture also uses a set of design principles that are similar to the Hannover principles for sustainability.

This literature review introduced three examples of permaculture curriculum for children. Nuttall and Millington (2008) provided a curriculum for K-8 based on 12 permaculture topics that serve as a basis for understanding sustainability. Alderslowe et al (2018) provided a new Children in Permaculture (CiP) curriculum for children ages 3-12. Both these curricula were heavily based on the original concepts of permaculture as put

forth by Bill Mollison. However, although these curricula provided correlations to general academic subjects, they were not correlated to United States academic standards for public schools. Christopher (2019) provided a permaculture-based garden curriculum for K-12 students. This curriculum was correlated to Next Generation Science Standards (NGSS). However, the curriculum did not cover permaculture as thoroughly as the other two.

The aim of the permaculture curriculum that was created in this capstone project was to answer the question: *How can a Permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* Given the findings in this literature review, the curriculum that was created is based on an adapted permaculture content, taken from both Nuttall and Millington (2008) and Alderslowe et al (2018). The learning plan was organized using a project-based learning framework. Ideas for lessons and activities were taken from Nuttall and Millington (2008), Aderslowe et al (2018), Christopher (2019), and other sources. Lessons and activities are aligned to Next Generation Science Standards and Common Core State Standards where possible. Chapter Three of this research paper describes this curriculum in greater depth.

CHAPTER THREE: PROJECT DESCRIPTION

Introduction

The aim of this project was to answer the question: *How can a permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* This chapter describes the design and realization of a permaculture curriculum for children in public schools, drawing on the research conducted in Chapter Two. The first section describes how the project was created. This includes a description of the permaculture learning content and frameworks that were chosen, as well as an outline of the components of the project. The second section describes the setting and audience for the project. The third section presents a timeline for implementation. The fourth section outlines how the project will be assessed. And the last section provides a summary of the chapter and introduces Chapter Four.

How the Project was Created

The aim of this project was to create a permaculture curriculum for public schools in the United States. The curriculum that was created is a Project-Based Learning (PBL) unit for grades 3-5. The unit is based on an adaptable PBL model that was also created, known as Permaculture Design Project Curriculum: Grades K-8. This model can be used to teach permaculture to students of all ages. In this model, students participate in a project-based learning experience that simulates the process that permaculture designers use in the real world when designing for a client. Through this process: students acquire foundational knowledge and skills by completing lessons and activities on topics that are necessary to understand permaculture design; make meaning of this learning by applying

it to tasks innate to the design process; and are able to transfer their understanding of permaculture design to to be able to create a sustainable environment in any situation. A complete project for the band of grades 3-5 was created in order to demonstrate how the Permaculture Design Project Curriculum model functions. This unit, known as Permaculture Design Project Grades 3-5, is the artifact produced for this capstone project.

Permaculture Foundations

The definitive curriculum for content knowledge on the subject of permaculture is based on Mollison's (1988) *Permaculture: A Designer's Manual*, with additional content taken from Holmgren's (2002) *Permaculture: Principles and Pathways Beyond Sustainability.* However, this curriculum is intended for adult learners, and not children. There have been two key efforts made to create a source of age-appropriate permaculture content knowledge for children. These include Nuttall and Millington's (2008) *Outdoor Classrooms: A Handbook for School Gardens* and the Alderslowe et al (2018) *Earth Care, People Care, and FairShare in Education: The Children in Permaculture Manual*. For purposes of this Capstone Project, these sources have been combined to create an adapted body of content knowledge referred to as Permaculture Foundations. Additional content was also added from *Introduction to Permaculture* (Mollison, 1997).

Permaculture Foundations represent the basic skills and knowledge, as stated by Nuttal & Millington (2008), for topics that are required to understand permaculture design and sustainability. Additional skills and knowledge from Alderslowe et al (2018) were added to the Permaculture Foundations, as well as an additional topic of *Social Permaculture.* The Permaculture Foundations topics include:

- Climate

- Patterns in Nature
- Water
- Earth Resources
- Topography
- Soils
- Plants
- Animals
- Trees
- Energy
- Buildings and Structures
- Social Permaculture
- Permaculture Design

These topics are only used as a guide and do not claim to represent the full body of permaculture knowledge content. They can be adapted as needed according to the particular project and student level. The desired skills and knowledge for each topic, broken down into the grade bands of K-2, 3-5, and 6-8, are listed in Appendix A Permaculture Foundations. After this list of Permaculture Foundations was chosen, a project-based learning framework was used to create a learning plan for the curriculum..

Project-Based Learning (PBL)

The creation of the Permaculture Design Project Curriculum model started with an end goal in mind, to teach students how to create a permaculture design for a site. In a typical permaculture design course, instructors use a traditional linear teaching unit that ends with a project. In this way, knowledge content is taught first, and later students

apply that knowledge to create a permaculture design for a fictitious site. A better approach that promotes a deeper learning experience is to use an authentic project as the structure for the learning experience (Wagner, 2022). This type of structure is known as Project-Based Learning (PBL).

This Permaculture Design Project Curriculum was organized using a project-based learning (PBL) framework. Guidance for using a PBL framework was found in the following key resources in the field: *PBL in the Elementary Grades: Step-by-Step Guidance, Tools, and Tips for Standards-Focused K-5 Projects* (Hallerman & Larmer, 2011; *Project-Based Teaching: How to Create Rigorous and Engaging Learning Experiences* (Boss & Larmer, 2018); *Keep it Real with PBL: A Practical Guide for Planning Project-Based Learning - Elementary* (Pieratt, 2020); and *Design a project based experience in less than 10 minutes* (Wagner, 2022).

Project-based learning is a student-centered, inquiry-based teaching method in which students learn by actively engaging in real-world and personally meaningful projects (PBLWorks, 2023). “Through academically-rigorous projects, students acquire deep content knowledge while also mastering 21st century skills: knowing how to think critically; analyze information for reliability; collaborate with diverse colleagues; and solve problems creatively” (Boss & Larmer, 2018, p. 1). Project-based learning helps to prepare and empower students to be able to meet the real-world challenges they face.

While project-based learning might be seen by some as a trend in education, it has actually been around since the early 20th century, associated with the Progressive movement and the works of John Dewey, Vygotsky, and Piaget (Pieratt, 2020). In *Experience in Education*, Dewey (1938) laid the foundation for project-based learning by

describing how education that is connected to the experiences of the student and relevant to the world can become more meaningful to children.

Teaching and learning strategies in project-based learning are different than in traditional settings. The characteristics of what high-quality project-based teaching and learning should look like are laid out in the Buck Institute for Education's Gold Standard PBL models (Boss & Larmer, 2018). These standards are based on a Framework created in 2018 by an international steering committee of 28 educators and leaders in the field of project-based learning. See Table 2.

Table 2

The Elements of High Quality Project-Based Learning

Teaching	Project Design
● Design and Plan. ● Align to Standards. ● Build the Culture. ● Manage Activities. ● Scaffold Student Learning. ● Assess Student Learning. ● Engage and Coach.	● A Challenging Problem or Question. ● Sustained Inquiry. ● Authenticity. ● Student Voice and Choice. ● Reflection. ● Critique and Revision. ● A Public Product.

Note: Adapted from "Project-Based Teaching: How to Create Rigorous and Engaging Learning Experiences", by S. Boss and J. Larmer, Buck Institute of Education, 2018, pp. 3-5.

Using Backwards Design with Project-Based Learning

The model for this Permaculture Design Project Curriculum was created by using a backwards design approach to curriculum development, as set out in the *Understanding by Design Guide to Creating High Quality Units* (Wiggins & McTighe, 2011). The PBL design process was integrated into a project-based learning framework, using guidance from Hallermann and Larmer (2011) in *PBL in the Elementary Grades; Step-by-Step Guidance, Tools, and Tips for Standards-Focused K-5 Projects* However, as Wiggins & McTighe (2011) warned, while these frameworks provided sources for guidance, the process of designing this curriculum was "nonlinear" and "inherently messy" (p. 2).

Big Idea. The Big Idea refers to the basic subject of the project. For this curriculum, the big idea was permaculture design. The focus within the big idea was to create a learning experience that was authentic and would provide deep learning for students. Since the core of permaculture is design, the most appropriate authentic learning experience was to mimic what permaculture designers do, create permaculture designs for a client.

Driving Question. The Driving Question refers to an open-ended question "that students explore or that captures the tasks they are completing" (Hallerman & Larmer, 2011, p. 21). A suggested format of this question is "How can we, as _____ (role), _____ (do a task/create a product) for/to/that _____ (purpose and audience)?" (p. 39). For this curriculum, the appropriate driving question was: How can we, as permaculture designers, create a permaculture design that meets the client's needs? Using the Permaculture Design Project Curriculum model, the choice of a project should be based

on this driving question and also be tied to a task that is local and meaningful to the students. In the Permaculture Design Project Grades 3-5, the project that was chosen is the design of an outdoor classroom at the students' school. As a result, the driving question is: *How can we use permaculture to design an outdoor classroom for our school?*

Final Product/Presentation. The final product/presentations should be the product that students present in order to answer the driving question. For the Permaculture Design Project Curriculum, the final product/presentation is the presentation of the final permaculture design to the client. In the Permaculture Design Project Grades 3-5, students present their final permaculture designs to a school committee, made up of students and school staff.

Project Phases/Benchmarks. In order to create a structure for a project-based learning unit, the project is divided into phases. These phases can be viewed as project milestones and also serve as benchmarks to assess learning. According to Hallermann and Larmer (2011), there are four typical phases in a project-based learning unit:

1. Project Launch - Entry Event and Driving Question;
2. Building Knowledge and Skills to Answer the Driving Question;
3. Developing and Revising Products that Answer the Driving Question; and
4. Presenting Products that Answer the Driving Question (p. 46).

The Wiggins and McTighe (2011) backwards design process can be used to connect these phases to the permaculture design process. Using this process, project benchmarks become the major stages that a permaculture designer goes through in the design process in order to complete a final design and present it to the client. These stages are similar to

the design process in engineering. For the purpose of this curriculum they have been simplified and combined to include:

1. Introduction to the Project;
2. Observing, Researching, Learning;
3. Making Connections;
4. Drafting the Design; and
5. Final Design Presentation.

Activities/Lessons. From this stage, it is necessary to use the Wiggins and McTighe (2011) backwards design process to create the learning experiences needed to help students come to an understanding of important ideas (Permaculture Foundations) that are necessary to complete each project benchmark, which includes the required assessment for that benchmark. (See Formative/Summative Assessments in the next section). Once a list of the required knowledge and skills was made, activities were created based on this knowledge and skillset using ideas from Nuttall and Millington (2008), Aderslowe et al (2018), and Christopher (2019).

Formative/Summative Assessments. A series of formative and summative assessments are used to evaluate student learning goals for each activity, benchmark, and final product/presentation. Mini-formative assessments are used within each lesson. Formative assessments in the form of a product to be completed are used for each benchmark. A Benchmark Rubric was created to be used as a guide for these assessments. A summative assessment is used for the final presentation of the design to the client. This summative assessment also evaluates the understanding achieved for the

entire project. A Final Product/Presentation Rubric was created as a guide for this assessment.

Learning Goals/Academic Standards

Learning Goals/Academic Standards refers to the content knowledge that is included in this project. This is based on permaculture content (Permaculture Foundations) and content in other academic subjects, which are assessed through academic standards. The academic standards that are included in this project include Next Generation Science Standards (NGSS) and Common Core State Standards (CCSS), as well as 21st Century Skills.

Project Forms

The Permaculture Design Project Curriculum Grades 3-5 includes six main forms that educators can use to facilitate the project, as well as a few miscellaneous forms relevant to the project. The main forms include:

- The Curriculum Model,
- The Permaculture Foundations,
- The Rubric for Benchmarks Products
- The Teaching and Learning Lesson Plan, and
- Lessons for Grades 3-5.

This section has described how the capstone project Permaculture Design Project Curriculum: Grades K-8 was created. It described the choice of permaculture curriculum used, which is referred to as Permaculture Foundations within the project. It introduced the project-planning frameworks used, which included backwards design and project-based learning. It described the steps that were used within these frameworks to

create the project, which included Big Idea, Driving Question, Final Product/Presentation, Project Phases/Benchmarks, Activities/Lessons, and Formative/Summative Assessments. This section also described the learning goals of the project, which included those within the Permaculture Foundations and the academic standards included in the Next Generation Science Standards, the Common Core State Standards, and 21st Century Skills. The next section describes the setting and audience intended for the curriculum.

Setting/Audience

In order to discuss the intended setting/audience for this capstone project, it is necessary to distinguish between the two segments that were created. These include the Permaculture Design Project Model and the Permaculture Design Project example for Grades 3-5.

Permaculture Design Project Curriculum Model

The intended setting for the Permaculture Design Project Curriculum is the K-8 public school system in the United States. However, this curriculum could also be used in private schools, for homeschooling, or by environmental education organizations. This curriculum was created to be used primarily in an outdoor setting, but some learning can take place indoors. The majority of the lessons fall under the content areas of science and engineering. However, because the curriculum model was designed to be transdisciplinary, other content areas can apply.

Grades 9-12 were left out of the curriculum model because students at that level have the learning capacity to handle an adult-level permaculture course. This model

could be adapted for use in grades 9-12, or for adult learning, by expanding the learning goals and aligning to academic standards for those grades.

Permaculture Design Project Grades 3-5

The artifact that was created for this capstone project is the *Permaculture Design Curriculum Project Grades 3-5*. This is a full curriculum learning unit/project created specifically for the grade band 3-5. Permaculture learning content and academic standards are aligned specifically to these grade levels. Similar to the Permaculture Design Project Curriculum Model: Grades K-8, this unit/project could also be used in private schools, for homeschooling, or by environmental education organizations. This unit/project was created to be used primarily in an outdoor setting, but some learning can take place indoors. The majority of the lessons fall under the content areas of science and engineering. However, because the unit/project was designed to be transdisciplinary, other content areas apply.

This section has described the intended audience and setting for this capstone project, known as the Permaculture Design Project Curriculum. It explained the differences between the two segments of the project, which are the Permaculture Design Project Curriculum Model: Grades K-8 and the Permaculture Design Project Curriculum example for grades 3-5. The next section discusses the timeline for this capstone project.

Timeline

This capstone research paper and resulting capstone project took approximately seven months to complete. Research took place from September through November 2022. The project design started in January 2023 and was completed, along with this paper, in April 2023.

There are no definitive plans to implement this curriculum until more content and resources are added to the lessons. In the future, it will be offered through a new permaculture organization that will be set up starting in the summer of 2023. Once the website for the organization is up and running, and the curriculum is expanded, it will be made available. The goal for this is the end of 2023. At that point, the organization will seek out a partnership with a school that is interested in testing out the Permaculture Design Curriculum unit for Grades 3-5. The earliest this could happen would be in the Spring of 2024. However, these dates are only tentative at this time.

This section of this chapter has addressed the timeline for this capstone project. It discussed how long it took to complete this capstone research paper and project. It also presented a potential timeline for implementation. The next section discusses how the project will be assessed.

Assessment

Assessment in this section refers to the assessment of the capstone curriculum development project known as the Permaculture Design Project Curriculum: Grades K-8. Initially, assessment will be based on the unit/project known as Permaculture Design Project Grades 3-5. Units for other grade bands will be assessed after they are created using the same process outlined in this section.

In *Important Things to Know About Evaluating Curriculum Development Projects*, Kapp (2019) presented twelve suggestions to consider when designing an assessment plan for a curriculum development project. Assessment for this project will include two of the suggestions from Kapp: 1) implementing a pilot program that can be

used to gather assessment data from, and 2) using the Kirkpatrick Four Levels of Evaluation Model as a framework for the assessment of the project.

The Permaculture Design Project unit for Grades 3-5 will be tested using a pilot project, undertaken by an interested school. An assessment plan for this pilot program will use the Kirkpatrick Four Levels of Evaluation Model for training programs as a guide (Kirkpatrick et al, 2006). See Table 3. This model has been used worldwide as a standard for evaluating training and learning programs (Connections Education, 2018).

Table 3

Kirkpatrick Four Levels of Evaluation for Training

Level	Measurement	Method
1. Reaction	Whether the learners find the training engaging, favorable, and relevant	After-training survey (smile sheet) to rate their experience
2. Learning	Whether the learners acquired the intended knowledge, skills, attitude, confidence, and commitment from the training	Informal and formal methods through pre-learning and post-learning assessments via exams or interview-style evaluations
3. Behavior	Whether participants were impacted by the learning and have adopted what they learned	Strategies that will assess behavioral changes

4. Results	Whether the training has produced direct results, measures the learning against the outcomes	Strategies that will show if the training produced the key performance indicators established before it

Note: Adapted from "Evaluating Training Programs: The Four Levels", by M.C. Anderson Kirkpatrick, J.D. Kirkpatrick, and D. Stoel, 2006, Berrett-Koehler Publishers.

School staff will collect formal and informal data to evaluate the effectiveness of the project. Effectiveness is defined by the learner's participation and performance and the educators' experiences using the curriculum. Data will be gathered from four specific levels: 1) Reaction, 2) Learning, 3) Behavior, and 4) Results. Materials used to gather data will be directed not only at students concerning their own input, but also toward instructors and learning coaches to gain insight from their observations of students. This should include baseline information about student knowledge of the curriculum subjects before implementation and be based on a clear identification of the outcomes expected from the curriculum as a unit, and from individual activities.

Methods that will be used to collect data include: after activity surveys to rate a student's experience (smile sheet), exams and interviews for pre and post-learning assessments, student and parent surveys reporting behavior changes, and formal and informal assessments on learning gained from each activity (Kapp, 2019). After data is collected, it can be analyzed and evaluated to determine what adjustments need to be made to the curriculum (Ardent Learning, 2020).

This section has presented a plan for assessing this capstone project, which includes both the Permaculture Design Project Curriculum: K-8 as a whole, and the Permaculture Design Project unit for Grades 3-5. It presented an assessment plan that is based on two ideas: a pilot program and the Kirkpatrick Four Levels of Evaluation Model. The next section provides a summary of this chapter.

Summary

Chapter Three has provided a description of the design and realization of a capstone project known as the Permaculture Design Project Curriculum: Grades K-8, which includes a completed unit/project known as the Permaculture Design Project: Grades 3-5. This curriculum was created to answer the question: *How can a Permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?*

First, this chapter introduced the project by providing a detailed description of the components and steps used to create it. This project model is based on a permaculture learning content that was adapted from multiple sources of permaculture curriculum and labeled Permaculture Foundations. The two frameworks used to organize the curriculum were backwards design and project-based learning. The backwards design process, as put forth in Wiggins and McTighe (2011) was used to create a project-based learning unit. This process followed the following sequence: 1) Big Idea; 2) Driving Question; 3) Final Product/Presentation; 4) Project Phases/Benchmarks; 5) Lessons; 6) Formative/Summative Assessments; 7) Learning Goals/Academic Standards; and 8)

Project Forms. After the project model was created, a project topic was chosen to complete an example unit/project for grades 3-5.

The next section of this chapter discussed the setting and audience for both the Permaculture Design Project Curriculum: K-8 model and the Permaculture Design Project: Grades 3-5 unit. Both the model and the unit for Grades 3-5 can be used in public and private schools, for homeschooling, or by environmental education organizations. The intended age group for the model is grades K-8. But, it can be adapted to suit grades 9-12 and adults. The intended age group for the example unit is the grade band of 3-5.

The next section described the time it took to complete this research and project, as well as a projected timeline for implementation of the project. The research for this project was started in September 2022 and the project was completed in April 2023. The exact timeline for the implementation of this project is to be determined, as it is dependent on the completion of startup activities for a new organization. An estimated date for a pilot project is the beginning of spring 2024.

The last section of this chapter discussed how the project model and example will be assessed. Assessment will be completed through a pilot program at a school that is interested in testing the Permaculture Design Project: Grades 3-5, using the Kirkpatrick Four Levels of Evaluation Model for training programs as a guide (Kirkpatrick et al, 2006). Chapter Four will discuss what was learned from the capstone and literature review process, some of the limitations of the project, and how it will be used in the future.

CHAPTER FOUR: CONCLUSION

Introduction

This capstone research and resulting project asked the question: *How can a permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* Chapter One provided the rationale and context for this research and project. Chapter Two reviewed the literature necessary to answer this question. Chapter Three described the details of the project that was created. This chapter provides a reflection on the capstone process, with respect to the research and project. The sections included in this chapter include: the major learnings from the process; a revisit and analysis of the literature review; the implication of and conclusions reached about the project; some of the limitations of the project; possible future projects; how the results of the project will be communicated; and how the project is a benefit to the profession. This process of reflection is necessary to promote a deeper understanding of the research that was done and the project that was created in order to answer the research question.

Major Learnings

I have learned so much throughout this capstone process, as a research, writer, and learner. When I think back to the beginning of the research process, it makes me realize that just about every moment was part of a steep learning curve for me. Although I could write for hours about what I learned, three major learnings stand out: one expected realization about the capstone process, three examples of making meaning during the capstone process, and two realizations about myself.

One expected realization I had was about the capstone process itself. I decided to organize the curriculum for my project using a project-based learning structure (PBL). While doing research on PBL, I realized that the whole capstone project process is based on PBL. The first stage of the capstone process started with a driving question (the research question). The second stage was for building knowledge and skills to answer the research question (research and literature review). The third stage was for developing and revising products that answer the driving question (the project). Finally, the last stage ended with a presentation of products that answer the driving question (Google Slideshow). I also recognized that the approach of the instructor was facilitative, another characteristic of project-based learning. This learning was definitely unexpected.

Three examples of making meaning during the capstone process also helped me to understand the meaning of *making meaning.* In the *Understanding by Design Guide to Creating High-Quality Units*, Wiggins and McTighe (2011) describe making meaning as understanding, or an "idea that results from reflecting on and analyzing one's learning" (p. 14). This can come in the form of a "realization that makes sense out of prior experience or learning that was either fragmented or puzzling" (p. 14). For me, the first incident of making meaning was coming to a much more solid understanding of permaculture design. This wasn't really a surprise because I know that teaching a subject can lead to learning about that subject. I guess it was more of a proof of this, demonstrating that we are all learners.

Another example of making meaning for me was finally coming to an understanding of how to paraphrase. I struggled with this while writing my literature review, using more direct quotations that I needed to. It always seemed difficult to rewrite

the perfect words that another author has chosen. It wasn't until I was developing my project that the idea of synthesizing and summarizing (paraphrasing) really clicked.

The last example of making meaning came from learning the distinction between *curriculum* and *a learning unit*. My project was somewhat complicated because I ended up creating both. Because the subject of permaculture doesn't have academic standards tied to specific learning goals, there was no definitive curriculum on childrens' permaculture. As a result, I had to combine a few sources to create a list of permaculture learning goals, referred to as Permaculture Foundations in my project. After that, I used a project-based learning structure to create a model for teaching a unit/project. Then, I created an example unit/project for grades 3-5. I spent a fair amount of time throughout the process confused about what parts were actually *the curriculum.* Recently, this became clear. This also explains why this project has been so much work. I realize now that I was not only creating a curriculum unit, I was creating a curriculum.

Two realizations about myself during the capstone process were a little surprising, but confirmed what I already knew. The first realization has to do with the scope of my project. Initially, my goal was to create a full permaculture curriculum for grades K-12. As I dove into the project, I soon realized that my scope was much too broad. As a result, I reduced the scope to grades K-8. I did in fact create a curriculum model that can be used for this entire grade range. However, creating a unit with lessons for this range became impossible. Eventually, I reduced the range to grades 3-5. And, even that scope was challenging. This realization just confirmed what I already knew about myself. I tend to take on more than I can handle, or as I like to call it inside my head, "Aim High".

The second confirming realization about myself was about the nature of my creative process. A requirement of the capstone research course was to write our project description (Chapter Three) before we actually created the project. I struggled with this a lot. In the end, I finished that chapter when required. But, I was not confident with what I had written. Sure enough, after I actually started creating my project, I realized that I would need to make major revisions to that chapter. After going through the process of applying my permaculture content to a project-based learning structure, using backwards design, I realized that Wiggins & McTighe (2011) were correct when they described the process of designing curriculum as "nonlinear" and "inherently messy" (p. 2). Many times, I have tried to be more of a linear planner, but deep down I know that the process of creation can't be planned.

This section has described what I learned through the capstone process as a researcher, writer and learner. Although the entire capstone process was a learning experience, I described three key themes that stood out. The first one was about project-based learning and that the capstone process was project-based learning. The second theme was about making meaning. Although originally unclear of what it meant to make meaning, through the capstone process I realized that I had in fact *made meaning* of concepts that I had previously been unclear on. The last theme was about the self-realizations that I tend to take on more than I can handle and linear planning does not work for me when it comes to the creative process. The next section will revisit the literature review.

Revisit Literature Review

There are many parts of the literature review that have been important for this capstone project. However, three key areas stand out as the most useful. These include literature related to: 1) the connection of permaculture to the field of environmental education; 2) sources of permaculture curriculum to use for children; and 3) learning how to navigate academic standards.

The Connection of Permaculture to the Field of Environmental Education

While permaculture is a type of environmental education, it is a subject that has not received much attention in the academic world, especially in the United States. While I knew there was a way to connect permaculture to the field of environmental education, I wasn't sure how. The most helpful sources for doing this were those that defined environmental education and sustainability.

Environmental Education. The United States Environmental Protection Agency (2022) defined environmental education as "a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment" (p. 1). The North American Association for Environmental Education (NAEE) (2022) further stated that environmental education provides the skills necessary for people to make informed decisions about the environment that lead to lifelong stewardship and a more sustainable society. The 1976 Belgrade Charter and the 1978 Tbilisi Declaration, the two main documents that represent the guiding principles of environmental education, the goal of environmental education is to provide experiences and learning that will foster environmental literacy (NAAEE, 2021). In *Developing a Framework for Assessing Environmental Literacy*, NAEE (2011) defines an

environmentally literate person, as "someone who both individually, and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life" (pp. 2-3).

Sustainability. There were two key sources of literature that defined sustainability. The United Nations Brundtland Commission's (1987) *Report of the World Commission on Environmental Development* contains the most widely-accepted definition of sustainability. It defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (p. 16). The Hannover Principles, created by architects for the 2000 World's Fair Expo in Germany, further expanded the definition of sustainability to include nine recommended principles created as a platform for architects and designers to consider when designing for sustainability (McDonough, 1992).

How Permaculture fits into These Definitions. Permaculture is an interdisciplinary sustainable design science that operates on three ethics: Care of the Earth; Care of the People; and a Return of the Surplus to the first two (Future Care) (Mollison, 1988). Permaculture teaches people how to design sustainable systems. By synthesizing the above sources for defining environmental education and sustainability, the definition of Environmental Education becomes: a process that provides learning experiences that give people the knowledge and skills that are necessary to explore environmental issues; make decisions about environmental problems; and take action to solve environmental problems, in order to promote lifelong stewardship and a more

sustainable local and global society and planet. It is now easy to see how permaculture fits into this field.

Sources of Permaculture Curriculum to Use for Children

The finding of literature on permaculture curriculum to use for children was key to this capstone project. Three main sources of permaculture curriculum stood out. These include Nuttall and Millington's (2008) *Outdoor Classrooms: A Handbook for School Gardens*, the Alderslowe et al (2018) *Earth Care, People Care, and FairShare in Education: The Children in Permaculture Manual*, and Christopher's (2019) *School Garden Curriculum: An Integrated K-8 for Discovering Science, Ecology, and Whole-Systems Thinking.* The permaculture content used in this project, known as Permaculture Foundations, is based on both Nuttall and Millington (2008) and Alderslowe et al (2018). Ideas for lessons are also taken from these two sources, as well as Christopher (2019).

Learning How to Navigate Academic Standards

Another key area of the literature review that was important for this capstone project was sources related to learning how to navigate academic standards. At the start of the capstone process, I had minimal knowledge of academic standards. Minnesota Department of Education's (2021) *Understanding Minnesota K-12 Academic Standards*, provided an adequate overview of how academic standards are structured. This understanding led to research into what standards might apply to this project. This led to the finding that states can choose their own standards, but numerous states used common standards. Because permaculture is a design science, the (NGSS, 2013) *Next Generation Science Standards: For States, by States* best applied to this project. The NGSS is a

source of academic standards for science and engineering. These standards were based on the National Research Council's (2012) *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* This framework contained helpful background information on the goal of NGSS. Finally, the NGA and CCSO's (2010) *Common Core State Standards for English, Language Arts, and Literacy in History/Social Studies, Science, and Technical Subjects* became a source for academic standards relating to speaking and listening standards related to project-based learning.

This section of Chapter Four has revisited the literature review that was completed in Chapter Three. It has described the parts of the literature review that proved to be most useful for this capstone project. This was divided into three key areas: 1) the connection of permaculture to the field of environmental education; 2) sources of permaculture curriculum to use for children; and 3) learning how to navigate academic standards. Sources that provided definitions for environmental education and sustainability helped to make a clear connection to the field of environmental education. Sources of permaculture curriculum to use when teaching children provided permaculture content and ideas for lessons for the project. Finally, sources related to academic standards provided an understanding of the subject as well a direction toward which standards would best align to the project.

In addition to the sources mentioned above that were included in the literature review, there were also key sources referenced in Chapter Three, the project development, that were important for the capstone project. These included sources on project-based learning (Hallermann & Larmer, 2011; Boss & Larmer, 2018; Pieratt, 2020; Wagner, 2022) and backwards design (Wiggins & McTighe, 2011). These sources

provided essential information for creating this capstone curriculum project. The next section in this chapter discusses the possible implications of this project.

Implications

If a pilot project using the Permaculture Design Project unit for grades 3-5 is successful in one public school setting, there are many possible positive implications. This success could increase interest in the subject of permaculture and lead to other schools becoming interested in the unit for grades 3-5. As use increases, a demand could be created for units for other grades. As the number of educators using the curriculum increases, a demand for teacher training might arise. This could lead to an expansion in environmental education programs, academic policies, and course offerings at universities.

Success of this curriculum in public schools could also lead to an increase in the number of schools creating outdoor classrooms. This would get children outside more and increase their connection to nature. Together, this connection with nature and training in the sustainable design science of permaculture could become an important step and tipping point towards helping children to create a sustainable future for themselves and this planet.

This section has discussed two possible positive implications of this project, the expansion of permaculture into the academic setting and the increased use of outdoor classrooms in public schools. Both of these scenarios could lead to a better future for this planet. However, while the implications discussed here present a sense of optimism about this project, there are some limitations. These will be discussed in the next section.

Limitations

While this project is intended to produce positive outcomes for children and their future, it is necessary to consider the possible limitations of the project. These have been broken into four categories: creator's lack of experience, current school structure, absence of data on children's permaculture curriculum, and possible backlash from the status quo.

Creator's Lack of Experience

As the creator of this curriculum, although I have an extensive background in the field of environmental education, I lack experience in creating curriculum and teaching children in a school setting. My previous background is in adult permaculture and environmental education. In these roles, I did not teach. Most of my experience was centered around writing for educational and promotional purposes, coordinating courses, networking, and administration. While this experience certainly provided an important skillset for contributing to the field of environmental education, it did not necessarily provide me with the skills for teaching children or writing curriculum. However, in spite of this lack of experience, I have worked really hard during this Masters Program to learn how to navigate this area. And, I plan to continue sharpening my skills beyond this capstone project.

Lack of Data on Children's Permaculture Curriculum

Another possible limitation of this project is the lack of research done on and data collected from implementing permaculture curriculum for children. Since permaculture is not as well known in the United States, and has not been taught to children in many schools, there is not a lot of data on the assessment of examples of children's permaculture curriculum. This could be a barrier for some schools that want sound

evidence that this curriculum is appropriate for their students. However, permaculture is better known in other countries and has been used to teach children. As a result, there may be data available in those countries. This could be the subject of another research project.

Current School Teaching Plans

Every school already has a structure in place for how they teach. Some schools may not use project-based teaching. Implementing a significant project such as the Permaculture Design Project Curriculum would require some restructuring of teaching plans. Teachers are already very busy and they may not have the time to take on all of the planning a project like this would require. As a non-teacher, I have little knowledge of this reality and am not sure how to remove this barrier.

Backlash From Status Quo

A final category of limitation of this project is the possible backlash that a permaculture education project might cause from parents, communities, education departments, and corporations. Permaculture is not well known in the United States. This may ignite a fear of the unknown in many people. While many public schools are now teaching about climate change and talking about sustainability, this is a relatively new protocol. And, it did not come without resistance. With the reality of climate change and the destruction of the planet caused by the unsustainable actions of humans, we desperately need to rethink our priorities. But, in a country where capitalism and profits are the bottom line for many, permaculture may be seen as a threat to some.

This section has presented some of the possible limitations of the Permaculture Design Project Curriculum. As a non-teacher, I did not have experience creating

curriculum or teaching children prior to this project. However, because of the diligent research I completed throughout this capstone process, together with my previous skills in environmental education, I learned what I needed to know. In addition, because of the lack of data available for implementing children's permaculture curriculum in the United States, some schools might hesitate to adopt a permaculture curriculum. This could be remedied through additional research on efforts using permaculture curriculum for children in other countries. Another reason that schools might hesitate to adopt this curriculum is due to the lack of experience with and use of project-based curriculum. For these schools, it may take a lot of work to implement a new teaching structure. Finally, the biggest possible, and hardest to control, limitation to this curriculum lies in the potential backlash of teaching the subject of permaculture in public schools. Due to the unknown nature of permaculture and our capitalistic society, it may not be received well by parents, communities, education departments, and corporations.The next section of this chapter talks about the potential future expansion of this project and new opportunities for research in the area of permaculture education for children.

Future Research/Projects

At present, the form of this project consists of an adaptable Permaculture Design Project model and an example unit/project for grades 3-5. There are many possible ways that this project could be expanded. Three ideas stand out. The first one is the expansion of the unit/project examples. A unit/project was created for only one grade band, grades 3-5. However, the model is set up to be adaptable to the other grade bands of K-2 and 6-8. This would require creating lessons that would use Permaculture Foundation knowledge appropriate for those grades, as well as alignment to academic standards for

those grades. The curriculum could also be expanded to use for adults and high school students. In order to use this for high school students in grades 9-12, adult-level permaculture content could be added, as well as an alignment to academic standards for those grades.

Another opportunity for expansion of this curriculum is the creation of a teacher training program. This could be a program that trains teachers in the subject of permaculture and how to use the curriculum. This type of training could be offered through an organization or university.

Finally, there is one key research opportunity that stems from this curriculum. This is the research and data collection from educators implementing forms of permaculture curriculum throughout the United States and in other countries. During this capstone research, I came across a few examples. A few projects taking place in other countries were mentioned in Alderslowe et al (2018) and Nuttall and Millington (2008). One example of a garden-based permaculture for children in the United States can be found in Christopher (2019). I have also come across other examples in the United States, but do not have sources.

This section has discussed several possible opportunities to expand this project in the future. Two of them involve direct expansion of the existing Permaculture Design Project Curriculum to meet a potential growing interest in the curriculum. The third expansion opportunity is for research to collect data from educators teaching some form of permaculture curriculum to children in the United States and internationally. This data could be beneficial for revising the curriculum to better meet childrens' needs. The next section discusses how I will communicate and use this project.

Communicating Results

Before I share the curriculum, I would like to add more content and resources to the lessons. Once that is complete, I plan to communicate the results of my capstone through a new permaculture education organization that I am forming. I plan to work on setting up a website for the organization during the summer of 2023. Once the website is up and running, I will upload the new curriculum in a format to be determined. First, I will make the curriculum available in a limited capacity in order to generate interest and find a school that is interested in doing a pilot project. Once the pilot project is complete, I use the data to make the appropriate changes needed to the curriculum. After that, I may expand the curriculum and turn it into an ebook. I could then sell the book, which would also include links to further resources on my website. I would promote the ebook on various permaculture and educational websites.

In this I have discussed my projected plans to promote the Permaculture Design Project Curriculum through the creation of an ebook that will be promoted on a new organization's website. This promotion plan could be key to launching a new permaculture education organization. It could also be a benefit to the permaculture education profession. This is discussed in the next section.

Benefit to the Profession

This project could provide a lot of benefits to me as a permaculture educator. In the past, while I had experience in environmental and permaculture education, I lacked formal training in curriculum development and teaching. As a result of this masters program, I feel a lot more confident about my abilities and qualification to move further

into the field of permaculture education. While the personal benefits of this project are obvious, there are also benefits of this project for the profession.

This project could bring more attention to the subject of permaculture. This could be a key step for integrating into mainstream education and society. This could help to create more opportunities for permaculturists, working as educators, consultants, and in other roles. This could increase the demand for educational courses, for both children and adults; teacher training; and project implementation. This demand could lead to more partnerships with schools and universities. It could also create opportunities for the creation of educational materials, such as books, videos, apps, or interactive websites.

This section has discussed possible benefits of the Permaculture Design Project Curriculum to the profession of permaculture education.These benefits could come as a result of the increased exposure to the subject of permaculture. This could lead to increased opportunities for permaculturists in all roles. The next section provides a summary of this chapter.

Summary

This final chapter of this capstone research paper has provided a personal reflection on the capstone research and project creation process that was used to answer the question: *How can a permaculture curriculum be developed for public school children in the United States that will teach them how to connect with nature and one another while also teaching them how to plan for a sustainable future?* It has discussed: the major learnings gained as a researcher, writer, and learner from the capstone process; the key areas that stand out as the most useful in the literature review; the possible implications of this project; some of the potential limitations of the project; possible

future research and expansion of the project; how the results of the project will be communicated; and how the project is a benefit to the profession.

Some of the major learnings from this capstone process were expected and personal, and came in the form of conformations of what I already knew about myself. Others came by surprise and became new learnings about the capstone process itself, project-based learning, and what it means to "make meaning". A revisit to the literature review helped to decipher what sources ended up being most important to this project. A discussion of some potential implications of this project painted a positive picture for the future of permaculture education for children. However, despite this positive picture, there are some potential limitations of this project that could lead to a bleak outlook.

Future expansion of this project is probable if there is an interest from schools. There is also an opportunity for additional research in the field of permaculture education for children. In an effort to create interest in this project, it will be uploaded to and promoted on a website for a new permaculture education organization, with possible expansion to an ebook. While this project is likely to become a significant benefit to me personally, there could also be a significant benefit to the profession of permaculture education. With the increased exposure of permaculture could come an increased demand for services for those working in all levels of permaculture.

In conclusion of this capstone paper, I would like to leave some final thoughts for the reader. When considering all of the potential limitations of this curriculum, the reality of it becoming successful may look bleak. While it is difficult to speculate the potential ramification of this capstone project, any positive feedback received should be seen as a success. There is an enormous potential for this project to make a real change in the lives

of children, their future, and the future of this planet. With a little patience, some trial-and-error, and revision, I am confident that this curriculum will succeed and can be used as a method to successfully teach permaculture to children.

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APPENDIX A: Permaculture Foundations

Permaculture Design Project: Permaculture Foundations

Permaculture Foundations refer to the basic skills and knowledge for topics that are required to understand permaculture design and sustainability. The Permaculture Foundations are divided into 13 topics, with age-appropriate skills and knowledge requirements listed for each topic. Age is divided into three grade bands: K-2, 3-5, and 6-8. Content for lower grades can also be taught in older grades. These topics should only be seen as a general guide to be modified as needed. This content was adapted from *Outdoor Classrooms: A Handbook for School Gardens* (Nuttall and Millington, 2018). Additional skills and knowledge have also been added from *Earth Care, People Care, and Fair Share in Education: The Children in Permaculture Manual* (Alderslowe et al, 2018).

Permaculture Foundations Topics:

1. Climate
2. Patterns in Nature
3. Water
4. Earth Resources
5. Topography
6. Soils
7. Plants
8. Animals
9. Trees
10. Energy
11. Buildings and Structures
12. Social Permaculture
13. Permaculture Design

Permaculture Foundations: Climate

Grade(s)	Skills	Knowledge
K-2	1. Observing the weather. 2. Recording simple weather details. 3. Reading a compass to locate North, South, East, and West. 4. Reading a wind vane. 5. Noting and celebrating the passing of seasons. 6. Watching the path of the sun.	1. Different cloud forms and how they can predict some weather. 2. Wind effects and wind direction. 3. Understanding condensation and evaporation. 4. Humidity.
3-5	1. Measuring weather details using instruments and relating them to growing seasons and plant species selection. 2. Examining the differences/similarities between the local and a different climate zone.	1. Influence on climate of latitude, altitude, and position in relation to ocean and continents. 2. The major climatic regions of the globe. 3. Reasons for the seasonal changes. 4. Cause of droughts and floods.
6-8	1. Measuring and reporting weather details. 2. Communicating with people in other climatic regions about effects on their food production, way of life, and the weather disasters they prepare for. 3. Performing a sector analysis for a specified site. 4. Designing a home/animal shelter that takes into account the climatic effects of a specified region.	1. Sector planning. 2. Map reading (contours, flood levels). 3. Global weather patterns and what drives them.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Patterns in Nature

Grade(s)	Skills	Knowledge
K-2	1. Observing patterns in nature. 2. Making collections of natural things and putting them into categories of the students choosing.	1. The natural world is made up of natural shapes and patterns. 2. Patterns in nature are repeated. 3. The same patterns are found throughout the natural world (many things in nature look like other things in nature). 4. Patterns in nature perform functions.
3-5	1. Naming common natural patterns. 2. Finding a certain pattern in many different places and in different scales (or orders of pattern) (i.e. branching in leaves, trees, vascular systems, and rivers). 3. Listing the patterns seen on the school grounds or in the school garden.	1. There are mathematical patterns evident in nature. 2. One of these patterns is the Fibonacci Series. 3. Vocabulary 4. Recognize branching, dendritic, spiral, and sphere.
6-8	1. Linking a pattern and a function on the school grounds or bioregion.	1. Some patterns are moving and occur in moving air or water (the Ekman Spiral and the Von Karman Trail). 2. Fractals are visible in nature and can be created by repeating a mathematical formula.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Water

Grade(s)	Skills	Knowledge
K-2	1. Pouring, watering gardens, using a watering can or hose.	1. Water is a liquid/gas/solid., 2. Water runs downhill. 3. Water is essential for life for plants and animals. 4. We need to drink more water in hot weather. 5. How to catch water. 6. The duties and uses of water.
3-5	1. Pouring accurately. 2. Measuring in milliliters, liters, and megaliters. 3. Adjusting water flows. 4. Watering gardens. 5. Selecting watering schedules for optimum growth and minimum water loss.	1. The Water Cycle. 2. Creeks and rivers (orders of streams). 3. Moving water carries materials (soil in erosion). 4. Moving water as an energy source. 5. Water can dissolve nutrients and pollutants. 6. How to catch & store water. 7. Finding water in the desert.
6-8	1. Catching, storing, and moving water. 2. Designing simple watering systems. 3. Reading a simple contour map. 4. Marking contours. 5. Conducting a water audit.	1. The duties of water. 2. Measuring water volumes. 3. Water pressure & how it works (ht. of storage/size of conduit/d. from source). 4. Water travels at close to 90 degrees to contour. 5. Strategies to slow and stop water flows. 6. Cleaning water and grey water systems. 7. Dendritic pattern. 8. Water in our bioregion (natural systems/home and property strategies).
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Earth Resources

Grade(s)	Skills	Knowledge
K-2	1. Identifying and manipulating soils and rocks. 2. Making items from earth resources.	1. The Earth provides all the resources used by people. 2. People have used earth resources for many thousands of years. 3. Our Earth's history is stored in rock strata. 4. Vocabulary: clay, ochres, salt, precious stones and metals, fossils, fossil fuels.
3-5	1. Creating useful items from clay and firing them. 2. Identifying common rocks in the region. 3. Making ochres from soil and using them in paints and/or renders.	1. Minerals in the Earth and mining. 2. Common uses of local minerals. 3. The soil strata locally or on school grounds (observing a soil core reading to identify topsoil, subsoil, parent rock).
6-8	1. Building in mud/brick or clay/cob (model or community project) 2. Designing or creating a useful or aesthetic item from earth resources extracted by the designer.	1. Building materials used in areas of study (depends on/influenced by other subject area planning). 2. Earth resources in our bioregion.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Topography

Grade(s)	Skills	Knowledge
K-2	1. Playing in a sand pit. 2. Building in a soil pit and adding water. 3. Finding the resting angle of wet and dry sand, clay, silt, and rocks. 4. Observing flat land and hills in our community.	1. Vocabulary: river flats, hill, ridge, mountain, river, creek, gully.
3-5	1. Identifying common rocks in the region.	1. How the local land was formed (water, wind, uplifts, etc.). 2. The soil strata locally or in the school grounds (observing a soil core reading to identify topsoil, subsoil, parent rock).
6-8	1. Locating the key point of a hill 2. Observing and selecting the best sites for water catchments and storages in the landscape. 3. Selecting a good site for a garden.	1. Various landforms across the globe: deserts, mountain ranges, volcanoes, wetlands, forests, heath, tundra, or river systems. 2. What determines our bioregion - the rivers, hills, and mountains. 3. The terminology for all landforms in our bioregion.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Soils

Grade(s)	Skills	Knowledge
K-2	1. Using hand tools to dig in sand and soil. 2. Digging holes in preparation for planting (seed, cutting, seedlings, and plants). 3. Recognizing different components of a garden soil (sand, compost, loam). 4. Feeding worms in a worm farm. 5. Adding to a compost heap.	1. Life cycle of a worm. 2. Beneficial activities of the worm. 3. Compost turns to humus. 4. Humus is formed by nature in forests and other natural systems.
3-5	1. Creating a healthy soil. 2. Building a No-Dig garden. 3. Testing the pH of soils.	1. The pH needs of plants in the school garden or a local garden. 2. The process of decay. 3. Bacteria. 4. Fungi.
6-8	1. Making humus from compost (building a compost heap, monitoring temperature, and the decomposition process). 2. Moving soil with spades, shovels, and rakes. 3. Preparing soil for planting trees and shrubs. 4. Observing soil life with a microscope.	1. How to manipulate soil pH to suit particular plant species. 2. Identification of common soil biota. 3. Soils in our bioregion: earth resources, farming soils, wetlands, degraded soils, and forest floor.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Plants

Grade(s)	Skills	Knowledge
K-2	1. Collecting seed for observation and identification. 2. Sprouting seeds. 3. Growing plants from seeds. 4. Identify some edible plants in the school garden or at a local garden. 5. Preparing some edible plants for eating.	1. Seeds come in many different shapes and sizes. 2. Seeds have mechanisms for dispersal. 3. Plants are living things. 4. Plants require sunlight, water, and nutrients from the soil to grow. 5. Some plants are edible. 6. Not all plants have seeds for reproduction.
3-5	1. Propagating plants from selected seeds and cuttings. 2. Saving seeds. 3. Recognizing a healthy and a sick plant. 4. Identification of 10 edible plants on the school grounds or in the community.	1. Parts of a plant. 2. The life cycle of a flowering and a non-flowering plant. 3. Weeds as indicators of soil condition. 4. Weeds as repairers of damaged soils.
6-8	1. Propagating and grafting useful plants. 2. Selecting appropriate plant species for the vegetable garden, orchard, or flower garden. 3. Successfully planting at least 5 edible plants and monitoring their health for several weeks. 4. Identifying 5 native plants.	1. Visiting and observing a local productive plant system. 2. Visiting and observing a local natural plant system. 3. How to establish a plant system in the school or at home.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Animals

Grade(s)	Skills	Knowledge
K-2	1. Meeting some of the needs of an animal (worms, fish, frogs, chickens, guinea pigs, or larger animals) for several weeks.	1. Animals are living things that have general needs and some specific needs for each species. 2. General characteristics of animal classes.
3-5	1. Meeting all the needs of an animal for several weeks. 2. Following the life cycle of an animal on the school grounds/ garden (butterflies, frogs, lizards). 3. Identifying animals, birds, & insects that use the school grounds/garden. 4. Providing shelter for animals on the school grounds /garden (diurnal/nocturnal). 5. Placing & observing bird boxes, rocks, water, etc. 6. Making use of an animal product (manure, eggs, feathers, etc.).	1. Animals reproduce in different ways. 2. Animal shelter and homes. 3. Animals have been useful to humans throughout history.
6-8	1. Designing an animal shelter that meets all the needs of the selected species. 2. Listing the needs of a farmed animal species. 3. Recognizing a healthy or sick animal. 4. Using animal products in a garden system so there is no waste (address morality /humane treatment of animals).	1. The functioning of an animal system in the bioregion, through visiting a working farm.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Trees

Grade(s)	Skills	Knowledge
K-2	1. Identifying a tree from other plants. 2. Observing some functions of trees (shade, shelter, habitat, erosion control, fruit, timber, etc.).	1. Characteristics of a tree. 2. Parts of a tree. 3. Forests are more than just groups of trees. 4. The composition of a forest floor.
3-5	1. Planting a tree. 2. Identifying 10 trees on the school grounds/gardens or in the local community. 3. Identifying a healthy and a sick tree. 4. Identify 5 native and 5 exotic trees.	1. Mulch as a replacement for the forest leaf litter. 2. Food forests as designed systems. 3. Different trees perform different functions in a natural or designed system. 4. The uses of 3 native and 3 exotic tree species.
6-8	1. Planting or maintaining a tree system (conservation or food production), 2. Identify 10 native species. 3. Identify 10 food tree species. 4. Identify 5 support species (those trees that help the establishment and growth of a target tree).	1. Tree systems in a local bioregion. 2. Using trees to modify climate. 3. Using trees to produce food. 4. Trees and forests are modifiers of global climate. 5. The use of trees in permaculture design. 6. Community organizations that support tree planting.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Energy

Grade(s)	Skills	Knowledge
K-2	1. Making things move by moving water & air (paddlewheels, sailboats, etc.). 2. Growing plants using the energy from the sun.	1. Energy, in the form of food, is needed for plants & animals to live and grow. 2. Energy is the ability to do work or the ability to move and change things. 3. Without energy, nothing happens.
3-5	1. Observing & reporting the use of a form of energy used to power a specific tool/machine/device. 2. Listing energy sources used in the school. 3. Reporting on local region energy transmitters. 4. Calculating the energy use in your school and how it may be reduced. 5. Reading & making graphs of home/school energy use.	1. Basic understanding of the process of photosynthesis. 2. The Power Grid and the energy source used to power it. 3. Energy sources: solar, wind, hydro, tidal, geothermal. 4. Energy transmitters: electricity, steam, compressed air.
6-8	1. Using an alternative energy source to perform a function most often performed by electricity or a fossil fuel. 2. Listing energy sources used in the local region. 3. Reporting on local region energy transmitters. 4. Rating energy efficiency. 5. Using equipment to calculate energy & energy efficiency (thermometer, light meters, etc.).	1. The combustion engine. 2. Appropriate energy source for specific functions. 3. Harnessing energy to perform work. 4. The Earth is a closed system. 5. Living things are open systems and rely on energy flows.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Buildings and Structures

Grade(s)	Skills	Knowledge
K-2	1. Identifying buildings & their purposes in our community. 2. Identifying the common building materials in our community. 3. Listing the fencing styles & materials in our community.	1. Buildings are designed to fulfill a function. 2. Local building materials are often used in local constructions. 3. Buildings are warmed & cooled by many different methods. 4. Hot air rises & cool air sinks.
3-5	1. Matching a construction to a climatic zone. 2. Recognizing the specific purpose of a construction. 3. Reading a simple building plan. 4. Drawing the scale drawing of the classroom. 5. Building a model of a simple building. 6. Categorizing buildings according to use. 7. Measuring the length of fences. 8. Preparing a materials list to build a specific fence.	1. People in different parts of the world design their homes and buildings to best suit the materials they have and their climate. 2. Scale drawing techniques. 3. Measuring length and area. 4. Cultural differences in the way people build fences.
6-8	1. Designing a building to perform a specific function (home, animal shelter, etc.). 2. Considering methods of warming/cooling a building. 3. Considering ways of providing water to a building. 4. Building a simple fence (for animals or trellising).	1. How to orient a building to take advantage of passive solar effects. 2. Thermal mass. 3. Multiple functions of fences. 4. Simple fence construction techniques.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

Permaculture Foundations: Social Permaculture

Grade(s)	Skills	Knowledge
K-2	1. Playing together and sharing. 2. Communicating with others. 3. Being quiet when others are talking.	1. Everyone has feelings, thoughts, and needs. 2. I need to take are of my body, heart, and mind, 3. My community is made up of families, neighbors and friends, 4. There are many languages and cultures in my community. 5. Peace and harmony.
3-5	1. Self-awareness. 2. Self-expression through body, heart, and mind. 3. Making decisions in groups. 4. Ability to work in teams. 5. Conflict resolution. 6. Compassionate Communication	1. My passions and interests are important. 2. There are many ways of learning. 3. What it means to live in a community. 4. Ethical trade and exchange. 5. The eight forms of capital. 6. Careers and work in permaculture.
6-8	● ALL OF THE ABOVE	● ALL OF THE ABOVE
Note. Adapted from *Earth Care, People Care, and Fair Share in Education.* 2018, *P.* 57, by L. Alderslowe, G. Amus, and D. Devapriya. CC BY-NC-ND.		

Permaculture Foundations: Permaculture Design

Grade(s)	Skills	Knowledge
K-2	1. Identifying some of the characteristics of a permaculture garden: mixed species planting, mulched beds, curved paths, water storages, companion planting, multifunction, perennials, etc.	1. Permaculture is a way of providing the needs of people with less environmental damage. 2. Permaculture has three ethics: Care of the Earth and species, Care of the People, and Fair Share. 3. Permaculture techniques provide clean & healthy food.
3-5	1. Selecting a garden site. 2. Growing food in a permaculture garden. 3. Contributing to recycling materials within the school.	1. Understanding the need for Sector Planning. 2. Understanding the need for Zonal Planning. 3. Observing the Edge Effect. 4. Permaculture is based on two sets of principles that tell us: 1) how to behave as responsible producers, and 2) how to produce and meet our needs.
6-8	1. Making a simple zonal plan of the classroom or garden. 2. Doing a simple sector plan on the garden or a building, (consider light, heat, & wind). 3. Recycling materials within the school. 4. Gaining a yield from a permaculture garden. 5. Harvesting and preparing a permaculture product. 6. Participating in a community market.	1. Communities need to share resources. 2. When to harvest specific produce from the permaculture garden. 3. Local trading systems.
Note. Adapted from *Outdoor Classrooms; A Handbook for School Gardens* (pp. 150-156, by C. Nuttall and J. Millington. Copyright 2008 by Carolyn Nuttall and Janet Millington.		

APPENDIX B: NGSS Standards - All Practices, Grades 3-5

NGSS Standards - All Practices, Grades 3-5

3-PS2-1 Motion and Stability: Forces and Interactions

Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

Performance Expectation

Grade: 3-5, 3

3-PS2-2 Motion and Stability: Forces and Interactions

Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
Performance Expectation

Grade: 3-5, 3

3-PS2-3 Motion and Stability: Forces and Interactions

Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
Performance Expectation

Grade: 3-5, 3

3-PS2-4 Motion and Stability: Forces and Interactions

Define a simple design problem that can be solved by applying scientific ideas about magnets.*
Performance Expectation

Grade: 3-5, 3

3-LS1-1 From molecules to Organisms: Structures and Processes

Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
Performance Expectation

Grade: 3-5, 3

3-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Construct an argument that some animals form groups that help members survive.
Performance Expectation

Grade: 3-5, 3

3-LS3-1 Heredity: Inheritance and Variation of Traits

Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
Performance Expectation

Grade: 3-5, 3

3-LS3-2 Heredity: Inheritance and Variation of Traits

Use evidence to support the explanation that traits can be influenced by the environment.
Performance Expectation

Grade: 3-5, 3

3-LS4-1 Biological Evolution: Unity and Diversity

Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
Performance Expectation

Grade: 3-5, 3

3-LS4-2 Biological Evolution: Unity and Diversity

Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
Performance Expectation

Grade: 3-5, 3

3-LS4-3 Biological Evolution: Unity and Diversity

Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
Performance Expectation

Grade: 3-5, 3

3-LS4-4 Biological Evolution: Unity and Diversity

Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.*
Performance Expectation

Grade: 3-5, 3

3-ESS2-1 Earth's Systems

Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
Performance Expectation

Grade: 3-5, 3

3-ESS2-2 Earth's Systems

Obtain and combine information to describe climates in different regions of the world.
Performance Expectation

Grade: 3-5, 3

3-ESS3-1 Earth and Human Activity

Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*
Performance Expectation

Grade: 3-5, 3

4-PS3-1 Energy

Use evidence to construct an explanation relating the speed of an object to the energy of that object.
Performance Expectation

Grade: 3-5, 4

4-PS3-2 Energy

Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
Performance Expectation

Grade: 3-5, 4

4-PS3-3 Energy

Ask questions and predict outcomes about the changes in energy that occur when objects collide.
Performance Expectation

Grade: 3-5, 4

4-PS3-4 Energy

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*
Performance Expectation

Grade: 3-5, 4

4-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
Performance Expectation

Grade: 3-5, 4

4-PS4-2 Waves and Their Applications in Technologies for Information Transfer

Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
Performance Expectation

Grade: 3-5, 4

4-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Generate and compare multiple solutions that use patterns to transfer information.*
Performance Expectation

Grade: 3-5, 4

4-LS1-1 From Molecules to Organisms: Structures and Processes

Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
Performance Expectation

Grade: 3-5, 4

4-LS1-2 From Molecules to Organisms: Structures and Processes

Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
Performance Expectation

Grade: 3-5, 4

4-ESS1-1 Earth's Place in the Universe

Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.
Performance Expectation

Grade: 3-5, 4

4-ESS2-1 Earth's Systems

Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
Performance Expectation

Grade: 3-5, 4

4-ESS2-2 Earth's Systems

Analyze and interpret data from maps to describe patterns of Earth's features.
Performance Expectation

Grade: 3-5, 4

4-ESS3-1 Earth and Human Activity

Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
Performance Expectation

Grade: 3-5, 4

4-ESS3-2 Earth and Human Activity

Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*
Performance Expectation

Grade: 3-5, 4

5-PS1-1 Matter and Its Interactions

Develop a model to describe that matter is made of particles too small to be seen.
Performance Expectation

Grade: 3-5, 5

5-PS1-2 Matter and Its Interactions

Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.
Performance Expectation

Grade: 3-5, 5

5-PS1-3 Matter and Its Interactions

Make observations and measurements to identify materials based on their properties.
Performance Expectation

Grade: 3-5, 5

5-PS1-4 Matter and Its Interactions

Conduct an investigation to determine whether the mixing of two or more substances results in new substances.
Performance Expectation

Grade: 3-5, 5

5-PS2-1 Motion and Stability: Forces and Interactions

Support an argument that the gravitational force exerted by Earth on objects is directed down.
Performance Expectation

Grade: 3-5, 5

5-PS3-1 Energy

Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
Performance Expectation

Grade: 3-5, 5

5-LS1-1 From Molecules to Organisms: Structures and Processes

Support an argument that plants get the materials they need for growth chiefly from air and water.
Performance Expectation

Grade: 3-5, 5

5-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
Performance Expectation

Grade: 3-5, 5

5-ESS1-1 Earth's Place in the Universe

Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.
Performance Expectation

Grade: 3-5, 5

5-ESS1-2 Earth's Place in the Universe

Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.
Performance Expectation

Grade: 3-5, 5

5-ESS2-1 Earth's Systems

Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
Performance Expectation

Grade: 3-5, 5

5-ESS2-2 Earth's Systems

Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
Performance Expectation

Grade: 3-5, 5

5-ESS3-1 Earth and Human Activity

Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.
Performance Expectation

Grade: 3-5, 5

3-5-ETS1-1 Engineering Design

Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
Performance Expectation

Grade: 3-5, 3, 4, 5

3-5-ETS1-2 Engineering Design

Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
Performance Expectation

Grade: 3-5, 3, 4, 5

3-5-ETS1-3 Engineering Design

Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. Performance Expectation

Grade: 3-5, 3, 4, 5

APPENDIX C: Common Core State Standards ELA - Speaking & Listening

Speaking and Listening Standards K–5

SL

Grade 3 students:	Grade 4 students:	Grade 5 students:
Comprehension and Collaboration		
1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion). c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion.	1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others. d. Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.	1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
2. Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.	2. Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.	2. Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.	3. Identify the reasons and evidence a speaker provides to support particular points.	3. Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence.
Presentation of Knowledge and Ideas		
4. Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.	4. Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.	4. Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
5. Create engaging audio recordings of stories or poems that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details.	5. Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.	5. Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.
6. Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification. (See grade 3 Language standards 1 and 3 on page 28 for specific expectations.)	6. Differentiate between contexts that call for formal English (e.g., presenting ideas) and situations where informal discourse is appropriate (e.g., small-group discussion); use formal English when appropriate to task and situation. (See grade 4 Language standards 1 on page 28 for specific expectations.)	6. Adapt speech to a variety of contexts and tasks, using formal English when appropriate to task and situation. (See grade 5 Language standards 1 and 3 on page 28 for specific expectations.)