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DEVELOPMENTALLY APPROPRIATE ENVIRONMENTAL STEM CURRICULUM FOR KINDERGARTEN AND FIRST GRADE STUDENTS

Mary Sweeney

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By

Mary K. Sweeney

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Primary Advisor: Jana Lo Bello Miller
Content Reviewer: Jennifer Eckman
Peer Editor: Kari Brant

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CHAPTER ONE

Introduction

The day the earthworm study begins is one of my favorite days each year. It begins with a classroom of twenty unsuspecting kindergarteners and a bottle of mustard water, and ends with squeals, dirty students, and a lot of earthworms. In this lesson the kindergartners are more curious, engaged, and actively learning than with any other lesson I teach all year. As an environmental science, technology, engineering, and math (E-STEM) teacher, I want to be able to teach lessons that are as engaging to the students all of the time, not just in this one lesson. I envision lessons where students use their power of observation to explore the world, interact with the environment, and start to form their own understandings of what they see and experience.

From these thoughts came my research question: *what are qualities of a developmentally appropriate environmental education curriculum for kindergarten and first grade students?* With the ultimate goal of writing engaging, developmentally appropriate curriculum for kindergarten and first grade students. This chapter focuses on describing the rationale for this study and identifying the journey, from my younger years through college, and teaching positions that have formed my views and beliefs on environmental education and led me to this topic.

Rationale

Creating a developmentally appropriate E- STEM program for kindergarten and first grade students is needed in my current position as a kindergarten through sixth grade E-STEM specialist teacher in order to fully complete a revision of the curriculum. When I was hired in 2015 the E-STEM position was the first of its kind in the school district. On their website, The North American Association for Environmental Education (NAAEE) defines E-STEM as "The integration of environmental education into STEM learning for youth" (2018). According to the US Department of Education, STEM is an interdisciplinary approach to teaching science, technology, engineering and math. The position was created based on a desire for more environmental education and STEM education in school from the parents, teachers, and administration (n.d). The goals of environmental education were first defined in the Belgrade Charter of 1976:

> The goal of environmental education is 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 commitment to work individually and collectively toward solutions of current problems and the prevention of new ones. (Biedenweg, et al., 2015)

With the task of creating a curriculum to achieve these goals, in the summer of 2015, I worked with parents and other teachers to write a scope and sequence for the E-STEM program. During this process the group reviewed current environmental curriculums, and found many that could be used in older grades, but little for kindergarten and first grade. We found curriculums for nature preschool settings, or for a homeroom

classroom setting, but none for a once (or twice) a week specialist setting for kindergarten and first grade students.

In the past four years I have worked to refine the current curriculum based on training, conferences, and classes I have participated in. For example, through a class titled Driven To Discover Citizen Science through the University of Minnesota, I was able to implement a third grade citizen science curriculum around birds. Through participation in classes at Hamline University and training with the National Park Service I have created a fourth grade curriculum that centers around water, specifically, water in the Mississippi River. While I have made significant improvements to the Environmental STEM curriculum from these training sessions, they are often targeted toward primary or middle school aged students.

Students in kindergarten and first grade have different needs, as they are considered to still be in the early childhood development stage. The NAAEE recommends developing environmental education programs for "young children from birth to age eight, with a focus of ages three to six." (2016, p. 3) Ruth Wilson describes environmental education in early childhood as one that "includes the development of a sense of wonder; appreciation for the beauty and mystery of the natural word; opportunities to experience the joy of closeness to nature; and a respect for other creatures" (Wilson as cited in NAAEE, 2016, p. 2). While this description matches my beginning lesson on earthworms, it does not fit the rest of the kindergarten and first grade curriculum. A developmentally appropriate curriculum will work toward the ultimate goals of environmental education and complete the revision of the current

curriculum. My research will focus on: what are qualities of a developmentally appropriate environmental education curriculum for kindergarten and first grade students?

Historical Context

Early Years

From a young age I knew I wanted to be a teacher. I am from a family of teachers, my mother and many aunts and cousins are teachers. At school, I was often seen as a teacher's pet because I was always the student that wanted to help, and would try to emulate my teachers. When I graduated from high school and enrolled in college it was with the single minded purpose of becoming an elementary teacher. I went to school at Bemidji State University (BSU) in Bemidji, Minnesota. BSU was known for being a teacher's college and had the added benefit of being the alma mater of both of my parents. Bemidji is a small town in north central Minnesota that prides itself on its outdoor activities: hiking, fishing, snowmobiling, outdoor hockey, etc . The school is beautifully situated right on Lake Bemidji, and there were plentiful environmental education opportunities for students. It was through these outdoor environmental educational experiences that my passion for the outdoors began, and guided my future career path.

Outdoor Education

After my second year at BSU I went to work at a Girl Scout camp in northern Wisconsin. I believed this would combine my new excitement for the outdoors, and

give me experiences that I could apply to my teaching, little did I know how much this experience would transform my life. In my eight years as a camp counselor for the Girl Scouts I learned how to build a campfire, pitch a tent, kayak, canoe, create a hiking trail, and outdoor survival skills. I also learned about the birds, trees, animals, and plants that inhabit the forests of northern Wisconsin, and how they all live together in a delicate balance. I learned both about teaching, and about myself as a teacher. I learned about how kids create their own understanding of the world and the importance of play. Most importantly, the experience of being a camp counselor taught me about what kind of teacher I wanted to be and that I needed to instill in my students a love and appreciation for the environment.

Teaching Positions

The first teaching position I accepted was as a first grade teacher in Richfield, Minnesota. The school was a kindergarten through sixth grade school with a high Latinx population. As a teacher there I was required to teach the standards set by the state of Minnesota through a strict adherence to the designated curriculum. While I enjoyed teaching first grade, it was hard to fit environmental education into a school that allowed few changes to the curriculum. Most of my environmental work came in the form of afterschool activities, and supplemental field trips for students.

While I was at the charter school, I was accepted as a National Park Service teacher ranger in the Mississippi River Park and Rec Area, which allowed me to learn about the Mississippi River and environmental programs around the Twin Cities area. Part of the requirements of this position was that I bring what I learned as a teacher

ranger to the students at the school, which meant I was able to design some curriculum to include environmental programs at the charter school. For example, I brought the *Big River Journey* curriculum and field trip as designed by the National Park Service to the fourth grade program. While working at the charter school I also created a program to take fifteen fifth grade girls to girl scout camp for three days during the summer. Both of these programs allowed me to grow in both the teaching profession, and as an environmental educator.

After nine years I left the charter school to accept a position as a second grade teacher in an elementary school in South St. Paul with the hope of having more flexibility with the curriculum in order to include more environmental education. It was at this school that I struggled the most with classroom behavior, who I am as a teacher, and how I teach. After two long years here, I was burned out from teaching and, for the first time ever, questioned my chosen profession.

Current Teaching Position

When applying for jobs in the Twin Cities metro area, I noticed a listing for my current position in Roseville, a kindergarten through sixth grade E-STEM specialist teacher. This newly created position appeared to meld both things I loved, environmental education and teaching in an elementary setting. When I was offered the position I was both overjoyed and overwhelmed. Being an E-STEM specialist teacher has allowed me to meld both passions, environmental education and teaching. After a year teaching in this position, I knew I needed to go back to school for a masters degree in environmental education, and was excited to begin the Masters of Education: Natural

Science and Environmental Education at Hamline University. I knew this program would give me the education to create the best E-STEM program based on current research and best practice.

Summary

My journey through college, camp, and first years teaching have shaped and refined my passions for both teaching and environmental education. My current E-STEM specialist teacher position has allowed me to express both of those passions every day. In order to instill a sense of wonder, joy, and love for the environment I need to design a developmentally appropriate curriculum for all students. In the past five years, I have accomplished that for second through sixth grade. In chapter two, I report on the current research around: *what are qualities of a developmentally appropriate environmental education curriculum for kindergarten and first grade students?* In chapter three I outline a curriculum development plan for kindergarten and first grade students to teach in an E-STEM specialist program. In chapter four, I reflect on the process and inform on my next steps for implementation.

CHAPTER TWO

Review of the Literature

Introduction

When I think of effective lessons with students, they are lessons where students were engaged and asked questions during the lesson. Most importantly though, they were lessons that students talked about over and over again, lessons that they still remember two or three years later. When this happens, teachers know they have made an impact in students' lives. This kind of teaching comes from having knowledge of the developmental needs of the students, or teaching in a way that allows the student to build on what they already know. In order to build an environmental science, technology, engineering and math (E-STEM) curriculum for kindergarten and first grade students I need to fully understand the answer to the question: *what are qualities of a developmentally appropriate environmental education curriculum for kindergarten and first grade students?*

When looking for a curriculum that fit the E-STEM model my school uses, I struggled to find relevant curriculum for the kindergarten and first grade years. There is ample curricula for fully immersive nature preschool programs, and curricula for the typical elementary homeroom classroom, and for students in third grade and above, but little for a separate specialist classroom that students attend once or twice a week

throughout their kindergarten and first grade year. The need for this type of programming led my desire to write a developmentally appropriate curriculum for students.

This chapter will lay out the research on three important components that make up the answer to my question; developmental characteristics of children ages five through seven, environmental education and its purposes, and how to combine these to create developmentally appropriate practices for early childhood students in environmental education.

A child's development includes their physical development, including gross and fine motor skills, social and emotional development, and cognitive development. In order to get a complete look at cognitive development it is helpful to understand their language abilities and mathematical and spatial abilities. Based on the developmental abilities of students, each section discusses best practices for teachers to follow that allow students to have the most success in school.

The second section of this chapter focuses on environmental education. It gives a background for environmental education and an understanding of the purposes and goals of environmental education. It links the area of environmental education with environmental science, technology, engineering, and math (E-STEM), and reviews aspects of quality environmental education curriculum being taught in schools.

Child Development

Background

Expert teachers understand the developmental stages of children, and how to help students continue to advance their skills. In their position statement on developmentally appropriate practice, the National Association for the Education of Young Children (NAEYC) indicates that teacher knowledge of student developmental abilities and stages is important for effective education in schools (Copple & Bredekamp, 2009). Teachers with an understanding of childhood development are more likely to make decisions and use teaching practices that help students understand and retain content and reduce behavior struggles (Oltman, 2002). They also can reduce the achievement gap and help students increase their emotional competence (Copple & Bredekamp, 2009). In addition, young children, children under age eight, are different from older children and adults, and need to be taught in a different way (Oltman, 2002). It is important to note that childhood development is not the same for every student. It varies both on the environment they come from and their heredity (Copple & Bredekamp, 2009; Miller, 2001; Pulaski 1980). Not all students will arrive at each stage at the same time, this chapter will focus on typical developmental growth of children ages five through seven.

Anthropologists have found patterns across multiple cultures that show around the age of six children are given more responsibility at home and formal education begins (Sameroff & McDonough, 1994). In 1965, Sheldon White created the term "five to seven shift" to describe this phenomena and the physical, social and emotional, and cognitive developmental changes that occur in students around the age of five through age seven (Sameroff & McDonough, 1994). The "five to seven shift" is a time when students shift from knowing what they see, to understanding the world around them; they

shift from a singular worldview, to understanding multiple perspectives; and from seeing a single dimension to multiple dimensions (Sameroff & McDonough, 1994). It is also a time when their moral development shifts from being based on adult rules and expectations to societal norms (Sameroff & McDonough, 1994).

While the five to seven shift has been noticed across cultures, it is important to note that culture does affect children's development (Huang, 2018). Child development is a process that is unique to each child and dependent upon their interactions with their environment (Huang, 2018). All cultures encourage some behaviors over others, this can change the way children think and develop. One example of this can be seen in children's view of their own identity. In Westeren European and North American countries personal needs and attributes are emphasised over societal needs. This changes the way children view themselves, their self view is of their own strengths (Huang, 2018). In cultures where societal needs are emphasised over personal needs, Southern European, and African, children view themselves in relation to others, "I am a brother" instead of "I am smart" (Huang, 2018). The culture a child is brought up in can impact all areas of childhood development.

Physical Development

Physical development pertains to what children's bodies can do. It includes both gross motor, or large movements, and fine motor, or smaller movements (Copple & Bredekamp, 2009).

Gross Motor. Physically the bodies of five to seven year old children are more coordinated in their movements, and more aware of their body parts, than those of earlier

years (Copple & Bredekamp, 2009). Children at this age have more control over their bodies, and they like to challenge themselves to find and test limits of their own bodies (Miller, 2001). This includes showing off their new skills, "watch me!" is often uttered by many children at this age (Miller, 2001). At this age learning to cartwheel, skip, climb trees, and skate are all typical skills. Children have a high need for movement and may get more tired by sitting for a long time than by movement (Copple & Bredekamp).

At ages five through seven the size of boys and girls are relatively the same and have the same amount of muscle mass. Through age seven boys and girls typically have the same rate of motor development, when given the same growing environment (Copple & Bredekamp, 2009).

Children at this age are often competitive, however it is important to encourage students to continually improve, not to be competitive with their peers. (Miller 2001; Copple & Bredekamp, 2009). Especially in kindergarten, students are not yet ready for organized sports, they become too competitive and overwhelming. Toward the end of first grade, or seven to eight years of age, students become more ready for organized sports as they have more physical endurance and are more socially mature (Copple & Bredekamp, 2009).

Fine Motor. Fine motor skills greatly improve for students ages five through seven. In kindergarten they may initially struggle with skills like cutting, grasping a pencil, and stringing beats, and tying shoes. By the end of first grade they are mostly able to master these skills with practice (Copple & Bredekamp, 2009). Right and left handedness has been established by now, and when they draw, their pictures are more

recognizable as what they are intended to be (Miller, 2001). Children's eyesight may not be fully developed at this age however, nearsightedness or farsightedness necessitates the need for a large print text (Copple & Bredekamp, 2009). They are still developing their visual tracking skills and may need a finger to follow text (Wood, 2007).

Teaching Strategies. There are many teaching strategies that can encourage both gross motor and fine motor physical development. The most widely promoted is play based learning (Copple & Bredekamp, 2009; Oltman, 2002). This includes both open ended, free play and teacher directed or structured play. In play based learning students use their whole body to explore and learn new skills. With teacher structured play, students are better able to learn and refine new skills. (Copple & Bredekamp, 2009). Within offering structured play, teachers are encouraged to provide a variety of opportunities to practice a task. This variety of tasks allows students to choose their activity, which increase their motivation to continue learning(Copple and Bredekamp, 2009).

Some strategies for developmentally appropriate practices are more simple. Including large print text, and paper with space for larger handwriting is one of those practices (Miller, 2001). Other ideas include ensuring all students have access to materials to practice at the same time (Copple & Bredekamp 2009). Including manipulatives and hands on experimentation whenever possible can greatly enhance physical development (Oltman, 2002). These strategies are in effect, small changes a teacher can make, that can have a large impact on student understanding.

Another strategy presented is to alternate gross motor skill based practice with fine motor skill practice to enhance all skills (Copple & Bredekamp, 2009). For example, if children need to practice hand and eye coordination, they can practice first by bouncing a ball for a period of time, a gross motor skill, and then practice cutting with scissors, a fine motor skill. By moving from a gross motor skill to a fine motor skill students are able to recover if exhausted, and able to focus better at each task (Copple & Bredekamp, 2009).

Ensuring that teacher scaffold skills for students so they do not become discouraged is also helpful in promoting physical development (Copple & Bredekamp, 2009). Students at this age can become discouraged easily when learning new skills. By scaffolding, or breaking down the skills into smaller pieces, students can find success more quickly. This will then help motivate them to continue learning the entire skill (Copple & Bredekamp, 2009).

Social and Emotional Development

When I think of kindergartners and first graders, I tend to think of generally happy, very social, and curious students. The research into social and emotional development of students in kindergarten and first grade agrees with those observations (Miller, 2001; Wood, 2007). Social and emotional skills allow people to create and keep relationships with others, manage and process emotions, and regulate behaviors (Copple & Bredekamp, 2009). Regulating behaviors means students aged five through seven are required to "delay, defer, and accept substitutions for their preferred goals without becoming aggressive or overly frustrated" (Copple & Bredekamp, 2009 p.192)

Social Development. Social development is defined by Copple and Bredekamp as the "ability to form and sustain relationships with others" (2009, p.192). When discussing social development, educators refer to the skills children have that help them to form positive relationships. Copple and Bredekamp call these prosocial behaviors. Things like working well with other students, solving problems, following classroom rules are all examples of prosocial behaviors (Copple & Bredekamp, 2009)

Children in kindergarten and first grade form friendships that are based on mutual interest, unlike younger students who will play with most anyone (Miller 2001). They tend to choose children that are the same gender and come from homes that look like theirs (Copple & Bredekamp, 2009). When playing with friends they participate in cooperative play, rather than parallel play. This means they play together towards one goal, instead of next to each other with their own goal (Copple & Bredekamp, 2009). Students at this age are searching for places to belong, and tend to form clubs and groups with their shared interests (Miller, 2001). These clubs, however, can exclude others, and often cause conflicts between friends (Miller, 2001). Overall, students at this age want to have friends, and are able to work to create and maintain friendships.

Children at this age are egocentric. They think that everything and everyone feels as they do (Pulaski, 1980; Oltman, 2002). Child psychologist Jean Piaget explains egocentrism as the child being the center of their own world, and everything exists for and because of them (Pulaski, 1980). They believe things such as the moon follows them when they ride in the car, or they can change the stoplight by snapping their fingers (Pulaski, 1980). This egocentrism also means they are unable to see perspectives other

than their own (Pulaski, 1980). This can become a problem in school when students have disagreements. Students are unable to distinguish between accidents and intentional acts because they only understand their own perspective (Oltman, 2002).

One of the most apparent social and emotional characteristics of children at this age is their black and white thinking, they are very literal (Miller, 2001; Wood 2007; Copple & Bredekamp, 2009; Pulaski, 1980) In school, this becomes apparent with students' ideas on equality and fairness (Oltman, 2002). Children at this age are very dependent on expectations and rules, and see any breach of those rules as very bad (Miller, 2001). The over abundance of tattling at this age is a result of this literal thinking. It also causes students to struggle to accept responsibility for their behavior. They feel that if they did something bad, they must be bad (Miller, 2001).

In their article on the "five to seven shift" Sameroff and McDonough (1994) argue that students must hit a certain social and emotional development stage to be ready for the cognitive tasks necessary for school (1994). They note that one characteristic of the shift is a change in the child's self concept. At earlier ages, a child's self concept is more about what they can do or like, for example "I can kick" or "I like honey." By age seven self concept switches to be more about who they are "I am smart" or "I am a good person" (Sameroff & McDonough, 1994; Copple & Bredekamp, 2009).

Children's self concept is also more dependent upon adult feedback at this age. Students are sensitive to adult feedback and tend to internalize it more than in previous years (Copple & Bredekamp, 2009). If adults in the child's life focus on positive reinforcement students tend to have more prosocial behaviors, if the adults give negative

feedback, students can become anxious or show low motivation (Copple & Bredekamp, 2009). In his work on psychosocial stages, Erik Erikson refers to this stage as the initiative vs. guilt stage (Cohen, 2016). When students set goals and try to reach them, it is the reactions from adults that cause them to feel successful or feel guilty about their behavior.

Emotional Development. Emotions guide behavior and learning for all people, regardless of age. Children ages five through seven are becoming better at reading the emotions of others and controlling their own emotions (Copple & Bredekamp, 2009). For children at this age, emotions are their guiding force. They are unable to infer what others might think, but can show compassion and empathy when they recognize their own emotions in someone else (Copple & Bredekamp, 2009). They are also able to feel conflicting emotions at the same time. Copple and Bredekamp give the example of "I like Sophie, but I don't like the way she is bossy sometimes" (2009, p.268). As students exit this stage, with modeling and instruction from adults, they are better able to consider the feelings of others (Copple & Bredekamp, 2009)

Students at this age are just beginning to enter Erik Erikson's psychosocial stage of industry vs inferiority (Cohen, 2016). They need to feel that what they do is necessary and important, or feel industrious. If they do not feel important, they will feel as if they do not belong or are wrong, inferior. (Cohen, 2016) They strive to become proficient at adult skills, and when successful, increases their sense of accomplishment and competence. Erikson indicates this dedication to accomplish adult tasks is just as

powerful to a kindergartener as the urge to walk is to a baby (Copple and Bredekamp, 2009).

Another major aspect of emotional development is self regulation, the ability to manage one's own emotions and behaviors (Copple and Bredekamp, 2009). Self regulation is improved over earlier stages and continues to improve. Children's reliance on adult rules and boundaries determine acceptable and unacceptable behaviors for students (Copple & Bredekamp, 2009). As students learn what is acceptable, they can improve self regulation with visual reminders and scaffolded lessons on self regulation strategies (Copple & Bredekamp, 2009).

Teaching Strategies. In their book on developmentally appropriate practice, Copple and Bredekamp (2009) indicate one of the most effective teaching strategies for teaching social and emotional skills is to model pro social behaviors for students. The warm, caring, understanding, and friendly actions of the teacher can teach students social and emotional skills needed to be successful (Copple & Bredekamp, 2009). In addition, if lessons teach specific skills, and scaffold these skills for students, children are more likely to show success with prosocial skills (Copple & Bredekamp, 2009). In addition, teachers that focus on positive feedback and praise effort strengthen prosocial behaviors (Copple & Bredekamp, 2009).

Jean Piaget notes that play based learning is another way to enhance social and emotional skills in students. Through play based learning, students can understand things that are unknown or scary to them (Pulaski, 1980). Piaget discusses two different kinds of play, therapy play and compensatory play. Therapy play is play where a child recreates

an unpleasant experience they had. Compensatory play is play where children imagine fictional characters breaking the rules (Pulaski, 1980). Through both of these types of play children imagine situations and work through the consequences of those situations to begin to better understand society and their own emotions (Pulaski, 1980).

Dramatic play is another strategy which allows students to enhance their social and emotional skills, particularly, their self regulation skills (Copple & Bredekamp, 2009). Dramatic play is child directed, make believe, free play. Through dramatic play children plan, assign roles, and follow agreed upon scripts. The ability to accomplish successful dramatic play with friends requires students to use their self regulation skills (Copple & Bredekamp 2009; Miller, 2001). Dramatic play also allows students to exercise flexible thinking, changing or expanding of ideas, when other children bring different ideas to a story (Miller, 2001).

Cognitive Development

Changes in their brain allow students in kindergarten and first grade to be better able to sort and categorize, problem solve, focus attention and memorize information than their younger peers (Copple & Bredekamp 2009). The brain grows up to 90% of its eventual weight at this age, and is being reshaped and refined which allows for flexibility of thought, faster processing, and more systematic and organized thought patterns. (Copple & Bredekamp, 2009). Children are beginning to engage in metacognition, or thinking about thinking (Copple & Bredekamp, 2009).

As they learn about the world, they are now able to categorize and group new information. For example, when shopping they know they will not buy a shirt in the

grocery store, but they will find milk (Copple & Bredekamp, 2001). Towards the age of seven, they are more able to hold two or more qualities in their brain at one time, for example the ball is both red and round, or the cup is tall and thin (Pulaski, 1980). Categorizing, grouping, and sorting are all appropriate activities students at this age (Miller, 2001).

Children's increasing ability for flexible thinking allows them to become better at problem solving. Because they are able to think about more than one piece of information at one time, they can devise new strategies to solve a problem (Copple & Bredekamp, 2009) For example, they can build a tower many different ways, or explain two different ways to sort a group of objects (Copple & Bredekamp, 2009; Miller 2001). They are also better able to understand and think about cause and effect beginning in kindergarten (Miller, 2001) Teachers are often exhausted by a child's repeated use of the "what if" question at this stage in development.

Children's ability to focus their attention and memorize information also increases. At age five through seven children can work for fifteen to twenty minutes on a single task, sometimes more if self chosen (Copple & Bredekamp, 2009). This ability to focus is a large part in why students enter formal schooling at this age (Sameroff & McDonough, 1994). Students at this age are getting better at deciding which information is important and which is not, however they will continue to struggle with this without teacher support (Copple & Bredekamp, 2009). This ability to focus for longer periods also leads to better memorization skills. Students are able to use memory strategies such

as grouping or creating a mental picture with teacher support (Copple & Bredekamp, 2009).

Language becomes a tool for memory and thinking during the "five to seven shift" (Sameroff and McDonough, 1994). With the advancement in language and sequencing skills, stories and experiences are repeated and cemented into memory more easily (Sameroff and McDonough, 1994). Students enjoy playing with language through rhythms and rhyme as do their younger peers, however they have a better sense of the sounds in a language, features of language (words, sentences, etc), and structures of texts (Copple & Bredekamp, 2009). They are more precise in their descriptions of events and ideas and their vocabulary expands rapidly (Copple & Bredekamp, 2009). Children also have a greater capacity to become bilingual at this age, and if they are bilingual they will have better linguistic skills in their home language, and perform better on cognitive tasks (Copple & Bredekamp, 2009).

When it comes to mathematical thought, children aged five through seven are able to apply visual and spatial strategies and mental images to solve problems (Copple & Bredekamp, 2009) Because they can hold more information in their head, sequencing tasks improve (Miller, 2001). Their better understanding of the past, present, future allow them to plan and carry out a sequence of events (Miller, 2001). They now can understand basic one to one correspondence, part and whole, and order smaller numbers (Copple & Bredekamp 2009). Students at this age are not able to understand abstract concepts, so concrete tasks or hands-on activities are necessary for learning (Miller, 2001).

Teaching Strategies. Scaffolding, physical movement, questioning, and concrete concepts are all teaching strategies that support the cognitive development of children in kindergarten and first grade. Scaffolding is when the teacher breaks down skills into smaller pieces and offers multiple practice opportunities during the lessons. This is also sometimes referred to as guidance and support (Copple & Bredekamp, 2009). By breaking down skills into smaller pieces and guiding students through multiple practice opportunities children are more likely to be successful at cognitive tasks (Copple & Bredekamp, 2001).

Children at this age have a high need for physical movement, and learn cognitive tasks better when they include movement (Miller, 2001). Using manipulatives, acting out stories, and repetitive movements are all effective strategies that are appropriate for their cognitive development (Miller, 2001).

Another strategy appropriate for kindergarten and first grade students is asking higher level questions (Copple & Bredekamp, 2001) As students develop their own reason and understandings, they may be wrong, and refuse to change their ideas. Asking higher level questions that challenge their assumptions increases flexible thinking, and helps them come to the correct conclusions (Copple & Bredekamp, 2009). Higher order questions can also help students to reflect on their learning, make additional connections to previous learning, and solve problems (Copple & Bredekamp, 2009).

Teachers should ensure that they teach concrete concepts that are relevant to daily life, or connected to previous learning (Miller, 2001). They can also use strategies such as giving choices, making lists, categorizing, sorting, or guided dramatic play (Miller

2001). In kindergarten and first grade students do not learn from worksheets. They can sometimes reinforce skills already learned, but worksheets are often too abstract for new learning and inhibit creativity (Miller, 2001). Sorting, scavenger hunts, matching activities are all effective alternatives to worksheets (Miller, 2001).

Summary. To answer the question, *what are qualities of developmentally appropriate environmental education curriculum for students ages five through seven?* I need to understand the developmental level and needs of students at that age, and how to use this information to write a curriculum that allows students to grow and succeed. Taking into account their physical development it will be imperative that I create a curriculum where students have a chance to move. Children who are not able to sit for extended periods of time, learn best through movements (Copple & Bredekamp, 2001). The movement should both allow students to refine their fine motor skills, and explore various gross motor skills.

When considering the child's social and emotional development I need to ensure that I give ample opportunities for play, both guided and free play. Through free play students are able to express their emotions, and practice self regulation skills (Miller, 2001). Copple and Bredekamp (2001) also emphasise the importance of a kind, caring, and supportive teacher in a student's social and emotional level growth. By modeling prosocial behaviors in the classroom, students are more likely to learn them.

When considering the child's cognitive development I need to make sure that I allow time for choice in activities, teach concrete concepts, and use higher level questions (Copple & Bredekamp, 2001). Students aged five through seven are creating their own

understanding of the world based on what they already know (Pulaski, 1980). By using these strategies I can ensure that students have success.

Multiple Intelligences

In addition to developmentally appropriate practice, another framework for guiding teaching decisions can come from multiple intelligences theory. In 1983, Dr. Howard Gardner described his ideas of multiple intelligences. He argues that all people are intelligent in different ways, and outlined eight different intelligences (Campbell, et. al, 2004). They are logical-mathematical, linguistic, bodily kinesthetic, musical, interpersonal, intrapersonal, spatial, and naturalist (Campbell et al., 2004). While all students have some intelligence in all of the areas, many students have one or more that outshines the other (Campbell et al., 2004). Creating activities that support all intelligences improves student learning and provides a more accurate understanding of student learning (Edutopia, 2016).

It is important when thinking about multiple intelligences not to confuse them with learning styles. Multiple intelligences represent different ways we process information, or our different intellectual abilities. Learning styles, in contrast, are the "ways in which an individual approaches a range of tasks." (Edutopia, 2016). These include kinesthetic, visual, auditory, among others (Edutopia, 2016). One person with a strong naturalist intelligence may be an auditory learner, learn best from hearing and speaking information; while another may be a kinesthetic learner, and learn best by using their senses to learn.

Teaching that enhances multiple intelligences could include various activities that allow students to show their understanding in different ways. Activities that require students to act things out, or sing a song support musical or linguistic intelligences. Play supports many different intelligences based on the student play. Activities that require students to sort, sequence, and draw support logical mathematical and spatial intelligences. Activities that draw from the natural world, or use natural items to explain phenomena support the naturalist intelligence. The important part is to provide all students with opportunities to show their understanding in a way they feel successful. While not specifically labelled developmentally appropriate, teaching using multiple intelligences is a framework to ensure a developmentally appropriate curriculum.

Environmental Education

Background

Environmental education as we now know it got its start in the early 1900's (Biedenweg, et. al, 2015). It has included many names, nature study, conservation education, and outdoor education to name a few ((Biedenweg, et. al, 2015). In 1970, members of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Union for Conservation of Nature (IUCN) defined environmental education as:

> The process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture, and his biophysical surroundings. Environmental

> education also entails practice in decision-making and self formulation of a code of behaviour about issues concerning environmental quality. (Biedenweg, et. al, 2015 p. 13)

With this formal definition, the idea of creating goals, objectives, and professional development curricula for environmental education started to take shape. In 1977, the first official international conference on environmental education was held in Tbilisi (Biedenweg, et. al, 2015). This conference further defined the goals and objectives for environmental education. The goals of environmental education set in the Tbilisi Declaration are:

- To foster awareness and concern about economic, social, political, and ecological interdependence in urban and rural areas;
- to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
- to create new patterns of behavior of individuals, groups, and society as a whole toward the environment. (Biedenweg, et. al, 2015, p. 15)

The ideas set forth by both the definition and the goals of environmental education changed the idea of environmental education from a set of topics, like forests and waterways, to sets of skills that allow people to analyze and interpret information to make their own decisions on how to best understand impacts on the environment (Biedenweg, et. al, 2015). The goals from the Tbilisi Declaration are now known as environmental literacy, the ability to have enough knowledge about the environment, and awareness of

things that impact the environment in order to change behavior into more environmentally sustainable practices (Biedenweg, et. al, 2015).

From the goals and objectives set in the Tbilisi Declaration the North American Association for Environmental Education (NAAEE) set essential themes for early childhood environmental education. These themes are systems, interdependence, importance of where one lives, integration with other subjects, roots in the real world, and lifelong learning (NAAEE, 2016). These themes should be central to any environmental education curriculum.

The goals of environmental education set the goals of any curriculum written for an Environmental Science, Technology Engineering, and Math (E-STEM). According to the NAAEE, E-STEM curriculum "engage individuals in the environment as a means to explore concepts in traditional STEM disciplines" (Fraser, Gupta, Flinner, Rank, & Ardalan, 2013). E-STEM then focuses on developing environmental literacy through engaging in science, engineering, technology and math (STEM) concepts.

Early Childhood Environmental Education

In its *Guidelines for Excellence: Early Childhood Environmental Education Programs* the NAAEE identifies four key characteristics of quality early childhood environmental education programs. The second characteristic outlines requirements for developmentally appropriate practices (2016). Four guidelines are then set to support developmentally appropriate practice, based on research and theory, child directed and inquiry base, whole child, and authentic experiences.

Based on Research and Theory. Included in this guideline by the NAAEE is a requirement to understand various theorists' approach to developmentally appropriate practice (NAAEE, 2016). This would mean understanding Piaget, Erickson, Gardener among others already discussed earlier in this chapter (NAAEE, 2016). One common developmentally appropriate practice among the theorists is play.

In their study of play, Australian researchers Amy Cutter- Mackenzie and Susan Edwards define three different kinds of play in early childhood classrooms: modeled play, open ended play and purposefully framed play (2013). Modeled play is play in which the teacher models and explains how to use the materials and demonstrates the concepts before students are allowed to practice through play (Cutter-Mackenzie & Edwards, 2013). This type of play is the most teacher centered, in that the teacher is leading an activity and the students are following the guidance of the teacher. This type of play allows students to experience a topic, but does not always lead to conceptual understanding (Cutter-Mackenzie & Edwards, 2013).

Open ended play is defined as play where students have no instruction or modeling of how to use materials, they create their own stories and ways to use materials (Cutter-Mackenzie & Edwards, 2013). This type of play could start with a question for students to explore through the materials, or could be free play. This type of play is the most child centered, in that children are setting both the directions and storyline during their play. Cutter-Mackenzine and Edwards note that when asked to reflect on their learning through open ended play, children often do not understand that they learned anything, they were “just playing” (2013).

The last type of play is purposeful play. This type of play has parts of both of the other two types of play. After exploring the materials on their own, students are given some explanation and modeling on the use of materials, and some instruction on a possible storyline and then allowed to play independently again (Cutter-Mackenzie & Edwards, 2013). It is this type of play that children are both able to understand the concept being taught, and the goal of the activity (Cutter-Mackenzie & Edwards, 2013).

Another idea echoed by many different theorists on developmentally appropriate practice is the idea that students need positive experiences and a warm caring classroom environment as part of a successful environmental education program (NAAEE, 2016; Torquati, Gabriel, Jones-Branch, Leeper-Miller, 2010; Wilson, 1997). Without positive experiences in nature children can develop fear of nature, which interferes with development of environmental literacy (Wilson, 1997). Through a warm and caring classroom children feel more secure in taking risks and trying new experiences (Torquati et al, 2010).

Child Directed and Inquiry Based. The next key characteristic of quality early childhood environmental education is in teaching child-directed or inquiry based curriculum. This means that teachers are observing children and using the child's interest to guide the curriculum (NAAEE, 2016). This also includes using open-ended activity choices throughout the day, so students are able to direct their own learning (NAAEE, 2016).

One example of open ended choice activities was given in an article about engaging children as researchers by Carie Green (2017). In the article, Green allows

students to explore a forested area, and through observations discovers four topics students are interested in. She then allows students to explore their topic through four separate open ended activities. One is an art activity, where students use common art medium, crayons, markers, pencils, to create an image of something they studied or learned. Another activity is role playing, where adults and children work together to act out learning directed by both the adult and the children. A third activity was building a model of their learning using natural materials. The last activity was annotating pictures of themselves to create a page in a collective book (Green, 2017). These four activities address all subjects, and allow students to show their learning using multiple types of intelligence. They were open ended, in that children could participate in each station for as long as they wanted or needed, including repeating stations, or skipping others (Green, 2017). Overall, the open ended choice activities allowed students to create nature connections, and increase their environmental literacy in a child-centered way (Green, 2017).

In 1995, Deborah Stipek, Rachelle Feiler, Denise Daniels, and Sharon Milburn looked at the effects of different instructional models. They studied the effect of child-centered or constructivist models of early childhood and compared them to teacher directed, didactic instruction (Stipek, et al. 1995). In their results, they mention that students from child-centered instruction lead to better perceptions of ability, more children expecting to succeed, less dependency of a teacher, more pride in their accomplishments, and lower anxiety (Stipek, et al, 1995). While teacher centered, or

didactic approaches only lead to better performance on reading and letter recognition (Stipek et al, 1995).

Whole Child. Another characteristic of developmentally appropriate practice outlined by the NAAEE is teaching toward the whole child (NAAEE, 2016). In teaching toward the whole child teachers balance the need for free exploration, with structure and planned activities (NAAEE, 2016). Free exploration in the forest allows students time to connect with nature, experience the quiet and peace of the forest, and to see its beauty (Barrable, 2019; Wilson 1997).

In their article on play based learning, Cutter-Mackenzie and Edwards (2013) note that spending time in the outdoors does not necessarily lead to environmental literacy. It takes more than just time outside for students to have pro-environmental behaviors. The role of the teacher is to connect children's experiences with the environment to experiences in the classroom that can further their knowledge about the environment.

When teaching students, it is impossible to ignore children's attraction to technology. It is also argued that in order to be successful in the workplace, students need to be fluent in the digital world (Willis, et al., 2013). In teaching toward the whole child, educators can include technology in environmental education (Willis et al., 2013). For children from higher income households, this access to technology will easily come from their own home while students from lower income homes rely on school to provide the technological experiences (Willis et al., 2013). The best use of technology allows students to enhance classroom and nature experiences, not replace classroom or nature experiences (Willis et. al, 2013). Some examples of ways to include technology include

observing webcams of wildlife, GPS devices for geocaching, cameras for taking nature pictures, and online citizen science databases (Willis et al. 2013).

Authentic Experiences. A third characteristic of quality early childhood environmental education programs is authentic experiences (NAAEE, 2016). Outdoor learning must take place in the area that the students live, not talked about as some other place (Wilson, 1997; Torquati et al., 2010) Nature is local, which makes it concrete for students, a requirement for their cognitive development. Exposure to their outdoor space should be ongoing and regular (Barrable, 2019).

Authentic experiences mean children use all of their senses, they have opportunities for immersion in the natural environment (Wilson, 1997). In allowing students to use all senses, touch, smell, hear, taste and sight, teachers are teaching both children's physical development needs and their cognitive development needs (Wilson, 1997). Sensory tables filled with water, soil, sticks, leaves, plants, etc allow students to play and experiment with nature (Oltman, 2002). Bringing the outdoors inside also allows students to fully immerse in the environment, and blurs the lines between the classroom and the outdoors (Oltman, 2002; Torquati, Gabriel, Jones-Branch, Leeper-Miller, 2010)

One important aspect of environmental literacy is teaching students the skills needed to protect the environment, and that they have a responsibility to help keep the environment healthy (NAAEE, 2016). Another name for this is environmental stewardship. When children participate in environmental stewardship projects, projects that allow students to actively improve environmental quality, they are more likely to develop those behaviors as adults (Blanchard & Buchanan, 2011). Some examples of

these types of projects include cleaning up trash, cleaning out storm drains, building wildlife habitats, and planting pollinator gardens (Blanchard & Buchanan, 2011). The most authentic projects however, come from the children's own ideas on how to improve the environment (Blanchard & Buchanan, 2011).

Summary

This section used guidelines set by the NAAEE to explore various ways that developmentally appropriate practice is taught in early childhood environmental programs. The qualities of ensuring that teaching is based on research theory, child centered and inquiry based, addresses the whole child, and utilizes authentic experiences is central to quality environmental education programs.

Chapter Summary

To answer the question: *what are qualities of developmentally appropriate environmental education curriculum for students ages five through seven?* I explored developmental stages of children at that age, environmental education purpose and goals, and common practices of high quality environmental education programs.

Appropriate lessons based on a child's physical development allow children to incorporate movement, both large and gross motor skills. These could include free play, or structured play and lessons that allow them to use all of their senses to explore the natural environment. Ensuring students have a variety of choices, and the ability to change activities when they lose motivation are also important.

When considering children's social and emotional development it is important to provide students with a warm and caring environment. Modeled behavior by the teacher can help students learn a number of social and emotional skills. Scaffolding skills for students through lessons is a way to teach new social and emotional strategies, in addition to free play where they can practice self regulation skills. Ensuring lessons are child centered and inquiry based also allows students to develop their prosocial behaviors, and a positive self image.

At ages five through seven teachers can support cognitive development by teaching concrete concepts, ensuring the lessons are child centered and inquiry based, and using higher level questioning. In the classroom teachers can pull concepts and topics from current seasons or cycles, or look at what the students are most interested in when creating curriculum. Teachers can also incorporate technology when used to support the concepts being taught, encourage collaboration through citizen science projects, and ensure that lessons allow students to express their learning through their multiple intelligences.

In an effort to help children to become environmentally literate, and give them the knowledge and skills they need in order to be better stewards of the environment through an E-STEM program, I explored the research behind *what are qualities of developmentally appropriate environmental education curriculum for students ages five through seven.* This research will guide my capstone project to write a kindergarten and first grade E-STEM specialist curriculum as outlined in chapter three. In chapter four I reflect on the process and provide ideas for future considerations.

CHAPTER THREE

Project Description

Introduction

The purpose behind this capstone project was to design a curriculum for kindergarten and first grade students in an environmental, science, technology, engineering, and math (E-STEM) program. Teaching students using developmentally appropriate practices increases student understanding and retention, reduces behavior problems, and can reach more students (Oltman, 2002). In an article on the benefits of the outdoors for students, the Natural Learning Initiative indicates that daily contact with nature supports all development (physical, social emotional, and cognitive), supports creativity and problem solving, and improves self discipline among other benefits (2012).

Chapter two reviewed the research behind the question: *what are qualities of a developmentally appropriate environmental education curriculum for kindergarten and first grade students?* According to the research, a developmentally appropriate curriculum provides students with multiple opportunities for movement, a caring and supportive experience, scaffolding of new learning, uses a child centered approach, and includes opportunities to use multiple intelligences. A developmentally appropriate environmental education curriculum accomplishes all of this through instruction about the environment with the goal of nurturing environmental literacy. This chapter

describes a project that created a developmentally appropriate E-STEM curriculum for kindergarten and first grade students. It includes a project description, the setting and participants, and timeline for completion.

Project Description

To write a developmentally appropriate kindergarten and first grade curriculum I used the unit planning guide format from the *Understanding By Design* by Grant Wiggens and Jay McTighe (2005). For this project I identified an essential question for each unit of study, the key understandings or objectives, assessment procedures, and the activities students follow to gain key understandings (Wiggins & McTighe, 2005). A unit plan template (appendix A), lesson plan template, (appendix B), and a learning station template (appendix C) are included in the appendix.

The curriculum project fits a rotating specialist schedule. This means that students attend E-STEM class for thirty minutes, once every three or four school days. Based on an average school year, this equals about forty lessons total. This curriculum does not include beginning of the school year management lessons, or lessons around important events, or themes important to individual schools. Therefore, these lessons address thirty of those forty lessons. The lessons are broken down into seven units of study: fall phenology, crickets, natural or man-made, outdoor exploration, plants, spring phenology, and winter phenology.

Most units of study include four or five centers based learning activities (stations). These activities follow best practice for a developmentally appropriate curriculum. The

station activities in the units of study are open ended, this means students will not be required to participate in all of the various activities and will be able to flow between them as they choose. Being able to choose their activity, and participating in open ended play allows students to learn what they are ready to understand, maintain interest and engagement in learning, and take ownership of their own learning. A centers based approach also allows students the freedom of movement they need for physical and cognitive development (Oltman, 2002).

The E-STEM curriculum units are designed to be "value added" units for a school. They are not intended to be the only science education students receive, they add onto an existing program to make it better. Because of this, the units are designed to address the overarching standard, not the individual benchmark. The units developed are also stand alone units, designed to be used in isolation, or as a complete set depending on the program schedule allowing for teacher discretion based on setting.

The topics for different units of study come from experiences and things they see in the school forest. Topics such as fall, winter, and spring phenology address the changes they see in their own local environment through the year. Other themes, such as crickets and plants, come from questions I have had from many students based on student observations outdoors. Basing teaching on the environment students live in ensures that nature is local, which makes it a concrete idea, not abstract, a requirement for their cognitive development (Barrable, 2019).

Since the units are designed to be stand alone units, they can be taught based on student interest. For example, if students are exploring the outdoors and notice many

insects, specifically the sound or abundance of crickets, a teacher could choose to teach that unit, instead of a different unit. Using student inquiry to drive instruction ensures students are engaged in lessons, learn to think scientifically about what they are interested in, and empowers them to ask their own questions (Oltman, 2002).

Each unit also allows students to show their learning through multiple intelligences. Gardener defined eight multiple intelligences as logical-mathematical, linguistic, bodily kinesthetic, musical, interpersonal, intrapersonal, spatial, and naturalist (Campbell, Campbell, & Dickinson, 2004). Teaching using multiple intelligences ensures that there are a variety of tasks to help students stay interested, and encourage all types of development (Oltman, 2002). Examples of activities in the winter phenology unit that align to multiple intelligences include a sorting activity that aligns with the logical-mathematical intelligence, an animal tracks storytelling station encouraging the linguistic intelligence, a blubber science experiment using four of the five sense aligns with the bodily kinesthetic intelligence, and an animal antifreeze lesson encouraging the naturalist intelligence.

One important strategy for teaching students environmental literacy is through teaching environmental stewardship (Blanchard & Buchanan, 2011). Environmental literacy is the idea that the responsibility for the health and quality of the environment is shared by all people (Blanchard & Buchanan, 2011). Included in the curriculum are opportunities for students to identify and carry out steps they can take to improve the environment. The most impactful experiences are experiences that are child driven and based on their observations and ideas (Blanchard & Buchanan, 2011). While this will be

the goal for all environmental stewardship projects, example ideas are written into some unit plans.

Included in each unit are authentic experiences with nature and the outdoors (NAAEE, 2016). Lessons encourage outdoor play, both free play and structured play (Oltman, 2002). When not outside, items from the outside are brought inside, and students are encouraged to use all of their senses to explore (Oltman, 2002). Using all of the senses supports their physical and cognitive development, helps students retain new learning, and is more enjoyable (Wilson, 1997; Oltman, 2002).

Finally, current twenty-first century teaching includes the use of technology. The best use of technology allows students to enhance classroom and nature experiences, not replace classroom or nature experiences (Willis et. al, 2013). The units are designed to use iPads as a resource for modifying lessons, but not as the main focus of learning. Technology is used as an eReader to assist struggling readers in reading books above their ability level. Technology is also used as an assessment tool. Students are encouraged to use the iPads to take pictures of their models and sorting activities, and take a video of their explanations of their thought process.

Setting and Participants

The setting of this project is in a suburban elementary school outside of St. Paul, Minnesota. Our schoolyard consists of the school, two outdoor playgrounds, a Minnesota Department of Natural Resources approved school forest, and an outdoor classroom

amphitheater. Lessons are taught in the outdoor classroom amphitheater, in the forest, or in the indoor classroom.

According to the Minnesota Department of Education (MDE), the school serves approximately 700 students in grades kindergarten through eighth grade. The racial demographics of students at this school are 6.1% Hispanic or latino, 12.3% Asian, 15.6% black or African American, 57.3% white, and 8.5% two or more races (MDE). The population of English Learners is 9.1%, special education students consist of 17.6%, and 24.7% qualify for free and reduced lunch (MDE).

The lessons take place through a specialist schedule. This means that students will attend this class outside of their homeroom classroom setting. Students alternate attendance to this class with participation in physical education and music, and participate in one lesson every three or four days, from kindergarten through sixth grade. This project focuses on the kindergarten and first grade years. There are approx 160 students in kindergarten and first grade at the school.

Timeline

This curriculum development project began in May and ended in August of 2020. The intention is to teach this curriculum beginning in the fall of 2020. In order to begin implementing the curriculum for the 2020-2021 school year, it will be important to gather all resources and materials for each unit in August and September 2020. Each unit is designed to be a stand-alone unit, they do not need to be all taught in one year, or taught

in order. The units do have time recommendations because of seasonal requirements they may have.

One major limitation to this timeline would be the implementation of distance learning during the 2020-2021 school year. The unit will be designed for an in person class, not an online format, and implementation would have to be delayed in the event of distance education. If a hybrid model, both in person and online education, is implemented, the timeline would be impacted from fewer in person classes, and fewer lessons.

The curriculum will be assessed and reevaluated throughout implementation based on student engagement, and mastery of learning objectives as evaluated in the rubrics created. If students are not engaged, choosing only one station, or not showing mastery of the learning objectives, the curriculum will be revised.

Summary

For this capstone project I wrote a developmentally appropriate E-STEM curriculum for kindergarten and first grade students based on the research question: *what are qualities of a developmentally appropriate environmental education curriculum for kindergarten and first grade students?* Using the understanding by design guide by Wiggens and McTighe, I wrote seven separate units that explore various environmental education concepts and encourage environmental literacy and stewardship. Developmentally appropriate practices such as activity choice, inquiry based, multiple intelligences, and authentic experiences will be interwoven throughout the units. The

units will be taught to students in a suburban setting over the course of the 2020-2021 school year. Chapter four presents my conclusions and my reflections on the process.

CHAPTER FOUR

Conclusion

Chapter Overview

My capstone project started with a desire for an engaging environmental curriculum that fostered environmental literacy and stewardship in kindergarten and first grade students to support my position as an Environmental Science, Technology, Engineering, and Math teacher. To begin the process, I started with the question: *what are qualities of a developmentally appropriate environmental education curriculum for kindergarten and first grade students?* In chapter one, I provided the context and the rationale for my capstone project. In chapter two, I explored the current research on both child development of students aged five through seven, and environmental education. In chapter three, I outlined a project which created a developmentally appropriate E-STEM curriculum for kindergarten and first grade that meets the needs of students and fits the schedule. The fourth chapter of this capstone project offers my reflections on the process. It includes things I learned and how I grew as a teacher throughout the process. I also include connections to the literature that inspired me as I created the units and outlines future projects and limitations to implementation of this project. In the end, I discuss how this project contributes to my profession and offer my final thoughts on the project.

Major Learnings

Through the process of creating my capstone project, the project changed as I learned more about developmentally appropriate practice, environmental education, and clarified my ideas. One way my capstone project changed through the process was in the themes for each unit. I originally planned on creating themes using the crosscutting concepts from the Next Generation Science Standards (National Research Council, 2012). The crosscutting concepts are larger themes that are found in all topics of science: patterns, cause and effect, systems, structures etc. In creating units around these concepts, the units appeared scattered and unfocused, too many topics were loosely covered under one concept. When I switched the units to fit five different crosscutting concepts in each thematic unit, the units became more cohesive and logical. For example in each unit, there is a station where students explore systems, and a station where students explore structures.

In the process of creating this capstone project the formatting of the unit overview and lesson plans changed. I based my format on the *Understanding by Design* model by Wiggins and McTighe (2005). The format for creating units begins with an essential question from which you design key understandings, assessment evidence, objectives, and, finally, lesson events. While writing these units my understanding of what is an essential question, and a key understanding was expanded and refined, and the units are clearer than before. One example of this change is through the evolution of an essential question. My original essential question for the Natural or Man-Made unit was "What is the difference between things made in nature and things made by people?" This question

is narrowly focused, and only has a limited number of answers. The final essential question to this same unit is "How do humans change nature to fit their needs?" This question is more broad, and addresses more concepts than description. It better leads to students exploring, observing, and inventing in order to gain a full understanding. With the shift in the unit plans, the lesson plans shifted similarly leading to more comprehensive lesson plans.

In writing the unit lesson plans I needed to align them to fit the Minnesota state science standards. These standards are in the process of going through revision, and are still listed as the commissioner's approved draft, they have yet to clear the final step to be made into a law. The new version of the state standards is formatted differently from the previous version. Instead of structuring the strands around types of science, life science, earth science and physical science, the new standards structure the strands around the process of science, observation, exploration and gathering data, drawing conclusions, and communicating. This shift from product to process was a large learning curve for me in the process of writing the units. Instead of designing key understandings such as understanding a flower's structure, the understanding was around asking questions and designing a process to understand a flower's structure. A seemingly small switch, that has large consequences when designing learning events.

Along with aligning the units to the Minnesota state science standards I needed to align the units with the environmental education standards put forth by the North American Association for Environmental Education (NAAEE, 2010b). There are four strands included in these guidelines, and a quality environmental education program

addresses all four of these strands. After writing the first draft of my units, I noticed that I was strong in writing units that aligned with strand 2: Knowledge of Environmental Processes and Systems, but had no lessons designed to address any of strand 4: Personal and civic responsibility. This caused me to add and change lessons and stations within the units to address these gaps in the standards. I also wrote an entire extra unit, outdoor play, specifically to address strand 4. These changes made for a better and stronger set of environmental units.

In writing this capstone project I grew as both a writer and a teacher. I now have a better understanding of writing deeper curriculum units around themes that incorporate larger concepts, units that have clear essential questions and key understandings, and are better aligned with the new 2019 Minnesota State Science Standards and the NAAEE Guidelines for Excellence.

Literature Review Connections

While writing this capstone project two ideas from the literature review guided its creation. The first was the importance of play for early childhood students. The importance of play was discussed in many different texts (Copple & Bredekamp, 2001; Cutter-McKenzie & Edwards, 2013; Miller, 2001; Pulaski,1980). Students ages five through seven need play as an immersive sensory experience to learn and understand the world. Considering this, I focused on including an aspect of play in every unit, including writing one entirely using outdoor play as an instruction model.

Another important aspect from the literature that guided the creation of my curriculum project was an article by Ruth Wilson titled *A Sense of Place* (1997). This article encourages teachers to create a program that fosters a "sense of place." Wilson defines this sense of place not as merely a geographical location, but as an idea of a place where students are encouraged to "explore, manipulate, and be involved" with the environment. The sense of place is as much about what is in the place as it is about how students feel about the place and how they see themselves in relation to the environment. Wilson's sense of place is similar to environmental literacy, the goal of environmental educators. Wilson provides a set of seven suggestions for fostering a sense of place in students, these suggestions were key in the creation of this project. For example, one of her suggestions is to "provide opportunities for immersion or immediate encounters with the natural environment" Keeping this in mind, I was able to include immersive experiences with the natural environment in all of the units.

Future Research and Projects

While this project is complete and accomplishes the goals I set out to accomplish, there is more that can be done to improve and strengthen the curriculum, particularly around the number of units, addressing all forms of multiple intelligence, and improving the service learning aspect.

Currently, there are seven units in this curriculum which cover approximately forty lessons, about the number of lessons taught in my E-STEM program in one year. My original goal for this project, however, included a two year unit cycle; teach half the units one year to both grades, and the other half of the units the next year. In addition,

upon reviewing the time considerations for the units, most of them are designed to be taught in the fall or spring seasons. More units that can be taught in the winter season would make the curriculum more complete. Continuing with writing more units of study for kindergarten and first grade is one way this project can be continued.

Another idea needing further research is in the idea of combining music and environmental education. While writing the units I struggled to include music in any of the stations. As musical knowledge is one of Gardner's types of intelligence, I had hoped to include it into this project (Campbell, et. al, 2004). With more time for research into music within environmental education, this form of intelligence could be included into the units to make them stronger.

My last thought on future research or programs is around the maintenance of a school first and students. Research suggests that environmental education programs are stronger when children can affect positive change on the environment (Wilson, 1997). Our school forest is in constant need of improvements, and this task is overwhelming for the small group of parents that oversee the school forest improvement committee. With more research and training on maintaining school forests, teachers could lead students in completing these improvements. This type of service learning would benefit the students social and emotional well being, align with state standards, and improve their environmental literacy.

Limitations

One limitation to this project is the materials necessary to complete the unit. One material that is vital for the units is a school forest, or easy access to a wilderness area. Without this access, the units may not be as effective at developing environmental literacy. In addition to the school forest, some of the units require materials that, while not terribly expensive individually, could combine to be a limitation for implementation. Without a small budget to purchase materials like track stamps, a food web game, microscopes for young students, etc. many of the lessons would not be as effective.

Another limitation to this curriculum is the schedule for which it was created. As an E-STEM specialist teacher, I see students once every three or four days for 30 minutes at a time. With that in mind, all of the units allow for a few days between classes, and sometimes require a week or two between lessons. For example, the spring phenology includes observing changes in nature as winter turns to spring. This change does not happen in days or hours, but in weeks or months. Trying to complete the spring phenology unit in a few days time would not allow sufficient time for students to see the change in seasons. With a different schedule some of the lessons may need to be modified or changed.

The final limitation to this project is the uncertainty of the current COVID-19 pandemic and how it will affect educational programming. As of the writing of this project, my district plans to return to school on a hybrid schedule. This means that students will be in school for only two days a week, and on a limited schedule. I will see fewer students, at any given time and I will see all students less often. Because the

curriculum created was written for a full time, in person, schedule, this curriculum may be negatively impacted by the reduced time with students.

Benefit to Profession

This project benefits this profession by providing another choice in environmental instruction. Currently, there are examples of early childhood environmental education curricula for nature preschools or elementary homeroom classrooms, but few for an environmental education specialist position. This type of model may be a way for a school to increase the amount of environmental education programming students participate in without changing its core model for instruction. The units are also designed to work as a whole, or stand individually. A school or teacher could choose to teach one, but not all of the units as needed. I hope this project allows schools with limited environmental education programming to see another option for inclusion in a school.

This project also benefits this profession because it teaches students in a way that is appropriate, engaging, and fun. When students are more engaged in their learning, they are more likely to remember it, and have positive connections with the subject. I hope that the units that I have created through this project inspire young students to love learning, become environmentally literate, and stewards for the environment.

To communicate this project to others, I will communicate with district leadership about its creation with the idea of creating a professional development for kindergarten and first grade teachers around including more environmental education in each of the schools. I will also be a model for teachers within the school and district that would like

to watch it being taught. In addition, I plan to include it on the Hamline Capstone Project website for others to review and implement.

Summary

The creation of this capstone project has allowed me to grow as a writer and a teacher. Through the process I have a better understanding of the process of writing units of study, developmentally appropriate practices for children ages five through seven, and environmental education and its goals. The seven units created for use in an E-STEM curriculum are based on current research, and are designed to help students establish their sense of place in the environment. While the project has limitations around structure and materials, it is my hope that it will contribute to the broader educational community as an option for adding more environmental education into general education, and foster environmental literacy and stewardship among students.

There is a common saying “people won’t remember what you say, but they will remember how you made them feel.” My hope with these units is that students will feel excited, engaged, and have fun learning about the environment. They will remember learning outside and about the environment as a positive experience in their youth, and carry on those feelings to become adults that are interested in protecting the environment for future generations.

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APPENDIX A

Unit Overview Template

Grades:

Time Recommendations:

<table>
<tr><td colspan="2">Established Goals:
What are the established standards?</td></tr>
<tr><td colspan="2">Minnesota State Science Standards:
NAAEE Guidelines for Excellence, K-4 Standards:</td></tr>
<tr><td>Essential Question:
What overarching question will they be researching and understanding?</td><td>Key Understandings:
What will students understand when they have completed this unit?</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Objectives:
Students will know
Students will be able to</td><td>Materials:
What are the necessary materials for this unit?</td></tr>
<tr><td>Lesson Overview:
What are the lessons being taught and how are they being taught?</td><td>Assessment/ Evidence:
How will students show their understanding? What evidence will be collected</td></tr>
</table>

APPENDIX B

Lesson Plan Template

Unit: _____

Lesson: _____ Grade:_____ Length:_____

Minnesota State Standards:	
NAAEE Guidelines for Excellence, K-4	
Key Understanding	
Objectives:	
Materials:	
Pre-Assessment:	
Learning Events:	
Assessment:	

APPENDIX C

Station Plan Template

Minnesota State Science Standard	
NAAEE Guidelines for Excellence, K-4 Standard	
Key understanding	
Objective	
Materials Needed	
Station Events	
Assessment	