Summer 2022

Growing Environmentally Literate Youth

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GROWING ENVIRONMENTALLY LITERATE YOUTH

by

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

Hamline University

Saint Paul, Minnesota

August 2022

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TABLE OF CONTENTS

CHAPTER ONE

Introduction

I wonder why that happens? I have never thought about it that way before. I can do that? Why does it matter? What would happen if… ? But, I am just one person. Oftentimes, children find themselves in a world filled with the unfamiliar, the new, and the mysterious. So, children do what children do best, wonder, and ask questions. Growing up in Michigan I found myself outside daily from sunup to sundown, fully immersed in the natural world. The fascination and curiosity that I experienced were at times overwhelming. Innocently, I had no idea that my wonderings were just the tip of the iceberg; I didn't know what I didn't know. Today, I find that many children are disconnected from nature and the impact that they have on the world around them, be it their environmental impact, their social impact, or even their influence on others' thinking. Many students enter elementary school being environmentally illiterate. As an elementary school teacher, I jump on these opportunities to provide authentic experiences to my students; this is my reasoning for the focus of my research: *What are the benefits of E-STEM practices in a learning garden when developing environmentally literate youth?*

I believe that through the use of a school learning garden, an E-STEM (environmental education, science, technology, engineering, and math) program will provide opportunities for students to become more environmentally literate and better prepared for their future. According to the United States Environmental Protection Agency (2022),

> To become environmentally literate one must: have an awareness and sensitivity to the environment and environmental changes, have the knowledge and an understanding of the environment and environmental challenges, an attitude of concern for the environment, and motivation to improve or maintain environmental quality, have the skills to identify and help resolve environmental challenges and participate in activities that lead to the resolution of environmental challenges. (p.1)

An E-STEM program taught through a learninggardening will enable students to develop their environmental knowledge, build their confidence, and empower them to live sustainably and care for our Earth.

In Chapter One, I will take you through both my personal and professional experiences that have led me to become so passionate about learning from nature rather than about nature; what has happened in my life that has made me realize that through literally getting my hands dirty, we can grow, and affect others' lifestyles by making responsible environmental decisions. In addition, I will discuss the far-reaching impacts of a school garden and how community partnerships, local environmental grassroots organizations, community gardens, and student-based eco-clubs, can support the growth of environmental literacy in elementary-age students.

So Many Questions

I have always been overly inquisitive, sometimes very similar to a two-year-old's ability to ask why sixty different times in a two-minute window, but most often as an adult, this is confined within my mind- just wondering and waiting for the appropriate opportunity to find an answer. Growing up, camping was my family's way of

vacationing. At a young age, I learned to pitch a tent, gather tinder, build a fire, and observe nature. Laying belly down in the dirt, magnifying glass in hand, watching the ants march in line. Where are they going? How do they know which way to go? Do they have a leader? Then rolling over to watch the trees swaying gracefully above our camp. How far can they bend before they break? How do the animals whose homes are in the treetops stay safe? How many animals are watching me right now? So many questions.

During the frequent visits to my grandparent's house when I was young, it was always time for lessons on food waste (composting), herb and vegetable gardening, and providing food for the family. While grandpa was out hunting, grandma was home tending the garden, burying her food scraps, and canning enough produce for the long Michigan winters. My siblings and I were taken along on smelt dipping trips, and then home to learn how to clean and serve them. The lessons taught to us by our grandparents, by us interacting with the natural world, were endless.

Now having the benefit of age, I can reflect back, on growing up in a time when your phone was hooked to your kitchen wall by a short cord, you had to go to the library and look in an actual book to find information, and your television weighed 100 pounds and took up a third of your family room. I attribute much of my ongoing curiosity, and my love of nature, to keeping myself entertained as a child. It was not until I became a mom, that I realized what an opportunity I had to influence my own children's love of nature and the world around them. But, when you have a child who doesn't like the feel of dirt on his hands or sand under his feet, you have to get creative. This was the time when I first learned that not everyone will naturally be drawn to nature, or even the outdoors. Little did I know, this was an opportunity for me to branch out.

As both an elementary educator and a mom, I knew that there are many different kinds of learners and there is always a way to connect or create interest if you let your child, or student, lead the way. With the diversity of interests in both my home and in my classroom, I became somewhat of an environmental educator to both my children and my students without realizing it. The lines had intersected. I found that so many of my students were lacking outdoor experiences, or had not been raised in an environment that encouraged questioning, while at home I naturally peppered my own children with my own wonderings and questions about our world.

There and Back Again

As my children grew into young adults, and then fully independent adults, my teaching career took a turn from elementary general education teacher in Michigan to teaching at a forest school in Mainland China, then back to Michigan to teach STEM to developmental kindergarten through fifth-grade students. I was now a self-proclaimed naturalist. It was through these professional experiences that I realized that many students go through their days unaware of their ability to make a difference in their community, or that they have the ability to make an impact in the world.

During my time teaching at Malvern College Chengdu in China, I had the opportunity to develop an environmental education program for a brand new, not yet opened, international bilingual school. Through this process, our focus was on two different areas: one being the forest campus, and the second being the brick and mortar campus. Forest school was designed to be in an open, wooded area with a lean-to shelter for extreme weather days. Students would be at forest school for three out of the five school days during the school week. The two remaining days they would be applying

what they had experienced in the forest to their classroom learning and working with others to grow the school-wide Eco-Warrior program. The Eco-Warrior program focused on becoming a Green Flag school, a title that no school in China had yet been able to achieve. The goal was to have a neutral carbon footprint, grow their own food, raise their own livestock, and learn and promote the recycling, reusing, and reducing culture in their community. With the adults as facilitators, the students learned to get their hands dirty, ask questions, and most importantly learn how to find answers to their questions and apply their new knowledge within the Eco-Warrior program. Largely, this was done through the forest school environment, gardening, and managing a poultry coop.

In addition to my hands-in-the-dirt approach to teaching in China, I had the absolute privilege to meet Ms. Jane Goodall, one of my mentors, idols, and all-around role models. She was visiting Chengdu, China to speak to the impacts that our young people can have, not only on their own lives but on the education of the people in their lives. Ms. Goodall expressed that her purpose in life, now that she is older, is to educate our youth, so they can in turn educate others in hopes that we can heal the natural world and protect our animals. The organization hosting Ms. Goodall was the local chapter of Roots and Shoots, a program of the Jane Goodall Institutes, which is a global movement of youth who are empowered to use their voice and actions to make compassionate decisions, impacting and leading change in their communities. She spoke to the importance of our young people knowing the depths of their part in living in harmony with the natural world- tending and protecting the Earth. My passion for environmental education and igniting a fire of curiosity within my students deepened. Taking this inspiration back to my school, sharing it with my colleagues, and students, further

empowered us, in time, to earn the very first Green Flag Award from the Government of The People's Republic of China. What a proud and impactful achievement for both students and staff. Although my time was cut short in China due to the COVID pandemic, my desire to share my experiences was not.

Returning to the states, a new opportunity awaited. Now, a year into a position as a Developmental kindergarten-5th grade STEM specials teacher, I have had the opportunity to see on a daily basis the importance of student-led, hands-on, 'real world' problem-based learning. Now, having worked with students from across the globe, it was even more clear that we are not raising environmentally aware youth. My current professional placement allows me to interact and have an impact on over 400 students a week. How can I make the most of my time with these students? It's time to get our hands dirty.

Reaching and Teaching

My passion for reaching and teaching students about the importance of their actions, interactions, and reactions to what is happening around them on a daily basis drives me to be a leader in my district. It is also important to me to engage with the local government to seek STEM-based environmental education for all students, but what will the effects be, what impacts will it have in the real world, how can I make it happen? Through an E-STEM program, we can grow environmentally literate youth who will have the tools to be critical thinkers, and problem-solvers, who can one day engage with ecological problems such as climate change, extinction, deforestation, loss of biodiversity, and plastic pollution just to name a few. By delivering an E-STEM program

through a school garden, students will have the knowledge to participate in and contribute to building a more sustainable, and green local community.

In chapter two, we will be exploring the literature available regarding the history of Environmental STEM (E-STEM) and how teaching it through a school garden will impact the student learning experience. We will be exploring the different focuses of E-STEM and how they come together to provide a real-world learning experience that will enable students to be informed, environmentally aware citizens. In chapter three, we will be walking through an overview of my project and the process that I went through when designing my send grade E-STEM Garden-based learning curriculum. Finally, in chapter four , I will reflect on the entire capstone process. I will discuss how I developed as a research, writer, and educator, as well as address the next steps for this project and the possible impact that it will have in the world of education.

CHAPTER TWO

Literature Review

My research aims to answer the question, *What are the benefits of E-STEM practices in a learning garden when developing environmentally literate youth?* Before looking into the research on developing environmentally literate youth, E-STEM, and school gardening, it is important to understand and define STEM, E-STEM, and environmental literacy (EL).

According to Southern Illinois State University (2022), "STEM is an acronym for Science, Technology, Engineering and Math education. It is an interdisciplinary approach that helps students succeed in college and in their future careers. The focus of STEM education is hands-on, problem-based learning" (What Is STEM Education: STEM Education Research Center, 2022). When taught together, each of the STEM discipline areas will help students develop the skills they need to acquire in order to tackle future challenges and develop the skills needed to be successful in a rapidly changing world. According to the North American Association for Environmental Education (NAAEE), E-STEM is learning about the environment as a pathway to STEM learning. The bridge between the E (environmental education) and STEM (science, technology, engineering, and math) is the focus of a variety of programs and educational initiatives that engage students in the environment as a means to explore the standard STEM disciplines (Nature-based Environmental Education of Children, n.d.).

In addition, environmental literacy is the understanding of the relationships between natural systems and human social systems (Barrett, G., Peles, J., & Odum, E., 1997). As stated by Marstellar (1922), there is a strong, but subtle, distinction between environmental education and environmental literacy. While environmental education is process-based, environmental literacy is focused on outcomes. Maintaining the health of our environmental systems, according to Marstellar (1992), will take a dedicated group of people who have the knowledge and ability to take action when necessary steps are taken to restore, maintain, and protect. Likewise, the state of California's Environmental Literacy task force in an effort with the California Department of Education (2015) stated the definition of environmental literacy as:

> An environmentally literate person has the capacity to act individually and with others to support ecologically sound, economically prosperous, and equitable communities for present and future generations. Through lived experiences and education programs that include classroom-based lessons, experiential education, and outdoor learning, students will become environmentally literate, developing the knowledge, skills, and understanding of environmental principles to analyze environmental issues and make informed decisions. (p. 1)

According to Oregon State University (2020), environmental literacy focuses on a working understanding of our environment. More specifically, a person's knowledge and ability to consider their own relationship with the environmental systems around them, and who are willing to protect those systems and communities for future generations (What Is Environmental Literacy, 2020). Environmental literacy is the outcome of a complete environmental education which provides learners with accurate scientific

information, improved critical thinking skills, creative problem-solving skills, and improved decision making (What Is Environmental Literacy, 2020). The following sections will define the different components of exploring the benefits of E-STEM practices in a learning garden when developing environmentally literate youth.

History of STEM Education

According to the Encyclopedia Britannica (2021), STEM educational practices have a rich history dating back to the Morrill Act of 1862. The Morrill Act promoted agricultural and engineering programs within land grant universities. As land grant universities became more common, STEM opportunities began to expand to a broad range of higher education organizations. This growth enabled STEM-educated students to saturate the workforce (Encyclopedia Britannica, 2021). An unforeseen development from World War II was the unprecedented advancements in STEM due to military, business, and academic partnerships. Following these advancements, President Eisenhower introduced the National Aeronautics and Space Administration (NASA) in 1958 in response to Russia's launch of the Sputnik satellite. An unforeseen outcome of the establishment of NASA was increased national attention toward science education. During the 1970s and 1980s, there was significant technological growth in the United States as the first computers and cell phones were produced (Rich History of STEM Education in the United States, 2021).

In 2000, a report published by the United States National Academies of Science, Engineering, and Medicine titled: Rising Above the Gathering Storm, made a connection between welfare, knowledge heavy jobs that depended on the STEM disciples, and the continued innovation to address current and future big problems facing society (stem,

2021). They reported that in order to compete in the global economy we must prepare our workforce to meet the demands of an evolving workforce (Rich History of STEM Education in the United States, 2021). Following the report published by the United States National Academies of Science, Engineering, and Medicine a census was published. At the turn of the 21st century, students in the United States were falling behind when compared to other developing nations in the areas of science, engineering, technology, and math (Rich History of STEM Education in the United States, 2021). In 2001, the National Science Foundation (NSF) developed the acronym SMET to mean science, math, engineering, and technology. Later in 2001, Judith Ramaley, NSF Director of Education and Human Resources, changed the acronym from SMET to STEM (Rich History of STEM Education in the United States, 2021). Then, in 2001, the No Child Left Behind Act passed, requiring K-12 public school students to complete annual standardized testing in an attempt to maintain high academic standards (Rich History of STEM Education in the United States, 2021).

Despite the broad efforts across the United States to improve STEM education, U.S. students were still lagging behind. In response, President Obama established the Educate to Innovate initiative in 2009. The goal of the Educate to Innovate initiative was to ensure that American students would lead the world in the areas of science, technology, engineering, and math (Rich History of STEM Education in the United States, 2021). Then, in 2015, the STEM Education Act of 2015 passed, which added computer science to the technology field of STEM education. Also in 2015, Congress replaced the No Child Left Behind Act with the Every Student Succeeds Act (ESSA), modifying standardized test usage and expanding the federal government's role in K-12

public education (Rich History of STEM Education in the United States, 2021). By 2021, the federally funded Educate to Innovate initiative would be actively preparing 100,00 K-12 STEM teachers to help ensure that U.S. students would continue to lead in the areas of STEM.

Finally, throughout the second half of the 20th century, many countries focused on improving the science, technology, engineering, and math instruction for their youth. Their intentions were to increase literacy in the STEM areas, and also to populate the workforce with scientists and engineers. The United States placed the importance of this accomplishment on the role of educational programs that would prepare our students to be competitive in the 21st-century world economy (The History and Importance of Steam Education, 2020).

STEM Literacy

Developing our youth's STEM literacy is essential to developing the skills necessary to be successful in the 21st-century job market. (Science, Technology, Engineering, and Math, Including Computer Science, n.d.). STEM literacy practices are taught through the Next Generation Science Standards (NGSS) Science and Engineering Practices (SEP). These practices include:

- SEP 1: Asking Questions and Defining Problems
- SEP 2: Planning and Carrying Out Investigations
- SEP 3: Analyzing and Interpreting Data
- SEP 4: Developing and Using Models
- SEP 5: Constructing Explanations and Designing Solutions
- SEP 6: Engaging in Argument from Evidence

- SEP 7: Using Mathematics and Computational Thinking
- SEP 8: Obtaining, Evaluating, and Communicating Information.

(The Standards, 2014). These practices encourage K-12 students to question, investigate, and draw their own conclusions in a space that is preparing them to be independent, responsible and motivated before leaving school (Pleasants, 2019).

The original push for the implementation of STEM stemmed from the low performance of students in the areas of science, technology, engineering, and math and the negative impact it was having on the U.S. workforce. According to the U. S. Department of Commerce, STEM jobs began growing at double the rate of all other occupations. People with STEM-related degrees were realizing higher incomes, even in non-STEM-related careers. As the economy evolved, STEM-educated workers were playing an important part in the growth of the United States economy (The History and Importance of Steam Education, 2020). With the continued popularity and success of STEM education, STEM educators begin seeing the need for a skills component. Skills such as communication, collaboration, critical thinking, and creativity. In 2020, STEAM started to come into the mainstream, adding A (arts), into STEM allowing for a more creative, cooperative approach to STEM education. Over time, this addition began to show students developing a more creative mindset and the ability to think critically which provides the opportunity to be successful in real-world professional settings as problem solvers and critical thinkers (The History and Importance of Steam Education, 2020).

An Introduction to E-STEM

Most recently, STEM came to include environmental education, or E-STEM (environmental education, science, technology, engineering, and math) (Stevenson,

2013). According to Stevenson (2013), in recent years, environmental education has been a growing focus due in part to the connectedness of education, politics, climate, poverty, health, and sustainability. Stevenson states that the history of environmental education dates back more than 40 years, even further if you include conservation, nature studies, and outdoor education. Stevenson (2013) also reported that the Belgrade Charter of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) developed the following educational goal:

> To develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and a commitment to work individually and collectively toward solutions to current problems and prevention of new ones. (p. 1)

Stevenson (2013), stated that the focus on environmental education is growing. This supports The Belgrade Charter (2022) goal of producing a population of environmentally capable and aware citizens. As an emerging field, E-STEM is an effective practice for motivating students through real-world problem-based learning (Soper, E., Fano, E., & Hammond, J., 2015). Motivated students will develop the abilities to be creative, and analytical thinkers allowing them to solve real-world problems (The History and Importance of Steam Education, 2020).

As stated in the UNESCO report (2022) the importance for students of all ages to develop the ability to find the solutions to both today's and tomorrow's problems, thus supporting a collective action that encourages positive change in our societies and how we care for our planet (Education for Sustainable Development, 2022). Spending time in nature will allow our students to be more active in their role as part of the environment

and be more attentive when making choices that impact the environment, and develop a connection and love of the outdoors through environmental education (Kinnear, 2021). In the Foreword of Coyle's (2005), Environmental Literacy in America he states:

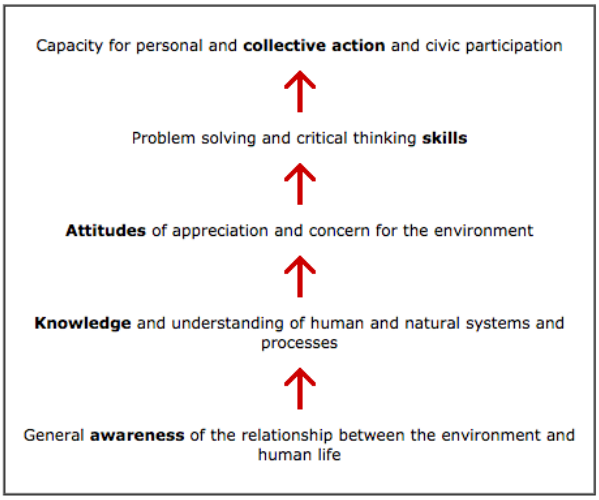
> In the course of a lifetime, an individual will accumulate environmental knowledge from a combination of school, the media, personal reading, family members and friends, outdoor activities, entertainment outlets, and a wide range of other professional and personal experiences. For a few motivated individuals, this can eventually add up to an accomplished environmental literacy. But for most Americans, it falls far short. Most people accumulate a diverse and unconnected smattering of factoids, a few principles, numerous opinions, and very little real understanding. Research shows that most Americans believe they know more about the environment than they actually do. (Foreword)

In 2022, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) found that for environmental education to be sustainable, students must be equipped with the necessary knowledge, skills, and attitudes in order to have a positive impact (Education for Sustainable Development, 2022). To obtain environmental literacy there are several key components. Those components are:

- Ecological Knowledge
- Socio-political Knowledge
- Knowledge of Environmental Issues
- Environmentally Responsible Behaviors

When combining environmental literacy and STEM (E-STEM), you are providing students with the opportunity to build the skills needed to develop environmental

awareness, knowledge of natural systems, environmental attitudes, critical thinking skills, and the capacity for civic engagement (Moon, 2021).



Campaign for Environmental Literacy (Moon, 2021)

Ecological (Environmental) Knowledge

Ecological knowledge is the foundation of environmental education. In order to develop ecological knowledge, students must be able to connect to nature, knowledge alone is generally ineffective in influencing environmentally responsible behaviors (Nature-Based Environmental Education of Children, 2017). Nature-based environmental education (NBEE) is the combination of environmental knowledge with the person's relationship to nature. This combination can be obtained through real-world, place-based learning such as a learning garden (Nature-Based Environmental Education of Children, 2017). Nature-based learning promotes internal motivation, through nature-based experiences, along with environmental knowledge, which is needed to make sustainable environmental decisions (Sobel, 2008). Gaining ecological knowledge is crucial for students' understanding of how they are connected to the natural world, how it can impact their well being and it provides them with the knowledge that helps them to

understand the importance of protecting our waterways, air, food production, and the biodiversity in a changing climate (Ecology is a Science That Matters, 2021). Nature-Based Environmental Education of Children (2017), found that increased participation in nature-based environmental education was related to greater ecological behavior. They also found that a student's connectedness to nature had a direct correlation to their environmental knowledge, and as their knowledge increased, so did their pro-environmental behavior (Nature-Based Environmental Education of Children, 2017). E-STEM provides real-world learning opportunities that cultivate young learners into stewards of the environment and of their communities (Kinnear, 2021).

Socio-political Knowledge

Due to the naturally sheltered lives of children, children are more likely to have positive interactions with nature since they have more limited exposure to unnatural environments than adults. A child's environmental awareness will develop in a positive direction when they are routinely exposed to diverse natural settings, and this can significantly affect their behaviors toward environmental activities (Fang, W.-T., 2017).

There is an ongoing need to develop environmental awareness through natural experiences that are designed to build a positive mindset toward the experiences. Different environmental education opportunities will develop students' relationships with the natural environment, their environmental awareness, behaviors, and their social relationships. Research shows that environmental behavior is a learned response, it increases environmental awareness and increases a student's knowledge of responsible environmental actions (Environmental Activities, 2017).

According to the Peace Corp, environmental education students are impressionable, open, and committed to protecting the environment. Students can do many things to take action in their own communities. They can get involved with environmental stewardship by planting trees, picking up litter, cleaning river beds and waterways, and sorting their trash. They can also educate the adults in their community through school and community gardens, community educational events, and science fairs (Environmental Activities, 2017).

> The premise is that educating kids about the environment will have an impact on their behavior, either when they are still kids or in the future when they are adults. Awareness and knowledge are ideally the means to the end, not the end in themselves. Behavior change that can be reflected in environmental conditions is the ultimate justification for spending time on environmental education. This is true even with kids. (p.5)

Both your knowledge and beliefs play an important part in decisions that impact the environment. According to Irmeli, Palmberg, and Jari (2010), a student's acquired knowledge of the environment and their relationship to it will impact their interaction with the environment and their willingness to take action to protect it (Talebour, L., Busk, P., Heimlich, J. & Ardoin, N.. 2020)

Knowledge of Environmental Issues

Sobel (2008) observed that children can easily become overwhelmed by large-scale environmental issues. Asking them to solve these issues will make them feel helpless and hopeless, leading them to develop a fear of environmental issues. In Jane

Spiteri's, Can You Hear Me?, Young Children's Understanding of Environmental Issues, she states:

> Children will have to solve environmental issues in the years to come. Considering that young children will suffer the consequences of environmental issues for longer, they are at an age at which they can start to explore environmental issues. (p. 191)

Essentially, environmental stewardship is about caring for the environment that children are familiar with, connected with, and in some contexts, that they depend on for needs and their livelihoods (Bennett, N., Whitney, T., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., & Allison, E., 2018). Children are not responsible for solving the global crisis created by the current and previous generations. Rather, children become critical and reflective individuals by participating in playful learning experiences that act as building blocks to teach children about environmental and sustainability issues (Davis, 2015). North American Association of Environmental Education (2016) explains environmental education as the opportunities to connect with nature, explore their curiosities, and enable them to develop an understanding of their place in the natural world, the impacts they make on it, and their responsibilities to care for the environment (Guidelines for Excellence Early Childhood Environmental Education Programs, 2016).

Environmentally Responsible Behaviors

By encouraging environmental connectedness at an early age, Kinnear (2021) says that kids become curious and passionate about nature, climate change, and the environmental issues facing our planet. He goes on to state that by raising children in this way they will grow to become advocates for the environment and live more sustainable

adult lives. (Kinnear, 2021). Teaching our kids about the environment can help them develop healthy habits that will influence the decisions they make as an adult, having an overall positive impact over time. It is believed that the earlier children start developing a positive relationship with nature and the outdoors, the more likely they are to grow into environmentally responsible adults, becoming stewards of the environment. Chepesiuk (2007), of Environmental Health Perspectives, reported that:

> Today's children will one day be responsible for making decisions that will shape the future health of the environment. To prepare them for such responsibilities, they need a sound environmental education as a foundation upon which to make those decisions." Most important, says Mitchell, environmental literacy helps develop and expand children's critical thinking skills, prepares them for citizenship, nurtures their appreciation of the natural world, and enhances their physical well-being. (p.1)

In 2015, Pierce considered that learning gardens could help bridge the gap between students and their communities by connecting them with nature and the environment. Thus increasing their environmental literacy and awareness of their relationship with the natural world, oftentimes leading to civic engagement (Pierce, 2015).

Garden-based Learning

Wells (2015) states that there are records dating back to the early 1900s showing that learning gardens have been an important part of many schoolyards. The benefits range from educational opportunities to developing real-life skills in a hands-on setting providing a setting for holistic learning and fostering natural values (Wells, 2015).

Findings by Environmental Education Research (2018) indicate that nature in and around the school garden contributed to students' well-being in the four areas:

- positive emotions (including feelings of happiness and satisfaction)
- interpersonal well-being (including positive connections with others and with nature)
- self-esteem (including positive self-concept and perceived competencies)
- behavior (including expressions of empathy and cooperation)

all of which enhance a student's academic growth (Dyg, P.M., Wistoff, K., 2018).

As students develop soft skills they are able to work together in a productive way that allows them to learn and work with other students. This promotes respectful relationships, conflict resolution, conversations, and group problem-solving abilities (Trish-Penny, n.d.). Reported in the Los Alamo National Laboratory (2021), by Trish-Penny:

> Gardening is an inclusive activity, it does not matter what your ethnicity, background, economic status, or academic achievement is, any child can nurture healthy plants and reap a bountiful harvest. A garden can raise the self-esteem of children who may be struggling in the classroom. (p.2)

The transition to becoming an effective professional is more than academic knowledge and research acquired through higher learning institutions. It requires awareness and an investment of time to identify and develop key professional skills necessary for success in any chosen career path. Soft skills [life skills] are personal competencies that improve human performance, facilitate effective interactions, and complement the technical requirements necessary to acquire and maintain employment.

(Soft Skills for Stem, 2021).

The pairing of the knowledge gained through teaching E-STEM through a learning garden will add to the development of a student's knowledge and soft skill development.

Environmental Education in the Garden

In conclusion, in a study done by Hammarsten (2018), in a forest learning garden in Sweden, it was found that students reported positive feelings and that time spent learning in a garden helped them to understand how human's interactions with ecosystems can be sustainable. They learned to coexist with the natural world and gained knowledge about ecology and biology. Overall, Hammersten (2018) found that learning in a garden serves to promote environmental literacy. According to Sobel (2004), it is necessary for students to develop a sense of place, and only when students have a sense of place can they develop a love of place, and know who we are and how we fit in. In addition, Sobel (2004) states that when we understand the places that we live and love, we want to protect them. It is within a learning garden that we can learn about so many different parts of our natural world, such as pollinators, plant interactions, animal communities, fungi, soil composition, human impact, erosion, adaptation, survival, severe weather impacts, pollution, and natural cycles (Garden-Based Learning Resources, 2022).

Science in the Garden

Learning gardens serve as a place to explore the world of natural sciences. A place filled with possibilities to engage with hands-on science experiments. Students can view seasonal changes, witness earth processes, record biodiversity data, document life

cycles, ask questions, and make endless observations of nature (Using Gardening to Promote Stem, 2022).

A study published in the International Journal of Science Education (2015) states that garden-based learning fosters student engagement and enhances science learning. The study highlights that garden-based science activities improve students' science identity and help to develop student confidence in relation to science (Wells, N., Myers, B., Todd, L., Barale, K., Gaolach, B., & Ferenz, G., 2015). Chapman and Feldman (2017) stated that students can solve real-world problems through active engagement. When the teacher engages students in science learning, it helps the students connect with real-world problems (Chapman, A., & Feldman, A., 2017).

Technology in the Garden

Integrating technology into a learning garden increases student engagement and participation, all while deepening their connection to nature. The use of technology in a learning garden is an invaluable way for students to get up close and personal with microscopic life, and witness the finer details in nature that are a challenge to view with an unaided human eye (Stem in the garden, 2018). Technology in the school garden can look different from school to school. It is important to emphasize to students that anything made by humans in technology (Using Gardening to Promote Stem, 2022).

Grant (2021) found that several types of technologies would enhance the gardening process. Smart technologies like smart plant monitors that test soil pH, moisture levels, and light and humidity levels, smart watering systems help to preserve water and can be programmed to meet each plant's needs. Another useful piece of garden technology is the use of a gardening application on a smartphone or tablet which can help

identify plant species, as well as identify any disease or sickness and how it can be treated. Lastly, robotic weeders limit the need for pesticides and allow the desired plants to get the water and nutrients they need to thrive (Grant, B., 2021).

Engineering in the Garden

Learning gardens provide students with the opportunity to use their environmental knowledge to plan, design, and create a garden that best suits their needs. The engineering design process can be applied to garden planning and installation, building raised beds and supports, to the students utilizing the space and resources in their learning garden to create, test, and improve upon designs (Native Plants for School Grounds Can Grow into a Teaching Garden, 2022). Students should be involved as early as possible with the planning and designing of a learning garden, it is great engineering and design practice. Students should be a part of deciding on the location of the garden based on the amount of sunlight, soil quality, and drainage (Using Gardening to Promote Stem, 2022).

Math in the Garden

According to Stem in the Garden (2018), there are countless math standards that can be addressed through a learning garden. Some of the skills they listed for early elementary are counting, finding patterns, shapes, and symmetry. In the upper elementary they could explore more complex math standards such as: calculating volume, area, and mass, calculating the amount of growing space, the population of plant species, and the amount of space each plant requires to determine how many plants can go in each bed (Stem, 2018). Students can learn a wide variety of math skills in a learning garden: counting, measuring, spatial awareness, proportions, shapes, patterning, fractions, and multiplication (Using Gardening to Promote Stem, 2022).

E-STEM in a Learning Garden

The National Wildlife Foundation says, “Making direct contact with soil, whether through gardening, digging for worms, or making mud pies, has been shown to improve mood, reduce anxiety, and facilitate learning.” (Bhattacharya, P., Rachel, Laurie, & Gast, M., 2021, p.1). An important aspect of learning is exposure to the natural world. It helps to develop a student’s psychological, social, cultural, physical, and environmental learning (Malone, K., 2008).

Food Gardening

Trish-Penny explains how our food production and consumption practices over time have had a negative impact on our environment. The habits we develop as adults tend to lean toward convenience, and we do not think about the origin, or the complex transportation involved in buying food from other places around the world, or that are simply out of season locally. When we understand the positive effects of growing and shopping for food locally, it minimizes the harmful emission, herbicides, and pesticides required to grow food outside of the natural process. Learning gardens are an opportunity for students to begin to gain an understanding of the concepts and issues of gardening and buying local while developing a knowledge base to become more environmentally connected (Trish-Penny, n.d.).

Whether you are growing a native wildflower garden or a food garden, you are creating a natural space that provides a real-time, hands-on, opportunity to learn about plants and the biodiversity that comes along with them.

Wildflower Gardening

Native wildflower gardens can be easily established and are beneficial for pollinators such as bees, butterflies, hummingbirds, bats, as well as our local ecosystems. With our native prairies, grasses, and wildflower populations in decline, the reestablishment of these native plants is beneficial to large ecosystems that negatively impact the environment (Native Plants for School Grounds Can Grow into a Teaching Garden, 2022). Native plants are those that have co-evolved over a long period of time with other local plants and animals in a place, and provide one another with the things they need to live productive lives (Native Plants for School Grounds Can Grow into a Teaching Garden, 2022).

According to Blair (2009), native wildflower gardens will foster student growth through an authentic learning environment. An authentic learning environment is defined by The Glossary of Education Reform (2013), to be a variety of instructional techniques that aim to connect classroom learning to real-world problems or issues. Blair (2009) found that childhood involvement with nature (plants, trees, and gardening) had a direct impact on the value they placed on nature in adulthood.

In order to offer endless learning opportunities to our students by giving them hands-on experiences that will allow them to learn about the natural world, we can connect them to real-world problems through a learning garden. Allowing students to interact with the intricacies of a native landscape that provide authentic learning experiences. By using native plant species for gardening we can offer our children endless learning opportunities that will impact their community's biodiversity and health. A learning garden filled with native plants offers a glimpse into nature that is capable of

teaching our students through their natural curiosity alone (Native Plants for School Grounds Can Grow into a Teaching Garden, 2022).

Forest Gardening

Crawford (2012), defines a forest learning garden as a multi-layered space designed by humans where students can learn about different ecosystems that can support the growth of fruit trees, berries, and edible perennials. Forest learning gardens support a student's environmental competence, increase their biological knowledge, and their ability to coexist with plants and animals. Forest gardens are also reported to improve a student's attitudes toward learning outside (Hammarsten, M., Askerlund, P., Almers, E., Avery, H., & Samuelsson, T., 2018).

The potential of utilizing a learning garden to develop environmental literacy is profound, not only in obtaining accurate science knowledge but also in the opportunities for students to gain soft skills that will serve them as stewards of the environment. According to a 2020 study, Children's connection to nature is fostered through residential environmental education programs: key variables explored through surveys and field journals when a student gets their hands in the soil or mud, it can encourage the development of the student's tactile functions, boost their creativity and imagination, support independent learning while developing their ability to think critically, communicate effectively with others, and problem-solve (Talebour, L., Busk, P., Heimlich, J. & Ardoin, N.. 2020).

Conclusion

This chapter provided a review of a variety of current literature focused on developing environmentally literate youth through the use of E-STEM practices in a

learning garden. It first presented an overview and definition of the disciplines of STEM, E-STEM, and environmental literacy. Next, it identified the history of the development of STEM educational practices, and how these practices came to be such an important focus on K-12 education. The chapter then presented literature related to how E-STEM has recently entered the educational STEM focus through the increasing need for environmental education. Following that, the chapter described the important components of E-STEM practices and how they apply to the educational practices of a learning garden. Finally, the chapter reviewed the role of learning gardens and their impact on developing environmentally literate youth.

The literature review revealed how E-STEM paired with learning gardens can be beneficial and effective when developing environmentally literate youth. Using E-STEM practices in a learning garden gives students the opportunity to learn from real-world, cross-curricular, hands-on experiences in an authentic environment allowing them to make connections with, and understand their relationship to the world around them.

The literature review also explains how developing environmentally literate youth can have a long-lasting impact on a student's mindset when it comes to being environmentally responsible and confident when faced with the challenge of solving the environmental problems in the world. Through the use of E-STEM practices, and the integration of an elementary environmental education learning garden curriculum, students will have the opportunity to become environmentally literate in an authentic, engaging environment beginning in their earliest days of school, supporting them throughout their elementary experience.

In the next chapter, I will describe in detail the second grade E-STEM Garden-based learning curriculum and its implementation in a STEM specials setting. As the students take part in this garden-based environmental education curriculum, their developing environmental literacy will allow them to influence others and make decisions for the greater good of our planet.

CHAPTER THREE

Project Description

Introduction

Being a white, able-bodied female being raised by middle-class parents in the midwest, I was provided almost endless opportunities to explore as a child. With ample forest, fields, freshwater, and natural areas so close to my doorstep, I was easily able to develop my environmental literacy by exploring my natural curiosity of the world around me. Now, as a tenured elementary school teacher with a natural science background, I understand the challenges that can inhibit young children from becoming environmentally literate, but I lack the knowledge and awareness on how to provide all students with environmental education in a STEM-centric school.

I have witnessed throughout my professional career the fall of the natural sciences. In an attempt to raise the nation's math and reading scores, I have seen science go from a core subject, an educational priority, to a discipline that is squeezed in when time allows. Due to it being deprioritized, and lacking dedicated instructional time, the way that the sciences have been delivered to students has moved away from a hands-on approach to a pencil paper approach. I have seen students disengage with the sciences, lose interest, and adopt a negative attitude. I have also witnessed with the increase of technology the decrease of time that young children spend outdoors, discovering and exploring. I wanted to understand how all student's interests could be reengaged, through the use of a learning garden as the main learning environment for an elementary STEM program with hopes of increasing the students' environmental literacy. As shown through

the literature review, it is beneficial to use E-STEM (environmental education, science, technology, engineering, and math) principles in a learning garden when teaching environmental literacy.

The importance of producing environmentally literate youth is becoming a priority around the world. Producing environmentally literate youth through E-STEM Garden-based learning practices will not only allow our students to become environmentally literate but also capable, aware, citizens with the skills needed to tackle today and tomorrow's problems.

There are limited resources for educators who want to begin integrating environmental education into their current STEM, or science curriculums. In this chapter, I will describe in detail a resource that will assist early elementary educators in teaching environmental literacy using a garden-based learning environment and E-STEM (environmental education, science, technology, engineering, and math) principles that they can use to develop environmentally literate youth. I will discuss the project's description, the setting and audience of its implementation, the timeline for its development, and the role of assessments for the educators using this resource. These components will help to give you a complete understanding of how this project will support the development of environmentally literate youth through the use of E-STEM principles in a learning garden.

Project Description

I have designed a second grade life science STEM-based environmental education (EE) curriculum that is comprosed of ten lessons that support the Next Generation Science Standards, as well as the The Michigan Environmental Literacy Plan goals. The

lessons are intended to be delivered in a learning garden setting, but can be modified for use in a traditional indoor classroom. The lesson progression will encompass a ten week period, if delivered successively one lesson per week as designed. The standards used in the development of this environmental education curriculum are the life science, Next Generation Science Standards.

My district has recently adopted a focus on nature-based learning utilizing an existing outdoor classroom and garden area at the Developmental Kindergarten-2nd grade building, and establishing a learning garden with an outdoor learning space at the 3rd grade-5th grade building. The lessons within this curriculum aim to support this nature-based learning focus. As mentioned the lessons will address the life science standards within the Next Generation Science Standards, but are designed to be mostly delivered in an outdoor setting: a learning garden. This curriculum is based around the already established learning garden at the lower elementary building. This E-STEM based environmental education curriculum provides an opportunity for students to build upon their background knowledge gained in kindergarten and first grade and move from a simple to a more complex understanding of the life science concepts, while removing barriers, and boundaries, between content areas. The value of this second grade life science curriculum when developing environmental literacy is: revisiting topics, repeating and increasing the level of difficulty, new learning is related to previous learning, and student competence increases over time.

The development of this curriculum follows the Understanding by Design best practices. Understanding by Design (UbD) has a goal of developing and deepening students' understanding, and their ability to make meaning of the learning, and transfer, or

apply, their new learning (Wiggins, 2011). Within the Understanding by Design practices understanding is realized when educators see that students can transfer their learning in an authentic way, and teachers act as coaches focusing on learning, not teaching the content (Wiggins, 2011).

During the design process, I took into account the progreession of The Michigan Environmental Literacy Plan goals and the Next Generation Science Standards to provide the maxium level of support for all learners moving forward. The curriculum also references the Next Generation Engineering Design Standards, Common Core Math Standards, Michigan Integrated Technology Competencies for Students, and the American Society for Engineering Education's Habits of Mind. The curriculum allows for flexibility based on what the students have been taught in previous grades, as well as what they will learn in future grades.

NGSS Life Science Grade-level Progression (Read the Standards, 2022)

Kindergarten

- Use observations to describe patterns of what plants and animals (including humans) need to survive.
- Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
- Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.
- Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

First Grade

- Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
- Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
- Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

Second Grade

- Plan and conduct an investigation to determine if plants need sunlight and water to grow.
- Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

- Make observations of plants and animals to compare the diversity of life in different habitats

Third Grade

- Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
- Construct an argument that some animals form groups that help members survive.
- 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.
- Use evidence to support the explanation that traits can be influenced by the environment.
- Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
- 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.
- 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.
- 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. *

Fourth Grade

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

Fifth Grade

- Support an argument that plants get the materials they need for growth chiefly from air and water.
- Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

(Read the Standards, 2022)

The Michigan Environmental Literacy Plan

Goal 1: Ensure students know and understand the systems of the natural world and the interactions between the living and nonliving components of the environment, including human interactions, which are fundamental to environmental literacy.
Goal 2: Ensure that students have hands-on and field experiences, outdoor play time (both structured and unstructured), and service learning opportunities that lead to environmental literacy.
Goal 3: Ensure students understand the actions that lead to natural resource stewardship, know the value of civic action, and have opportunities to be civically active.

(The Michigan Environmental Literacy Plan, 2015)

The curriculum will address all of the life science (Interdependent Relationships in Ecosystems Systems) areas of the second grade Next Gereration Science Standards. The structure of the curriculum includes the necessary elements to support the learning progression through the students' different levels of development and learning styles. The curriculum also includes checkpoints, and both formative and summative assessments, that allow the educator a chance to reflect on the students' progress as they move forward through the environmental education curriculum. Throughout the lessons students will be assessed through Think-Pair- Share, Garden Talks, and several different written assessments in the form of diagraming or recording within our, Our School Garden student packet. At the end of the unit, there is a summative assessment in the form of a project demonstration and student presentation that addresses all standards taught throughout the unit. The project is appropriate for use as an independent second grade life science environmental education curriculum, or as a supplement to another science curriculum.

Setting and Audience

This environmental education curriculum will be delivered during the second graders' one hour STEM block each week in both our indoor classroom and our school's outdoor learning garden. The STEM block is a required special for all DK-5 students in my district, and it allows classroom teachers an opportunity to analyze student data and plan for their small group instruction. This environmental education curriculum will serve the entire second grade student body, which consists of 125 students. Within the second grade student body this curriculum will support all students regardless of their

academic, social, or cognitive abilities, all students outside of the general education population attend specials with their assigned homeroom class.

Timeline

This capstone project was completed during the summer of 2022. Implementation of the project will begin during the spring of 2023. The planning process for this project began during GED 8400 in the spring of 2022, as the course progressed and I dove deeper into my research question, "What are the benefits of E-STEM practices in a learning garden when developing environmentally literate youth?", my project started to come together in outline form.

In June 2022 in GED 8490, I began organizing the second grade life science standards in a way that will allow me to combine them with the Michigan environmental literacy goals. Once the standards and goals were aligned, I developed a framework that outlined environmental literacy from the youngest years, through 5th grade. After this information was gathered and organized, I consolidated the information into a usable format. In July 2022, I began to design the environmental education curriculum. The final project was completed in August 2022.

The Summary

This project was designed as a tool to increase the environmental literacy of students through the use of STEM instructional practices in a learning garden. The long term goal of this project is to increase the number of students leaving elementary school who feel connected to the natural world, understand their relationship to it, and are able to use the skills they have developed to face, and hopefully prevent, the big problems of today and tomorrow: students who are environmentally literate. This will be

accomplished by combining district curricular requirements, such as Next Generation Science Standards, with The Michigan Environmental Literacy Plan's goals for K-12 students in a way that is usable by the entire second grade staff.

Throughout the process, I created a user-friendly free-standing E-STEM based environmental education curriculum that is also easily adjusted to fit other lower elementary grade levels as a supplement to other science curriculum. In the next chapter, I will discuss the outcome of this project. I will share the successes, failures, and new thinking that has come to light in its development.

CHAPTER FOUR

Reflection

Introduction

The purpose of this capstone project is to provide a second-grade E-STEM Garden-based environmental education curriculum that aligns with my research question: *What are the benefits of E-STEM practices in a learning garden when developing environmentally literate youth?* The project takes the form of an environmental education curriculum that supports the second-grade life science standards through the use of E-STEM (environmental education, science, technology, engineering, and math) practices in an outdoor learning garden.

The end goal of the project is to increase the number of students who feel connected to the natural world, understand their relationship to it, and can use the skills they have developed to face, and hopefully prevent, in the future, the big problems of today and tomorrow: environmentally literate students. It was important to me to provide a tool to other lower elementary educators that will provide the support they need to provide an environmental education opportunity to their students' whether this curriculum is used as a stand-alone tool, or as a supplement to other required standards.

Connecting people with environmental education opportunities, not only offers enriched opportunities to our students but also has the potential of exposing and influencing educators to the importance of pro-environment behaviors that can be built through the use of this curriculum. This curriculum was designed to be hands-on, project-based, and to support the E-STEM Garden-based practices. Throughout this chapter, I will be discussing myself as a researcher and writer, and what I have learned

from this capstone experience. I will then revisit my literature review by highlighting some of the major learnings that I discovered while researching: *What are the benefits of E-STEM practices in a learning garden when developing environmentally literate youth?,* and I will share some of the new connections that I made during the research writing process.

I will then discuss the limitations that I experienced and the implications of what I was learning throughout the research process. I will then go on to discuss the future projects that will be pursued to continue the development of a complete second-grade environmental education curriculum. Lastly, I will discuss the impact this project will have on the elementary education profession and how in turn it will impact the community in which I serve.

Major Learnings

Completing this capstone was a challenging journey that stretched me to my cognitive limits. The time commitment and sacrifices required were great, and it was felt by not only me, but my family, friends, and coworkers. I often doubted my abilities and had to reach out to my 'circle' for encouragement and reassurance that I could do this- I was qualified and capable. This is my first experience with writing a literature review. it was something that challenged my way of thinking and pushed my limits on how much information I could absorb and synthesize in the time allowed. The mental stress turned into physical stress toward the end. My focus, energy, mental capabilities, and sleep seemed to be distant and somedays impossible to access.

At the start of the process, I felt that I had a solid plan in place, a supportive workspace, a manageable timeline to follow, and a great list of resources to get me

started. As I dove into my initial list of resources I immediately noticed that every new resource that I studied led to two or three new resources for me to explore. It began to become overwhelming and at the same time, it was exciting being led by my resources through this spiderweb of rich environmental education research. As a result of the ever-growing list of resources, I was at times doubting that I was headed in the right direction, or that my research questions were the best question for me to be researching. Throughout the process, my question changed three different times and was further tweaked all up to the very end of the writing process. These redirections, clarifications, narrowing-ins, and tweakings eventually led me to a place of passion and pursuit. I knew, finally, that I was on the right path after many wrong turns and dead ends.

The writing process taught me the importance of organization, attention to detail, time management, and the value of friends and family who were willing to offer their time and energy to proofread my work countless times. I have never considered myself a strong writer, I have always lacked the confidence to tackle even my interest in writing children's books due to my seemingly weak spelling, and grammar abilities. So, to tackle a literature review of this level was a huge, uncomfortable, undertaking and it honestly took everything out of me. In hindsight, now that I have had some time to reflect and recover, I now feel more confident in my abilities to write a cohesive paper and to communicate effectively the knowledge that I have gained.

Lastly, I learned that not all information is good information, and not all sources need to be incorporated. My inexperience at the onset of this process made me believe that I had to include every pertinent piece of information in my paper. I began to realize about halfway through that there was good information and resources out there, and then

there were great resources and information out there. This realization helped me to stay more focused on my question: *What are the benefits of E-STEM practices in a learning garden when developing environmentally literate youth?,* it also caused me to have to go back in and take another look at what I had already completed. The writing process turned out to be a balancing act of back and forth information juggling, protecting family time, and above all maintaining my mental and physical health.

In summary, my major learnings were very personal and allowed me to see a new side of myself, one that withstood the interjection of severe academic pressures into an already full day-to-day life. Throughout the process, I became more aware of my abilities, more deeply connected to the topic and importance of environmental education, and the positive impact my work could have on others whether educators, community members, or students. After all, going out in nature was partly what got me through this capstone experience.

Revisiting the Literature Review

After completing the capstone project, there were three topics from the literature review that stood out to be most important in designing my E-STEM learning garden curriculum. The importance of sustainability in environmental education, what it means to be environmentally literate, and the importance of using E-STEM practices to help kids reach their fullest potential. These topics allowed me to understand how all of the aspects of teaching students to become more environmental literate are interconnected and support today's best practices in the classroom.

As stated in my literature review, in 2022, the United Nations Educational, Scientific, and Cultural Organization found that for environmental education to be

sustainable, students must be equipped with the necessary knowledge, skills, and attitudes to have a positive impact (Education for Sustainable Development, 2022). To obtain environmental literacy there are several key components. Those components are Ecological Knowledge, Socio-political Knowledge, Knowledge of Environmental Issues, and Environmentally Responsible Behaviors. Learning this helped me to put in perspective the depth of what it means to reach environmental literacy. It is not merely being in touch with nature, understanding the science of nature, or how humans impact nature, it has many components that all are interrelated and dependent on one another.

The literature goes further to say that environmental literacy is the understanding of the relationships between natural systems and human social systems (Barrett, G., Peles, J., & Odum, E., 1997), and while environmental education is process-based, environmental literacy is focused on outcomes. Environmental literacy is the outcome of a complete environmental education which provides learners with accurate scientific information, improved critical thinking skills, creative problem-solving skills, and improved decision making (What Is Environmental Literacy, 2020). This was very impactful, it taught me that this project, the environmental education curriculum, is an important piece to a bigger puzzle. A puzzle that needs all of the pieces to give the full picture, or understanding.

My second-grade curriculum needed to give the students a foundation on which to build, a place they could begin to understand their connections, and relationship to the natural world, and how they are a steward of the environment moving forward. Finally, the connection between environmental literacy and STEM, or E-STEM, and its role in developing environmental literate youth was bridged.

In my literature review, E-STEM practices encourage K-12 students to question, investigate, and draw their conclusions in a space that is preparing them to be independent, responsible, and motivated before leaving school (Pleasants, 2019). Allowing the students to be thinkers, to go after their answers to their questions, and to grow into confident individuals, who can solve problems and know that they can make a difference in our world. All of this makes this foundational curriculum so important, such a valuable tool in developing environmentally literate youth.

In summary, the sections of my capstone that were most beneficial in the process of completing my curriculum were understanding E-STEM practices, what environmental literacy looks like, and realizing what it takes for it to be sustainable. Many of my findings, and resources could be beneficial to elementary school teachers and throughout the research process, several free resources that support science education were found. I have included a list of these free resources within my curriculum resources as a supplement to my work.

Implications and Limitations

The conclusion that can be drawn from the use of this project is that it offers lower elementary educators an opportunity to develop the environmental literacy of their students and in turn have a possible positive impact on their environmental outlook and choices in the future. The E-STEM Garden-based practices that this curriculum encourages would allow students to explore their natural curiosities, explore their wonderings along the way, and learn how their interactions with the natural world matter through cross-curricular learning opportunities in the disciplines of science, technology, engineering, and mathematics.

Some of the limitations that come with this project are time constraints and personal interest. In Michigan, environmental education is not yet a state requirement, we (the state of Michigan) are in the beginning stages of developing environmental education standards. In today's academic environment, a general education teacher is encouraged to prioritize math and reading in the classroom, and often science (and social studies) is something that is squeezed in where, or if, it fits. For a classroom teacher to make time for this curriculum, either as a stand-alone lesson or as a supplement, I believe they must have a personal interest in the topic of environmental education. I feel that without a personal interest in the topic that the time required for the implementation of the lessons would not be a priority.

In summary, there are many positive outcomes from using this curriculum that supports lower elementary teachers in teaching environmental education through using E-STEM Garden-based practices. However, with the time restrictions in the classroom, it may not be a priority for all teachers.

Future Projects and Benefits to the Profession

In the future, I will be designing the environmental education E-STEM Garden-based curriculum to include all of the second-grade science standards that were not included in this project. The next unit will include the following:

What Do Plants Need To Survive: Plan and investigate to determine if plants need sunlight and water to grow.

Lesson 1: Water, Sun, and Soil
Lesson 2: Dark and Light (Can plants survive without light?)
Lesson 3: Designing a Greenhouse
Lesson 4: Building your Greenhouse
Lesson 5: Culmination of Learning: Present Your Greenhouse!

I hope that with this long terms project completion that the general education teachers will find that this life science E-STEM Garden-based curriculum, in addition to the completed project, will be user-friendly as a stand-alone curriculum, or used in their classrooms as a supplemental science curriculum.

The benefit this curriculum offers to the profession is as a starting point for my district, and others, to continue their path of interest toward environmental education and become an example for other districts on how to incorporate environmental education into their school, thus having a positive impact on students, community members, and possibly even make an impression on the local political figures when it comes to them supporting, and pushing forward The Michigan Environmental Literacy Plan.

In summary, making available a complete second-grade environmental education curriculum that focuses on the required life science standards and is delivered using E-STEM Garden-based learning principles, provides an opportunity for students, educators, and politicians to gain the knowledge and resources necessary to promote and pursue the development of environmental literacy. And further, they will be able to witness for themselves the benefits of E-STEM Garden-based learning while developing environmentally literate youth.

Conclusion

In this chapter, I gave a personal reflection on my journey through this capstone project. It was a journey of challenges, personal growth and development, and an increased passion and understanding of the importance of environmental education. I was able to revisit some of the literature that I studied during the research and review phase of the project, finding that the field of environmental education is deep and

systematic; It is much more than helping students develop a love of the natural world. I was able to discuss the limitations and implications of an E-STEM Garden-based learning curriculum. Lastly, this chapter provided me the opportunity to talk about future projects and how my project is beneficial to the academic community.

The goal of this project was to answer the question: *What are the benefits of E-STEM practices in a learning garden when developing environmentally literate youth?* Through my academic research, I have discovered several ways that E-STEM Garden-based learning practices help to develop a student's environmental literacy. E-STEM garden-based learning supports a student's natural curiosity, not only when it comes to nature, but also about interactions, and the impact humans have on our natural surroundings. These practices allow for students to connect, explore, and drive their thinking and learning, in turn supporting them in their growth toward working cooperatively with others to solve today's and tomorrow's environmentally based problems. Students who are given the freedom, and guidance to learn authentically, on authentic environmentally focused problems, will grow in time into environmentally literate youth.

I look forward to the many opportunities that this project will present, and the doors, or minds, that it will open. I can only hope that other educators will embrace the power of E-STEM Garden-based learning and want to share this curriculum with their students. I am so thankful to have had the opportunity to delve into this topic and to come out the other side with a stronger sense of understanding of the directions that I need to work to push Michigan in the direction of environmental education for all public school students.

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