2023

Environmental Education In The Classroom: Selected Early-Career Teachers' Experiences Navigating Pre-Service And In-Service Activity Systems

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ENVIRONMENTAL EDUCATION IN THE CLASSROOM: SELECTED EARLY-CAREER TEACHERS' EXPERIENCES NAVIGATING PRE-SERVICE AND IN-SERVICE ACTIVITY SYSTEMS

A Dissertation

Presented to the

The Faculty of the School of Education

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

By

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December 2023

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Dedication

For my girls—I hope you always chase your dreams and know that anything is possible. And for the environmental educators of the world—you are truly making a difference in the world every day.

Acknowledgments

There are so many people I want to recognize for helping me along this journey. First, I would like to thank my committee for all of the kindness, support, and strong leadership. I would like to especially thank Dr. Harris for the immense time and support she has provided over the last several years.

I would also like to thank my team and colleagues at VIMS. Many of them have stepped up when I have needed to focus on my dissertation, and all have provided support and interest in my topic and journey.

A large thanks goes to my School of Education group—from our Sunday Writing Club, Room 3107 accountability meetings and writing time, and general encouragement throughout the entire process—I do not know if I would have survived this without you all. A very special shoutout goes to Sharice Adkins who has been my very dedicated writing partner for over 2 years of this process and has always encouraged me, commiserated with me, and been a willing ear.

Most of all, I want to thank my biggest cheerleaders—my friends and family. Thank you to my mom, who has always believed in me and supported me throughout this entire journey and has been such a huge help with the girls when I needed to write. Thank you to my girls who have been my biggest source of inspiration and have been cheering me on from the first doctoral class until the last edit of the dissertation.

And finally, thank you to my husband. I could not, and would not, have done this without you. You have picked me up from every challenge and celebrated every win right by my side. You understood this dream of mine and never hesitated to support me in pursuing that and I will forever be grateful for that.

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Abstract

Recent publications argue that to prepare teachers of all grade levels to be confident and competent in incorporating environmental education into their classrooms, pre-service teacher training is effective (e.g., J. T. McDonald & Dominguez, 2010). But the systems in which teachers learn and work are complex, making professional learning about, and implementation of, environmental education both disparate and limited (Franzen, 2017). This study sought to understand the nature of participants' experiences within and between teacher preparation and in-service learning systems as they relate to environmental education. Cultural historical activity theory (CHAT) provided a framework to allow for deeper understanding of the systems of university-based teacher preparation and K-12 schools, as well as influences of the state department of education. By focusing on how learning is influenced by cultural, historical, and social factors, CHAT allowed for a systems approach to understand study participants' experiences. I used a phenomenological research approach (Vagle, 2014) involving teachers, school administrators, and faculty members from the teachers' pre-service preparation programs, generating data through interviews and artifact analysis. Participants reported several challenges related to the inclusion of environmental education: motivation versus implementation, transitioning from university learning to in-service teaching, and the availability of professional learning about environmental education. Additionally, participants identified sources of innovation such as place-based education and champions within all three systems. A discussion of these results is offered, leading to a series of suggestions for informal educators outside of the three systems to assist in advancing the inclusion of environmental education within K-12 learning.

ENVIRONMENTAL EDUCATION IN THE CLASSROOM: SELECTED EARLY-CAREER TEACHERS' EXPERIENCES NAVIGATING PRE-SERVICE AND IN-SERVICE ACTIVITY SYSTEMS

CHAPTER 1

INTRODUCTION

Increasingly, anthropogenic (human-caused) impacts on the planet are responsible for global environmental issues—such as rising temperatures, severe drought, and sea-level rise—that are rapidly worsening (Steffen et al., 2011). Extreme weather events are increasing in frequency and intensity (Doherty et al., 2018), and while some are short-lived, they can still cost the United States (U.S.) human lives and billions of dollars (Bey et al., 2020). Other effects, such as rising sea levels, are more chronic and will have long-lasting effects on our planet's natural resources and, therefore, its population (National Environmental Education Advisory Council, 1996; Steffen et al., 2011). These realities suggest a vital need for an environmentally literate society. Citizens need to develop a deep understanding of their local, natural environment as well as significant issues affecting the planet, and how their actions can heighten or mitigate these issues (American Association of Colleges and Teacher Education, 2010; Franzen, 2017).

Environmental literacy is a complex aggregate of knowledge, skills, attitudes, and behaviors that affect and shape each other (Bey et al., 2020). The National Oceanic and Atmospheric Association defines environmental literacy as:

> the possession of knowledge and understanding of a wide range of environmental concepts, problems, and issues; cognitive and affective dispositions toward the environment; cognitive skills and abilities; and appropriate behavioral strategies to make sound and effective decisions regarding the environment, including informed decision making. (Bey et al., 2020, p. 28)

Environmental literacy is expressed on a continuum, from a basic understanding of the environment and our effects on it, to more in-depth knowledge, including how to be better stewards of the environment. A person's level of environmental literacy can change throughout their life (Bey et al., 2020). Their life experiences, social interactions, and personal beliefs shape their knowledge and understanding of the environment, including how their actions can positively or negatively affect the environment. This understanding, and their personal experiences and interactions with the environment, can lead to more responsible, informed behavior, which is the goal of environmental literacy efforts (Hollweg et al., 2011).

A person's degree of environmental literacy can be categorized as *nominal*, *functional*, or *operational* (Bey et al., 2020). *Nominal environmental literacy*, the lowest level of environmental literacy on the continuum, includes a basic understanding of the terms surrounding environmental issues and a general awareness of the environment. Nominal environmental literacy could describe someone's knowledge of their local environment without the deeper understanding that they might have a personal effect on that environment, or the skills to mitigate these effects.

People with a deeper understanding of how humans interact with natural resources and a general concern about how their actions negatively affect the environment have somewhat higher levels of environmental literacy, called *functional environmental literacy*. People with functional environmental literacy can assess various sources of information, evaluate that evidence to determine how their actions affect the environment, and begin to feel a personal motivation to make changes in their lives to mitigate any negative effects. Additionally, people with functional environmental literacy are more likely to share their sentiments toward environmental issues with others.

Finally, *operational environmental literacy*, the highest level of environmental literacy, encompasses an understanding that extends beyond knowledge, including skills such as advocacy, action, and feelings of active responsibility for the environment (Bey et al., 2020). People with operational environmental literacy have an ongoing concern for the environment, including a felt obligation to prevent or mitigate additional negative effects. To reach operational environmental literacy, general care and concern about the environment are insufficient to protect and preserve our natural resources. Instead, people must build knowledge and skills to understand and take action on behalf of the environment.

Environmental Literacy Through Environmental Education

One pathway to promoting operational environmental literacy is through *environmental education*, a process that helps people develop understanding and skills to address both local and global environmental issues (North American Association for Environmental Education [NAAEE], n.d.-a). The NAAEE (n.d.-a) defines environmental education as:

> a process that helps individuals, communities, and organizations learn more about the environment, and develop skills and understanding about how to address global [environmental] challenges. It has the power to transform lives and society. It informs and inspires. It influences attitudes. It motivates action. Environmental education is a vital tool in expanding the constituency for the environmental movement and creating healthier and more civically engaged communities. (What is Environmental Education? section)

Therefore, although environmental literacy is the goal, environmental education is the process of inspiring, engaging, and encouraging people toward that goal. The term *environmental education* was first used in 1762 when Jean-Jacques Rousseau called for children’s education to include the study of the environment (NAAEE, n.d.-c). Two centuries later, the term was first used in a professional setting at the 1948 Conference for the Establishment of the International Union for the Conservation of Nature. Following the Conference, several seminal works related to the environment brought environmental issues to light for many people, including Aldo Leopold's (1949) *Sand County Almanac* and Rachel Carson's (1962) *Silent Spring*. These works spurred the environmental movement of the 1970s in the U.S., where individuals and social organizations came together to protect the environment. Several critical policy changes also occurred during this time, such as the first Earth Day, the passing of the National Environmental Policy Act, and the creation of the National Association for Environmental Education, now the NAAEE (McCrea, n.d.; NAAEE, n.d.-c).

One of the pivotal international events that formed the foundation of environmental education was the 1977 Intergovernmental Conference on Environmental Education, held in Tbilisi, in the Republic of Georgia. This conference was sponsored by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the United Nations Environment Programme. It created goals and objectives for environmental education that are still used today (McCrea, n.d.). This conference coincided with the environmental movement of the 1970s in the U.S. which continued for several decades, leading to the passing of the National Environmental Education Act in 1990, which created an Office of Environmental Education within the U.S. Environmental Protection Agency. Additionally, in 1994, the NAAEE created national guidelines for environmental education to give K-12 teachers a set of standards for how to integrate environmental education in the classroom. In the 2000s, an international Decade of Education for Sustainable Development was declared for 2005-2014, drawing attention to environmental education and including additional guidelines for excellence in environmental education, encouraging all educators to develop a deeper understanding of the design, implementation, and evaluation of these programs (NAAEE, n.d.-c).

The environmental education movement has continued across many decades: recent national efforts such as the No Child Left Inside initiative (U.S. Senate, 2011) have promoted environmental literacy in K-12 education to help students develop the knowledge, skills, and dispositions to design potential solutions to some of our most significant global environmental challenges. Environmental literacy efforts build a baseline of understanding and practical skills in students and support their use of the problem-solving and critical thinking that are needed to create innovative solutions to problems catalyzed by our changing environment, such as alternative energy sources (Badger, 2010). Therefore, to achieve environmental literacy, environmental education is needed.

Benefits of Environmental Education

In addition to helping people develop understanding and skills to address local and global environmental issues (Ardoin et al., 2018; Lieberman & Hoody, 1998), the benefits of environmental education extend to include increased stewardship behavior (Chawla & Cushing, 2007); critical thinking skills (Ernst & Monroe, 2004); social skills (Volk & Cheak, 2003); and school achievement (Bartosh, 2003; Ferguson et al., 2001). These results were derived empirically through studies examining environmental education provided within a K-12 school or school district. Additionally, a systematic review of dissertation research within the environmental education field found that environmental education influences students' attitudes about and essential awareness of environmental issues (Marcinkowski et al., 2013). In a more recent analysis of more than 119 peer-reviewed studies of environmental education conducted over 20 years, environmental education benefits were synthesized and included increased knowledge, stewardship actions, process-oriented skills, socio-emotional skills, and engagement within the school (Ardoin et al., 2018). I describe these benefits in the sections that follow.

Increased Knowledge

The primary benefit of environmental education is increased knowledge and understanding of environmental concepts, including humans' roles in affecting the environment (Lieberman & Hoody, 1998). The relatively recent meta-analysis on environmental education cited in the previous section found that 68% of studies published within the last 20 years focused on knowledge-based changes in student participants, including awareness, skills, and content knowledge (Ardoin et al., 2018). Most of these studies used knowledge tests or other survey instruments to collect these data and reported improvements overall.

Stewardship Actions

In addition to extending students' knowledge about environmental issues that affect their local environments, environmental education's ultimate goal is to create an informed citizenry who will take action to protect the environment in the future. This can be characterized as *stewardship actions*, activities that benefit and care for the environment. Participation in nature-based activities as a child, whether with a parent, teacher, or other adults, can influence future environmental and stewardship behaviors (Chawla, 1999; Chawla & Cushing, 2007). Children's experiences in nature are the most formative in developing stewardship actions and behaviors, including those they experience during their education (Chawla, 1999). Additionally, if those actions are focused on political or community activity, these pro-environmental behaviors can have an even greater effect on the environment than individual actions (Chawla & Cushing, 2007). Although participating in stewardship action during an environmental education program or class—such as planting native species to restore a wetland—is beneficial, the long-term change in attitude and behavior within the participant will have a greater positive effect on the environment as the participant continues to act as a steward.

Process-Oriented Skills

Several researchers have discovered an increase in process-orientated skills, sometimes referred to as 21st-century skills (critical thinking, creativity, communication, collaboration, character, citizenship, and computational thinking; Pellegrino & Hilton, 2013) after students participate in environmental education programs (Ardoin et al., 2018; Ernst & Monroe, 2004). Developing these skills has been a focus within schools in the U.S. since the late 20th century and continuing into the 21st century (Pellegrino & Hilton, 2013). Environmental education could assist in building these skills and related competencies because it tends to be investigative in nature; this type of teaching encourages students to draw on their previous knowledge across classes and disciplines, to think critically and creatively to conduct investigations, draw conclusions, and provide suggestions on how to address an environmental issue or problem (Ernst & Monroe, 2004). Students can increase their critical thinking skills and aptitude for applying those skills during and after participation in environmental education programs (Ernst & Monroe, 2004; Volk & Cheak, 2003).

Socio-Emotional Skills

Students who participate in environmental education activities can also improve social and emotional skills through the collaborative nature of many environmental education activities (Ardoin et al., 2018; Lieberman & Hoody, 1998; Volk & Cheak, 2003). When tasked with exploring the outside world and investigating an environmental issue collaboratively, students can develop interpersonal skills such as teamwork, leadership, and improved communication with their peers and teachers (Ardoin et al., 2018; Volk & Cheak, 2003). Additionally, students' personal skills, such as self-esteem, poise, maturity, and ability to work independently, can grow as they are challenged and put in unfamiliar learning situations, such as new outdoor environments (Ardoin et al., 2018).

Engagement

Students who participate in environmental education activities within their schools have been observed to increase participation and engagement in learning, even in classes beyond those that address environmental education (Blatt, 2013; Ernst & Monroe, 2004). Being part of a team working toward the betterment of their local environment can create feelings of ownership for students, which can translate into a stronger sense of belonging within their school community. Students who participate in environmental education in school can also experience increased engagement in learning across multiple subject areas, fewer discipline issues, and increased pride in and ownership of their work (Lieberman & Hoody, 1998). Although there is still much to learn about the possible influence of environmental education on students' knowledge, skills, and dispositions, the noted improvements summarized above can positively affect students' futures in school and beyond.

Environmental Education in the U.S.

Environmental education could have a larger role within K-12 education due to the abundance of benefits it provides and the alignment of those benefits with the skills educators want students to develop, such as the 21st century skills of critical thinking, creativity, communication, collaboration, character, citizenship, and computational thinking (Pellegrino & Hilton, 2013). In the U.S., environmental education can be offered through both formal curricula in K-12 schools and non-formal programs such as camps, clubs, and other public outreach opportunities that are offered outside the structure of a K-12 classroom. *Formal education* refers to organized and structured efforts, such as K-12 curricula, which specify particular objectives for learning (M. K. Smith, 2002). *Non-formal education* retains some structure but often occurs outside of the formal K-12 school day, and the participants self-select into the program (e.g., camps, after-school clubs, and public outreach events; M. K. Smith, 2002). In non-formal programs, learning objectives can be part of the organized effort, or the goal could be only to expose the participant to nature. In these cases, an effect of participating in the program, such as a heightened sense of responsibility to protect the environment that was explored, might be unplanned but occurs as a by-product of this exposure (Organisation for Economic Co-operation and Development, n.d.).

Both formal and non-formal environmental education can have a similar goal: to support environmental literacy development within a particular audience, whether adults, students, or the general public (National Environmental Education Advisory Council, 1996). Still, with only 3% of a person's life spent in school on average, non-formal education can provide an ancillary avenue for lifelong learning and can be a valuable space for environmental education (Paraskeva-Hadjichambi et al., 2020). Non-formal educational organizations also often have more flexibility in time and space to design and offer programs, fewer restrictions in structure, and the option to employ educators with expertise specifically in environmental education (Petsch, 2019; White & Stoecklin, 2008). These programs can reach students who opt into attendance and can successfully strengthen their environmental behaviors and attitudes (Petsch, 2019).

However, although non-formal environmental education programs are often successful at increasing environmental literacy among participants who attend them, they are not accessible to all students (Romero et al., 2019). To remedy this, systemic implementation of environmental education is needed. *Systemic implementation* refers to environmental education programs offered through entire K-12 schools, where all students in a district, school, grade, or class can participate (Sprague et al., n.d.). K-12 classrooms are better suited for systemic implementation than non-formal programs with optional participation. It is easier to ensure that all students have the opportunity to develop the essential skills and dispositions leading to environmental literacy when environmental education is part of the required curriculum (Ham & Sewing, 1988).

Teachers and Environmental Education

If environmental education is required in K-12 education, teachers will play a significant role in ensuring how it will occur. Teachers are the primary decision-makers regarding specific lessons and learning activities explored within their classrooms (Goldberg & Houser, 2020; Winther et al., 2002). Despite many teachers having positive attitudes toward environmental education, it remains a challenge to facilitate full implementation of environmental education in K-12 schools (Bruyere et al., 2012; Kim & Fortner, 2006). Teachers cite various challenges to incorporating environmental education, including lack of training, resources, and even commitment to teach this topic (J. T. McDonald & Dominguez, 2010). These challenges can be contextual, such as available resources, or individual, such as the teacher's understanding of environmental education's content and how to teach it (Kim & Fortner, 2006). Although essential and complex, implementation of environmental education can be constrained by several types of barriers within K-12 schools, including conceptual, attitudinal, logistical, and educational obstacles (Ham & Sewing, 1988).

Conceptual Barriers

Several misconceptions about environmental education impede its implementation in K-12 schools. The first is a lack of a clear understanding among stakeholders of what environmental education truly is. Many teachers believe that environmental education must occur outdoors, specifically on field trips; however, it is not limited to either. The conflation of environmental education with outdoor learning could prevent implementation for teachers and administrators (Ham & Sewing, 1988). *Outdoor learning* refers to any teaching that takes place outdoors, and the focus of that learning could be any topic, such as a literacy class reading outside (Knapp, n.d.). Environmental education can include field excursions or more in-depth learning time spent outdoors. Although closely related and with some commonalities, environmental education is distinguished by creating an informed citizenry that can address environmental problems in the local, and sometimes global, environment (Bey et al., 2020). The lines between environmental education and outdoor learning can be blurred if environmental education includes field investigations to study those environmental issues. Still, students are not required to leave the classroom to participate in environmental education. Teachers and administrators with a clear conceptual understanding of the differences between environmental education and outdoor learning might encounter fewer barriers to implementation than those with these misconceptions.

Additionally, there is a lack of understanding of where environmental education is placed within existing K-12 curricula. Environmental education's content reaches into multiple subject areas, including science, mathematics, English, and social studies (Ham & Sewing, 1988). The multidisciplinary nature of environmental education might be resolved more easily within elementary schools, where multiple disciplines are often taught by the same teacher, simplifying the process of combining subjects within environmental education. By contrast, the multidisciplinary nature of environmental education is almost antithetical to how many secondary school classes are arranged, separated by distinct subject areas and with little opportunity for teachers to collaborate. Secondary-level teachers might be unsure about their responsibility to teach environmental education due to this multidisciplinary nature (Kim & Fortner, 2006; Ko & Lee, 2003).

In many cases, environmental education is assumed to be an additional content area that will place a further onus on the teacher or school, rather than being part of existing curricula. Often, teachers feel they must separate environmental education from the curriculum already offered to assist their students in meeting state testing requirements in other content areas or because their administrators might not support its implementation within existing courses (Ernst, 2012). Instead of viewing environmental education as an additional curriculum to be taught, it can be incorporated into existing courses, classes, and curricula at each grade level. Environmental education contains clear linkages to many disciplines, such as social studies, mathematics, English, and science (National Environmental Education Advisory Council, 1996). The principles of environmental education can be embedded through a multitude of disciplines' curricula, rather than requiring a separate subject or class to be added to the school schedule (Ham & Sewing, 1988). Despite this, in the U.S., environmental education is most often associated with the science classroom, where natural phenomena can be observed and studied using scientific processes (Ashley, 2000; Ko & Lee, 2003; Marcinkowski et al., 2013). In other countries, such as the United Kingdom, it is common to see environmental education associated more closely with other disciplines, such as geography (Marcinkowski et al., 2013). Still, it has been seen most commonly in science classrooms for decades in the U.S.

Attitudinal Barriers

Attitudinal barriers are tightly linked to conceptual obstacles. If teachers do not understand environmental education conceptually, it could negatively influence their attitudes.

Teachers might have a range of personal attitudes and intentions toward environmental education, but most have been shown to have positive attitudes related to the environment (Ko & Lee, 2003; Shahnawaj, 1990). Although this appears to be still true today, teachers' positive attitudes toward the environment do not always translate into a personal drive or commitment to bring environmental education into their classrooms (Ham & Sewing, 1988; Zachariou et al., 2017). Within the continuum of attitudinal barriers, some teachers are uninterested in environmental education, some might be personally interested but feel it is not as crucial as other curricular content, and still others are highly motivated to ensure its inclusion their classroom.

Because teachers are the direct link to environmental education implementation, those with poor attitudes toward the subject represent definite obstacles (Ham & Sewing, 1988). Of particular concern are teachers within elementary schools who might lack general science background knowledge, and who are often more hesitant to include environmental education (Hug, 2010). In this case, a lack of knowledge can contribute directly to poor attitudes and affect teachers' motivations to create meaningful environmental education experiences. They might also lack the pedagogical content knowledge (Shulman, 1986) of how to work in this setting, such as how to teach and manage a class of students conducting a field investigation (Hug, 2010). Teachers who have had coursework or other personal experiences with environmental education are more likely to have positive attitudes toward it (Kim & Fortner, 2006). Teachers with positive attitudes and comfort regarding environmental education are more likely to include it in the K-12 classroom (Ko & Lee, 2003).

Logistical Barriers

Logistical barriers are among the most often reported barriers to environmental education among K-12 schoolteachers (Kim & Fortner, 2006). These can include lack of time to plan environmental education experiences, lack of materials, lack of funding, and safety concerns (Ernst, 2007; Ham & Sewing, 1988; Ko & Lee, 2003). Lack of time, both actual and perceived, has been noted as one of the significant barriers to including any new topic or program that deviates from the current curriculum (Ernst, 2007; Winther et al., 2002). Additionally, if environmental education is viewed as a separate topic to be addressed, rather than a process to teach concepts already existing in the curriculum, teachers might feel overwhelmed and dismiss opportunities to include it (Winther et al., 2002).

Lack of materials and funding can also be viewed as barriers to implementing environmental education. While environmental education can be conducted inexpensively with readily available materials, teachers might feel that special equipment and resources—such as data collection instruments or prepared teaching materials—are needed. Funding concerns might also include transportation costs to take students off campus (Ernst, 2007). Lastly, concerns about taking students out of the safety of the indoor classroom or off-campus for field experiences, and the additional liability teachers might incur to do this, can be perceived barriers (Ernst, 2012; Ko & Lee, 2003; Tal, 2012). Many teachers have never taken their students off-campus, and the outdoor management of students in open spaces with potential hazards (e.g., running water, wildlife, extreme temperatures) without the support of other teachers or administrators can be paralyzing (Ernst, 2007; Tal, 2012).

Although teachers might have positive attitudes toward environmental education and even feel responsible for teaching it, logistical concerns are often perceived as too challenging to overcome, overriding teachers' attitudes and intentions (Kim & Fortner, 2006). If logistical problems become too burdensome for teachers, they might relinquish any efforts to offer environmental education to their students. Additionally, logistical concerns can be intimately tied to conceptual barriers. As stated previously, two common misconceptions about environmental education are that it is a separate content area to be taught and that it must take place off of school grounds. If teachers believe these misconceptions, their logistical concerns could affect their attitudes about environmental education.

Educational Barriers

Teachers have also reported educational barriers to implementing environmental education (Ham & Sewing, 1988; Kim & Fortner, 2006). These barriers refer to the professional learning (or lack thereof) that teachers have had with environmental education. Many teachers have not experienced environmental education themselves, as teachers or as K-12 students, and therefore might feel unprepared to provide it to their students. Teachers might be unsure of how to teach environmental education, but those who have undertaken professional development or participated in environmental education opportunities as students are more likely to teach these concepts (Kim & Fortner, 2006). Studies that provide rich descriptions of environmental education activities, and that are accessible to teachers, can offer guidance for implementing high quality environmental education practices (Ernst et al., 2020).

In-depth training might be required for teachers to build conceptual and pedagogical knowledge for teaching environmental education (Kim & Fortner, 2006). However, training can be limited by the availability of environmental education organizations and expertise. Additionally, teachers often self-select into these types of training, and if their interests or feelings of responsibility toward environmental education are lacking, they might not participate. Similar to the lack of systemic implementation of environmental education within K-12 schools, systemic professional learning opportunities for teachers related to environmental education is lacking (Ernst, 2007). These challenges leave teacher education opportunities constrained.

Despite this, teachers who undertake professional development for environmental education are better prepared to include it in their curricula (Ernst, 2007). Training for in-service teachers in environmental education is constrained and there is limited research on teacher preparation programs and their inclusion of environmental education within the U.S. One researcher found only approximately 10% of future teachers in the U.S. take courses in environmental education during their teacher preparation programs (Ernst, 2007).

These four types of challenges—conceptual, attitudinal, logistical, and educational—that teachers encounter can influence the integration of environmental education in their classrooms. Educational barriers underscore the other obstacles to teachers integrating environmental education into their teaching. If teachers have not experienced environmental education themselves, from either a student's or a teacher's perspective, they might not understand it or might feel overwhelmed and underprepared to teach it in their classrooms (Winther et al., 2002). Without knowledge of what environmental education is, teachers' attitudes towards environmental education could be influenced, and they might also be unclear about the logistical requirements of this type of work. This could lead to a retreat from offering environmental education experiences for their students.

Professional development and teacher education focused on environmental education can address many of these barriers. By increasing their understanding of environmental education's practices and pedagogy, teachers can also build explicit conceptual knowledge of environmental education, strategies to overcome logistical barriers, and a deeper understanding of the importance of this topic for future generations. To increase teachers' knowledge of environmental education, educational leaders can focus on in-service teachers' professional development and on educating future teachers as part of their formal preparation process. With limited research surrounding environmental education as part of teacher preparation, my study will focus on teacher induction.

Study Rationale

Teacher education is one way to address the conceptual, attitudinal, logistical, and educational barriers teachers face when implementing environmental education in the K-12 classroom. Some suggest that teacher education in this area should focus on *pre-service teachers,* who are future teachers enrolled in formal teacher preparation programs, but not yet fully licensed to teach (J. T. McDonald & Dominguez, 2010). By focusing on this audience, pre-service teachers could build their knowledge and skills about environmental education before they begin working full-time. Historically, professional development about environmental education has been offered to in-service teachers more frequently than pre-service teachers (Ernst, 2007; Nagra, 2010; Wilke et al., 1987).

To understand how pre-service teacher education plays a role in environmental education, we need more information about what, if anything, occurs in early career teachers' prior teacher preparation regarding environmental education. How do future teachers build the knowledge, skills, and dispositions required to implement environmental education into their classrooms successfully, if at all? And as these pre-service teachers move into their classrooms full-time, what, if any, facilitators and challenges do they encounter?

CHAPTER 2

REVIEW OF LITERATURE

Before examining teachers' knowledge and understanding of any particular discipline, such as environmental education, it is important to reflect on how teachers build their professional knowledge, skills, and dispositions as they move through different stages of their careers. This review of relevant literature includes the complexity of teaching, the need to develop a highly qualified teaching staff, and the teacher preparation process across multiple pathways to teacher licensure within the U.S. I will focus on the traditional university preparation process, investigate how *novice teachers*—those teachers who are early in their careers—transition into full-time teaching, and explore the specific challenges associated with teachers' early careers. By examining these contexts of novice teachers' preparations and early careers, I can explore how these contexts potentially influence teachers' inclusion of environmental education in the classroom.

Complexity of Teaching

The quality of schools depends on the quality of the teaching and learning taking place. Teachers play significant roles in providing quality education (Feiman-Nemser, 2001). The quality of teaching can shape students' school experiences and affect their academic achievement (Guerriero, n.d.; Hanushek, 2007; Harris & Sass, 2011). Therefore, one of the best ways to support students and schools is to encourage and strengthen teachers throughout all stages of their professional careers, from novice to experienced (Feiman-Nemser, 2001; National Academies of Sciences, Engineering, and Medicine [NASEM], 2015). But teaching is not straightforward, and a teacher's job is complex. Therefore, the support needed to build and sustain quality teaching must be comprehensive and continual (Riedler & Eryaman, 2016).

Within their classrooms, teachers not only help students learn new skills and knowledge, but "work as professors of disciplinary content, facilitators of individual learning, assessors and diagnosticians, counselors, social workers, and community resource managers" (Darling-Hammond, 2006, p. 5). To succeed, teachers need a plethora of competencies, including discipline-specific knowledge; communication skills; understanding of children's needs; and professional skills and attitudes, such as determination, collaboration, and flexibility (Darling-Hammond & Sykes, 2003). But their classrooms are just parts of the school communities to which they belong. Teachers also interact with other teachers and students, school administrators, and other staff. The school community also includes the parents and volunteers participating in school activities and extra-curricular events like clubs. Schools and their communities are complex environments that are constantly changing (Cochran-Smith, 2003; Hammerness et al., 2020; Livingston, 2017). School policies and processes can be affected daily by funding, school culture, community support, and key actors—such as parents, students, teachers, and local and state administrators (Riedler & Eryaman, 2016). Therefore, school contexts, as well as individual teachers, can be affected by complex pressures, sometimes conflicting, from the state (e.g., standards for learning); district (e.g., curriculum and assessment requirements); and parents (e.g., specific needs for their children). To meet these ever-changing needs, teachers must constantly adapt, reconstructing their plans for teaching based on the needs of students and external pressures that arise (Florio-Ruane, 2002). Teachers must be prepared for the myriad responsibilities and challenges and operate with limited resources and time. Teaching is complex.

In addition to the variety of everyday challenges that novice and experienced teachers encounter, both in the classroom and within their school, there is tremendous pressure on all schools and teachers in the U.S. to improve the education system and provide quality learning for all students (Reback et al., 2014). The pressures of teaching are magnified when examining achievement gaps in U.S. schools. The U.S. faces student achievement deficits compared to other countries (Desilver, 2017) and between different subgroups of students within the country (Shores et al., 2020). These achievement gaps led to the passage of the No Child Left Behind (NCLB) Act of 2001, which included several federal mandates for education, including funding, assessment standards, and a requirement for schools to have "highly qualified" (NCLB, 2001, Sec. 1119) teachers, primarily aimed at improving the "academic achievement of the disadvantaged" (Sec. 101). Of particular note for this study is the focus on "highly qualified" teachers; it is generally accepted that, although myriad factors affect student achievement in school, teachers and socio-economic factors (e.g., school funding) exert the most extensive influence (Hanushek, 2007; Harris & Sass, 2011). Although school leaders might not control the socio-economic factors affecting their schools' communities, they can focus on hiring, training, and supporting quality teachers to better support school communities. Expert teachers can increase student learning and achievement by almost double what is expected in 1 school year compared to teachers with less skill and expertise (Hanushek, 2011). This suggests a need to know what determines if a teacher is "highly qualified," and how to prepare future teachers to be successful.

Highly Qualified Teachers

Quality schools require quality teachers (Feiman-Nemser, 2001). Although the need for quality teaching and teachers is generally understood and agreed upon, questions remain about the specific characteristics and skills needed to be a good teacher (Goldhaber, 2002) and how these characteristics and abilities are measured (NASEM, 2020). Many studies of teacher quality have examined teachers' years of experience or retention in the education field, certification types, and completion of an advanced degree (e.g., Guerriero, n.d.; Hanushek & Rivkin, 2006; NASEM, 2020). Other studies of teacher quality have focused on the influence of mentorship and classroom practice during the early years of a teacher's career for building teacher quality and effectiveness (e.g., Cochran-Smith & Power, 2010; Goldhaber et al., 2013). But how is teacher quality measured in these studies and others?

In many cases, teacher quality is assessed through students' performance on standardized tests as evidence of student learning and, therefore, quality teaching (NASEM, 2020; Popham, 1999). But assessing teacher effectiveness using student test scores is not necessarily fair. Often, standardized tests are created to compare general performance for all students in a particular grade level, rather than as a way to evaluate individual learning. Students' performance on standardized tests can be affected by their teachers, but it is also affected by factors such as their learning environments and opportunities for learning outside of school; therefore, it is not a reliable measure of teacher quality (Popham, 1999).

Tying teacher quality to student test scores or other characteristics of the individual teacher, such as completed professional development, undergraduate coursework, or advanced degrees, has yielded conflicting results regarding whether these are valid measures of teacher quality (Goldhaber, 2002; Hanushek & Rivkin, 2006; Harris & Sass, 2011). Instead, studies focusing on teacher certification (e.g., NASEM, 2015) or how teachers learn through practical experience (e.g., Hanushek & Rivkin, 2006) could be more promising in predicting teacher success. Even though a teacher's certification in the subject they plan to teach suggests higher teacher quality, only about two-thirds of U.S. states require a degree within a particular subject area for licensure, and that requirement is mainly limited to high school teachers (NASEM, 2015). Similarly, the suggestion that more experienced teachers are of better quality than those with less experience has only been proven during the early years of teaching (Goldhaber, 2002; Harris & Sass, 2011).

Some findings suggest that teacher quality increases with professional learning opportunities, especially during early-career work (Goldhaber, 2002; Harris & Sass, 2011), defined as within the first 5 years of teaching (Paniagua & Sanchez-Marti, 2018). During this time, teachers assemble critical knowledge, skills, and competencies to better support student learning and development while building the practical and professional knowledge and skills to operate within their school's community. During the time when teachers enter the profession, sometimes called an *induction period*, they continue to need support and professional learning. The induction period is "a bridge from student of teaching to teaching of students" (Ingersoll & Strong, 2011, p. 203). This continuation of professional learning after university coursework and student teaching are completed could include additional meetings and mentoring, workshops, collaboration with more experienced colleagues in the department, or further assistance within the classroom (Ingersoll & Strong, 2011; Kardos et al., 2001). The focus of this support could include organizing skills, such as pacing, classroom management, and planning (Frieberg, 2002); it could also provide the emotional support needed for novice teachers to integrate with the existing school community (Kardos et al., 2001; Schuck et al., 2018). The continuation of professional learning and support within a teacher's first year is especially critical to retaining teachers in the profession (Lovett et al., 2019). Teacher retention continues to be an issue, and greater than 44% of teachers leave the profession within the first 5 years of full-time work (Ingersoll et al., 2018).

Therefore, while support is needed for novice teachers learning to teach, support for early career teachers should also be considered as they enter the workforce (Bezzina, 2006; Ingersoll & Strong, 2011). Support should be extended throughout their early careers to ensure they continue growing and developing (Coolahan, 2002). The process of preparing teachers and supporting their continued growth throughout their careers requires considerable expense and coordination but can develop quality teachers, which U.S. schools need. Many organizations have sought to create lists of required knowledge, skills, and dispositions to assist teacher educators in developing high-quality teachers (e.g., National Science Teachers Association [NSTA], 2020). Teacher educators use these lists—including skills such as planning, pacing, deep content knowledge, and classroom management strategies—to help prepare future teachers for the K-12 classroom.

Preparing Teachers

As stated previously, teaching is challenging and complex (Darling-Hammond, 2006; Grudnoff & Tuck, 2003; Hammerness et al., 2020). The complexity of teaching and the importance of preparing K-12 students for the future, which has implications for society, suggests that preparing new teachers is a significant task (Cowles, 2018; Darling-Hammond, 2006). Although there are similarities between in-service teacher learning and preparation of novice teachers, pre-service teacher preparation is much more complex due to novice teachers' lack of teaching experience. Robust teacher education can prepare novice teachers to meet the myriad demands of the profession (Darling-Hammond, 2006), and the more prepared novice teachers are, the longer they might remain in the profession. Science teachers have an even higher attrition rate than teachers in other content areas (Carver-Thomas & Darling-Hammond, 2017), with twice as many science teachers leaving the profession as those in social studies (National Commission on Teaching & America's Future, 2003). Therefore, specialized teacher education is needed to prepare pre-service science teachers before they reach the classroom.

Science Teacher Preparation

But how do we know what teachers need to know to be prepared for the classroom? For this review, I will focus specifically on the preparation of science teachers to demonstrate the specific knowledge, skills, and dispositions needed to teach science. In many school systems, science is often a lower priority than other subjects such as math and reading due to accountability measures enacted by NCLB (NASEM, 2015). These accountability measures focus on what was determined to be the essential knowledge and skills that all students should master and attempt to ensure quality education for all students. Because of this, science is often regarded as less essential for students to master than reading and mathematics. Despite this, it is imperative to prepare K-12 students for possible careers in science that might not yet exist (H. Jang, 2016). Careers in science, technology, engineering, and mathematics (STEM) are some of the most needed, especially as employers look to the future. Additionally, all students need general scientific literacy, whether they pursue careers in the STEM fields or not. Scientific literacy is necessary to make informed decisions, discern fact from fiction, and participate as informed citizens regarding anything from food preparation to health issues. Therefore, schools must prepare students with knowledge, skills, and competencies in STEM (McGarr & Lynch, 2017).

Additionally, recent reform within science education has moved the science classroom toward addressing the need for scientific literacy, focusing more closely on scientific inquiry and toward a 3-dimensional focus on scientific and engineering practices, cross-disciplinary concepts, and disciplinary core ideas (Morrell et al., 2020; NASEM, 2015). This focus is referred to as the Next Generation Science Standards (NGSS), a set of science standards that outline what students should know and be able to do at each grade level (NASEM, 2015). The scientific and engineering practices included outline how scientists practice science and, therefore, what students should experience in classrooms as scientists themselves, such as developing models and planning and carrying out investigations (National Research Council, 2010). Cross-disciplinary concepts—such as patterns, cause and effect, and stability and change—allow students to see connections across different science content areas and build their scientific literacy sequentially across various science courses. Finally, NGSS include disciplinary core ideas that showcase the essential concepts for each specific content area. For example, the disciplinary core ideas for earth science include Earth's place in the universe, Earth's systems, and Earth and human activity (National Research Council, 2010). The NGSS standards are supported by both scientists and educators and focus on bringing the act of practicing science alive with students, rather than asking them to memorize facts and processes (NASEM, 2015).

This recent reform within science education has put additional strain on science educators. Teachers might not have experienced this type of learning themselves as students, nor feel prepared to teach in this manner (NASEM, 2015). Despite this, they now need to be prepared to teach using this student-centered, inquiry-based approach, and in-service teachers might need support to do so (Loughran, 1994; NASEM, 2015; Sanford, 1988). This new way of educating students about science and engineering practices, as well as the focus on STEM within many schools, has led to a set of required knowledge, skills, and competencies for current and future science teachers.

Knowledge, Skills, and Competencies

With the adoption of the new NGSS standards for knowledge, skills, and competencies for K-12 students to master within the science classroom by the NSTA in 2014, science teacher preparation standards became outdated. To help teacher educators prepare teachers with the 3-dimensional thinking inherent in the NGSS, NSTA and the Association of Science Teacher Educators (ASTE) partnered to create an updated set of standards for training science teachers. The two organizations worked together from 2016 to 2018, and both fully adopted the resulting standards in 2018 (Morrell et al., n.d.). The new standards were developed using current research in science teaching and learning and include six key focus areas for science teachers' knowledge, skills, and competencies: content knowledge, content pedagogy, learning environments, safety, impact on learning, and professionalism (Morrell et al., 2020), which will be described next.

Science teachers must have deep *content knowledge* within the curricula they teach. Teaching science includes teaching how scientists practice science and bringing students into that practice, so understanding science and engineering practices is necessary. Additionally, teachers should know how to structure students' knowledge and practice of science at an appropriate level for their development (Morrell et al., 2020). Within secondary-level teacher education specifically, there is a recent shift toward a focus first on subject matter expertise, and then on teaching expertise (Coolahan, 2002; Mase, 2021; G. Ryan et al., 1996). Therefore, most secondary teachers come to the teaching profession with content knowledge from their areas of specialization gained through their undergraduate educations (Feiman-Nemser, 2001), but they need to refresh and maintain that content knowledge continually. They must have a deep understanding of facts, concepts, and core relationships amongst content-related topics. Although teachers with an advanced degree might have a deeper understanding of the content and be better able to help explain concepts to the students, content knowledge alone does not encompass all of the knowledge, skills, and dispositions that equate to teacher quality (Hanushek & Rivkin, 2006) in science.

Just as essential as content knowledge is how to teach it in a motivating and engaging way, known as *content pedagogy* (National Council for Accreditation of Teacher Education [NCATE], 2006). Pedagogical content knowledge, or how to teach and create successful learning environments within particular content areas (Goldhaber, 2002; Guerriero, n.d.; Shulman, 1986), is "critically important" (NCATE, 2006, p. 4) to teacher success and student learning and achievement. Specific to science, teachers should be able to develop learning opportunities that demonstrate the nature of science (i.e., social, observable, testable, biased), showcasing science and engineering practices for use in a variety of learning environments such as in the laboratory, classroom, and even outdoors (Morrell et al., 2020). This specialized knowledge might include using labs, discussions, and field trips as instructional strategies to build understanding of the nature of science (Feiman-Nemser, 2001).

In addition to a solid understanding of content pedagogy, science teachers must also create *learning environment*s or classroom atmospheres where students are encouraged to discover, explore, and interpret phenomena, using evidence-based reasoning to develop conclusions about those phenomena (Morrell et al., 2020). To do this, science teachers must know how to connect students' prior knowledge, experiences, and interests with classroom activities. Scientific investigations are a vital component of learning in the science classroom, allowing students to make observations, collect data, and compose results and conclusions. Again, this could include hands-on activities such as lab and field experiences. Most importantly, science classrooms should be equitable, trusted spaces where students can feel safe exploring the world as scientists.

Because teachers are responsible for caring for their students during classroom instruction, they must understand the experiments, tools, and environments included in the lesson (Morrell et al., 2020). This includes knowledge of the potential and associated *safety risks* within their planned instruction (DeMary et al., 2000). Due to the nature of scientific investigations, such as using flammable substances in the chemistry classroom, science labs are one of the higher-risk activities students participate in while at school. In this example, the chemistry teacher must be knowledgeable about any potential safety hazards, needed equipment, and appropriate procedures, such as proper ventilation, safety goggles, and proper disposal of chemicals. Teachers working in other science-based content areas might have separate safety concerns. For example, an environmental science teacher might be less concerned with chemical safety, but more concerned with risks such as running water, wildlife, and extreme temperatures in an outdoor space.

Another facet of a teacher's role in the classroom is assessing their *impact on student learning*. Teachers must use both their content knowledge and pedagogical content knowledge to create and implement aligned assessments that showcase appropriate evidence of learning within the discipline (Feiman-Nemser, 2001). In the science classroom, that might entail determining which evidence is appropriate to demonstrate that students "have learned and can apply disciplinary core ideas, crosscutting concepts, and science and engineering practices as a result of instruction" (NSTA, 2020, Standard 5 section). This assessment of learning also requires an understanding of individual students, and how to differentiate instruction and assessment accordingly.

Finally, the NSTA/ASTE science teacher preparation standards include a focus on *professionalism*. Science teachers are expected to update both their content knowledge and science pedagogical knowledge throughout their careers (NSTA, 2020). Teachers expand this knowledge through participation in professional development opportunities and through reflection on their teaching practices. By reflecting on their needs as teachers and on their teaching in a constantly evolving content area, they can improve the science education that all of their students receive.

These are the current standards for science teachers, as outlined by NSTA and ASTE, suggesting what science teachers must know and be able to do and are not limited to scientific concepts and isolated facts (NASEM, 2015). Instead, teachers' roles within their school communities extend beyond classrooms and require knowledge and skills beyond content knowledge. In addition, this newest reform of science education requires teachers to cross disciplinary boundaries that were taught to them in isolation, requiring a deep understanding of the nature of science and how to encourage students to develop that understanding through investigation and exploration of core scientific ideas and crosscutting concepts. This is a significant change from what is currently seen in most science classrooms (NASEM, 2020). Due to the complexity of teaching and the mosaic of teacher knowledge, skills, and dispositions needed, preparing science teachers for the classroom is also complex.

Teacher Preparation Programs

There are many paths to receiving a teaching license and becoming a teacher; because of that, teacher preparation programs can vary widely (Kloser & Windschitl, 2020). Each state's department of education has its own requirements for receiving a license to teach in that state, allowing the state to control the specific qualifications they require in their teachers (Olson et al., 2015; Zientek, 2007). State licensure may require a minimum number of hours of observing at a K-12 school and a certain number of hours of student teaching (Kuenzi, 2018). The state licensing process aims to ensure that teachers have received both coursework and teaching experience to adequately prepare them for teaching in a school.

Therefore, there is no straightforward, common path to address national competencies, such as the NSTA/ASTE science standards, put forth for teacher preparation (Kloser & Windschitl, 2020). As of 2018, there were more than 26,000 approved teacher preparation programs in the U.S. (Kuenzi, 2018). Regardless of the path, teacher preparation programs aim to ensure that novice teachers are primed with the knowledge, skills, and competencies needed for the classroom. Novice teachers might choose to attend a university program for their teaching license and training or opt for more direct paths to teaching, such as fast-tracked school district programs or independent organizations that offer teacher licensure options. Even within universities, the variations between teacher preparation programs can be considerable, encouraging debate on the best way to prepare future teachers (Boyd et al., 2009; Olson et al., 2015).

Much of the variation in pre-service teacher preparation programs is due to localized policies for teaching licensure, with individual states creating regulations, including required coursework or hours spent teaching (Gray & Furtak, 2020; NASEM, 2020; Olson et al., 2015). This makes it difficult to compare programs, and the variation of pathways can also make it difficult for teacher educators to determine how to best prepare future teachers. Ultimately, U.S. teacher educators must rely on the standards set forth by their states and within their disciplines to prepare highly qualified teachers as mandated by NCLB (Darling-Hammond & Sykes, 2003; Olson et al., 2015). Whether a traditional university program or a non-traditional path to licensure is selected, once enrolled, participants are considered to be pre-service teachers, meaning they have chosen teaching as a future profession but have not yet received certification for full-time teaching (Stroupe et al., 2020).

Traditional Teacher Preparation

Traditional teacher preparation programs are situated within universities, with partnerships extending out into local school districts for prospective teachers to receive experience observing and teaching in K-12 classrooms before receiving a license (Mase, 2021). They will be the focus of discussion for this review, because approximately 75% of prospective teachers choose traditional programs for their teacher preparation (Wilson & Kelley, 2022). Most states require, at minimum, a bachelor's degree to earn a teaching license (Olson et al., 2015), and many secondary science teaching positions require a bachelor's degree in the specific content area (Mase, 2021). Therefore, some traditional teacher preparation programs rely on models in which undergraduates move into a 5-year program, with content specialization developed before building teaching skills (Darling-Hammond, 2006; Zeichner & Bier, 2015). In these programs, prospective teachers receive a bachelor's degree in a content area, such as a science specialty, while taking education courses. These courses allow novice teachers to apply their content knowledge to the practice of teaching and often enable them to earn an advanced degree.

Teacher preparation programs, including undergraduate and graduate programs, can include university-based learning, such as coursework, rehearsal of teaching within the university classroom (Stroupe et al., 2020), and observation of experienced teachers' classrooms. Pre-service teachers also often spend some time collaborating with local teachers to continue their teaching practice, often called either *clinical practice* or *field placement* (Olson et al., 2015). The components of university teacher preparation programs will be discussed in more detail in a subsequent section of this chapter.

Most studies suggest that teachers prepared within traditional teacher preparation programs remain in the teaching profession longer than those prepared via non-traditional routes outside of the university, although there is continued debate on this topic (Goldhaber et al., 2013; Henry et al., 2014; S. Jang & Horn, 2017). The question of how to judge a preparation program's success is also highly debated. Should we consider the teachers' knowledge at graduation and the retention rate in the field? If so, research suggests that traditional programs outperform non-traditional programs (S. Jang & Horn, 2017). Or should we consider a novice teacher's students' achievement as a measure of success? If so, studies show equal success across both traditional and non-traditional pathways to certification (Goldhaber et al., 2013; Henry et al., 2014; Xu et al., 2011). In some cases, within particular content areas (e.g., all levels of math), non-traditional programs like Teach for America can produce more effective teachers than those trained traditionally, as determined by student achievement scores on standardized tests (Henry et al., 2014). This uncertainty of how best to prepare quality teachers forces us to examine both non-traditional and traditional preparation programs more closely.

Non-Traditional Teacher Preparation

Prospective teachers can pursue a variety of pathways to receive their teaching licenses (Cochran-Smith & Power, 2010). Just 2 decades ago, non-traditional teacher preparation—defined as anything that deviates from a university program—educated only a small percentage of prospective teachers (Henry et al., 2014). Now, non-traditional programs make up approximately 30% of teacher preparation programs, and they are seen to be acceptable pathways to teacher certification (Kuenzi, 2018; Zientek, 2007). Although non-traditional teacher preparation is difficult to define and can include programs associated with museums, school districts, and non-profit organizations (Cochran-Smith & Power, 2010; Henry et al., 2014; National Research Council, 2010), these pathways will be grouped together for the purposes of this review.

The length of a teacher preparation program is one of the most distinguishable differences between non-traditional and traditional teacher preparation. Non-traditional programs tend to be condensed, suggesting less coursework and fewer clinical experiences for future teachers (Cochran-Smith & Villegas, 2015; Olson et al., 2015; Stronge, 2018). These differences from traditional programs, such as the amount of time a prospective teacher spends teaching in a classroom during their preparation, can affect the preparedness of the future teacher (Cochran-Smith & Villegas, 2015; Olson et al., 2015). Novice teachers report that longer teaching time in classrooms afforded during traditional teacher preparation programs helps them develop needed skills and the professionalism required in their future work as educators (NASEM, 2020). Alternatively, some research has shown that non-traditional programs that include rigorous clinical practice, mentorship, and pedagogical coursework can produce teachers with high self-efficacy for teaching who are prepared for their first year of work as a teacher (Boyd et al., 2009; Darling-Hammond & Sykes, 2003).

One of the most widely recognized non-traditional teacher preparation programs is Teach for America (Henry et al., 2014). The Teach for America program places high-achieving college graduates in high-needs schools across the U.S. and requires a 2-year commitment to teach in a high-needs school after completion of the program (Teach for America, 2020). Teach for America's program consists of 5 weeks of training, including coursework and practical experience teaching in a classroom, followed by an immediate transition into full-time teaching.

After 2 years of full-time teaching, along with the mentorship they receive while teaching, teachers receive their licenses. This program allows novice teachers to begin teaching much more quickly than those attending university training. Although Teach for America has been shown to be successful in increasing K-12 student achievement, specifically in STEM, teachers prepared through Teach for America are less likely to stay in the field long-term, with most leaving the profession after their 2-year requirement has been met (Goldhaber et al., 2013; Henry et al., 2014; Stronge, 2018).

Another example of a non-traditional program is offered through Vermont's Agency of Education. In this program, prospective teachers who have not attended a traditional teacher preparation program but have a bachelor's degree can apply for a license directly to the state (State of Vermont, 2022). Prospective teachers must take standardized tests to demonstrate content knowledge and submit a portfolio of lesson plans. Experienced teachers then interview these prospective teachers, and a decision is made as to whether teaching licenses are granted.

Museum-based teacher licensure programs such as the American Museum of Natural History's Master of Arts in Teaching program, where graduate students learn how to teach both in the museum setting and within high-need schools in New York City (MacPherson et al., 2020), represent another pathway to receiving a teaching license. This 15-month program includes coursework and practical experience, plus intensive mentoring for prospective secondary Earth Science teachers (American Museum of Natural History, n.d.). Teachers prepared through this program complete graduate courses and apply what they are learning in their coursework within the museum's walls by participating in museum education programs. By practicing their teaching in non-formal spaces that have lower expectations than K-12 classrooms, novice teachers build confidence and self-efficacy before teaching full-time in schools (MacPherson et al., 2020). Teachers then complete two 5-month residencies at local schools alongside mentor teachers who provide feedback and support. These residencies also help address the lack of teachers in high-need schools in New York.

According to 2019 data about teacher preparation and teacher candidates, approximately one-quarter of U.S. public school teachers had received their licenses from a non-traditional program, including *career switchers* who have a degree in another field but are interested in transitioning to a career in teaching (Wilson & Kelley, 2022). Career switchers can receive provisional licenses with which they can begin teaching in K-12 schools immediately, but they must take courses while teaching to obtain their full licenses. Alternative pathways to teaching such as those described here have a place within the field of education and can provide appropriate options for those who want to enter the profession (Zientek, 2007). However, individual states will ultimately decide what options are available to prospective teachers and what they must demonstrate to receive a license (Henry et al., 2014).

Again, although teachers can enter the teaching profession through non-traditional pathways, most prospective teachers still choose traditional university-based programs (Kuenzi, 2018; NASEM, 2020). These programs are designed to help novice teachers build skills and understanding of teaching practices and allow a scaffolded approach to hands-on practice and rehearsal of teaching (Darling-Hammond, 2006; Shaughnessy & Boerst, 2018; Stroupe et al., 2020). Ultimately, though, how do we determine the effectiveness of teacher preparation programs in producing quality teachers prepared for future classrooms?

Quality Teacher Preparation

Across the different pathways to licensed teaching that preservice teachers can select among, there are several quality-control measures to ensure that programs are appropriately preparing future teachers. First, U.S. teacher preparation programs must undergo accreditation every 7–10 years through the Council for the Accreditation of Educator Preparation (2020). These external assessments of universities' teacher education programs assess program quality to ensure that universities meet the Council's standards, which require that future teachers have an understanding of their students, content, how best to work with students of different abilities and backgrounds, and the pedagogical skills to teach that particular content. Additionally, the Council ensures that pre-service teachers receive clinical practice through field placements and does post-graduate assessments to garner graduates' perceptions on how well their programs prepared them for full-time teaching.

Second, to ensure that all public-school students receive a quality education and that teachers are prepared for the myriad challenges they might encounter, there are national guidelines and competencies for teaching. A national non-profit, the Council of Chief State School Officers (CCSSO), which is focused on ensuring quality education for all public-school students, created the Interstate Teacher Assessment and Support Consortium, which developed a set of standards for teacher preparation programs to guide the development of effective teachers (CCSSO, 2013). These standards describe a framework for preparing future teachers, such as foundational knowledge, practices, and skills that teachers of all disciplines should have mastered before beginning full-time teaching (CCSSO, 2013). These standards can be used to guide teacher preparation programs across the nation and include similar topics to the NSTA/ASTE framework for science teachers, such as understanding learners and their different needs, specific disciplinary content, effective instructional and assessment practices, and the professional skills needed for working within differing school contexts.

Although these competencies might seem universal across disciplines, some of the specific requirements for science teachers include teaching the nature of science, facilitating rigorous student-centered problem-solving investigations, helping students understand abstract concepts and natural phenomena, using engineering practices, and ensuring the humane treatment of animal specimens (Hammerness et al., 2020; Morrell et al., 2020). The variety of science-related standards highlights the diversity of topics addressed in science teacher preparation programs, suggesting that science teacher preparation programs cannot focus solely on content knowledge or even content-based pedagogy. Instead, they must consider teachers' responsibilities and required competencies both within science, such as knowledge of safety and risks, and across multiple disciplines, such as using culturally responsive pedagogy and equitable teaching practices, creating equitable assessments, and designing learning environments.

Using accreditation processes, goals, and frameworks from educational organizations—at the national level, in a school district, or even in an individual school—as well as state licensing requirements, are ways to ensure teacher quality within schools by setting standards for teachers and schools to meet (Boyd et al., 2007). Whether the teacher is entering through a traditional teacher preparation program or is switching careers and needs to acquire a teaching license, these rules regulate teacher preparation programs to help ensure that teachers are prepared to the best of their abilities for what they will encounter. Again, most teachers are still trained traditionally; therefore, the focus of this study will be on traditional university-based teacher preparation programs. Further examination of those programs is needed.

University Teacher Preparation Programs

University teacher preparation programs aim to prepare future teachers for work in the classroom (Shaughnessy & Boerst, 2018). Still, they are often overwhelmed with the ever-increasing demands facing teachers (Darling-Hammond, 2006; NASEM, 2020). The difficulty of preparing teachers for all that they might encounter has been named "impossible" (Grudnoff & Tuck, 2003, p. 38) as the number of responsibilities teachers have within their schools is seemingly infinite. Nevertheless, university teacher preparation programs and teacher educators carefully consider the limited time that pre-service teachers are enrolled in their programs to design programs that prepare novice teachers by building both knowledge and practical skills. Programs can include coursework, observation of teachers in K-12 classrooms—including their assigned *cooperating teachers* who serve as in-service mentor teachers—and *field placements* where novice teachers are placed within their cooperating teachers' classrooms, typically toward the end of their degree program, for observation and teaching opportunities. These experiences build a novice teacher's capacity to learn "not only to 'think like a teacher' but also to 'act as a teacher'" (Darling-Hammond, 2006, p. 305).

Each pre-service teacher preparation program is somewhat unique in its curriculum and graduation requirements, including necessities for receiving a license within that state. It is essential to understand the university-based system of pre-service teacher preparation, to help us to understand why teachers choose (or choose not) to implement particular knowledge and skills from their preparation within their own classrooms. Additionally, pre-service teachers are exposed to a variety of perspectives and voices throughout their preparation, including coursework, teacher educators, their cooperating teacher, and other students, so contradiction and tension between the pre-service teacher and these other voices can be expected (Gray & Furtak, 2020). In subsequent sections, I will explore university-based learning for pre-service teachers, including practical teaching skills, field experiences, and field placements, and then discuss potential challenges that pre-service teachers might encounter throughout those components.

University-Based Learning

University-based learning is designed to give pre-service teachers a clear understanding of general requirements and expectations of teachers in the classroom (Hollins, 2011). Novice teachers are especially prone to hold mental models of teaching based upon their experiences as K-12 students, which could lead them to think they have a more robust understanding of what teaching is like than they actually do (Hammerness et al., 2020; Lortie, 1975). Most pre-service teachers have observed their own teachers as students, but those observations are incomplete in considering the complexities of the work of teaching. To accommodate for this, university-based learning might need to respectfully uncover these visions of teaching to prepare pre-service teachers for the realities of the classroom. University-based learning might build on teachers' experiential knowledge (Feiman-Nemser, 2001), or if that knowledge is biased or incomplete, the actual responsibilities of teachers can be clarified to provide future teachers with knowledge and skills of how to teach K-12 students within their disciplines (Hollingsworth, 2016; Lortie, 1975; Zimmerman, 2017). University-based learning does this through coursework and practical teaching experiences that allow pre-service teachers to build this understanding.

Teaching Content. Pre-service teachers might also arrive at their university preparation programs with background knowledge, some even with a degree, in their content specialty. Still, many lack the foundational background in educational theory or the hands-on practical knowledge necessary for teaching (Shaughnessy & Boerst, 2018; van Driel et al., 1998). Faculty at the university, often referred to as *teacher educators* (Mase, 2021), are typically the first professional influences within teacher preparation that pre-service teachers encounter. Teacher educators play a prominent role in the university-based learning portion of pre-service teacher preparation, and the university faculty's expertise and chosen course structures and materials can vary from program to program (Grudnoff & Tuck, 2003; Hammerness et al., 2005; Loughran et al., 2001). The expertise and the experience that teacher educators have in preparing pre-service teachers can greatly affect the success of pre-service teachers in the future.

While pre-service teachers are introduced to educational theory and general instructional practices (Grudnoff & Tuck, 2013), they also take courses that focus on classroom management; teaching within particular disciplines (e.g., science); and working with students with disabilities or English language learners (Olson et al., 2015). These courses provide opportunities for the novice teacher to learn about teaching strategies and can also provide time for novice teachers to practice strategies on their peers within the university classroom (S. McDonald et al., 2020).

Practical Teaching Skills. Applying the new knowledge acquired in university-based courses and building practical skills are equally critical to understanding foundational elements of education in preparing teachers for what they will encounter in the classroom (Darling-Hammond, 2006). During university-based learning, pre-service teachers are also provided opportunities for *microteaching*, where they rehearse short, practical teaching exercises within the safety of their university classrooms (Snyder, 2010). During microteaching, novice teachers test out different strategies and practices they are learning about in university classrooms. By practicing instructional strategies, pre-service teachers develop a deeper understanding of the resources and time needed and how individual students might respond to the activities (Stroupe et al., 2020). These rehearsals also give pre-service teachers the opportunity to build skills and confidence before beginning to teach in their own classrooms or the classrooms of their cooperating teachers. This practical experience is an essential component of preparing teachers to work effectively in the K-12 classroom (Boyd et al., 2009; Cochran-Smith & Power, 2010), especially when they can also observe these practical skills through experienced teachers' classrooms.

Field Experiences. With the increased focus on practice throughout teacher preparation, university-based learning extends out of the university classroom into local school districts that collaborate with the university to provide field experiences for pre-service teachers. Through this aspect of the teacher preparation process, novice teachers work within, across, and between the two very different contexts of university learning and K-12 schools. Novice teachers are exposed to partner schools by observing teaching and learning in K-12 classrooms, where they can witness experienced teachers (Olson et al., 2015). In some cases, pre-service teachers have field experiences within different school districts to see the variety of school types and contexts and longer-term observation and assistance in a single classroom during their field placements. This scaffolded introduction to classroom instruction—from university classroom, to observation of experienced teachers in a K-12 classroom, to a field placement where the novice teacher takes on more of a leadership role within the K-12 classroom—allows pre-service teachers to build and apply their knowledge and practical skills of teaching.

Field Placements. The field placement, or practicum student teaching experience, is a mainstay of most pre-service programs, allowing the novice teacher to dive deeply into observing, assisting, and interacting with students in a K-12 classroom (NASEM, 2020). During this field placement experience, the pre-service teacher might lead many aspects of teaching, including planning and implementing instruction; planning, administering, and grading assessments; speaking with parents and attending school staff meetings; and dealing with discipline and other behavioral issues that occur in the classroom. In some cases, the cooperating teacher is still present in the classroom to provide guidance and reinforcement for the pre-service teacher, and the pre-service teacher serves as the lead teacher for several weeks. In other cases, such as teacher residency models, the pre-service teacher participates in a long-term internship alongside an experienced teacher. Either way, at this point, pre-service teachers are transitioning from learning about teaching to experiencing teaching (Grudnoff & Tuck, 2003).

A field placement could take place at various times within the pre-service teacher's preparation, but in most cases, the majority of the hours spent in observation of in-service teachers occurs near the end of their university-based learning and entails several weeks of full-time observation and teaching in their cooperating teacher's classroom. In 60% of traditional teacher preparation programs, novice teachers spend one semester in their field placement; 20% of traditional programs have their pre-service teachers spend even more time in their field placement (Olson et al., 2015).

Cooperating teachers can profoundly influence pre-service teachers' experiences during the field placement, in addition to the influences of university staff members who taught and mentored throughout the students' university-based learning (Grudnoff & Tuck, 2003; Ward et al., 2011). Cooperating teachers serve as mentors to novice teachers, both as a model for the novice teacher and by providing direct feedback as the novice teacher begins to practice teaching in their classroom. *Mentoring*, or pairing a novice teacher with an experienced teacher who can provide guidance, feedback, and direct support, is often a crucial component of a pre-service teacher's preparation (Ingersoll & Strong, 2011). It is especially important during the time when the teacher is building their understanding of teaching, their self-efficacy to lead a classroom, and throughout their field placement (Luehmann et al., 2020).

Potential Conflicts. Novice teachers might encounter several conflicts as they progress through university-based learning into the K-12 classroom, including conflicting viewpoints and perspectives from multiple voices and clashing opinions on what constitutes the most important aspects of teacher preparation. First, many voices influence pre-service teachers throughout their teacher preparation, including university faculty, their cooperating teachers, school administrators, other pre-service teachers, and department heads. As the novice teacher spends more time with their cooperating teacher in their field placement, the influences of their K-12 field placement take precedent over research-based teaching practices presented in coursework; pre-service teachers observe how cooperating teachers use strategies to manage the classroom and engage students with content-specific learning (Lortie, 1975; Ward et al., 2011). Before their field placement, cooperating teachers play minimal roles in the teacher preparation process (Pryor, 2006). The primary influences remain in university-based learning with teacher educators. During field placements, with a cooperating teacher at the forefront of the pre-service teacher's experience, there is an increased chance that topics covered in university-based learning might not be supported or might be contradicted by what pre-service teachers observe and discuss during this clinical experience (Windschitl et al., 2020). These potential contradictions can confuse the teacher about which educational models to follow (Ward et al., 2011). For some pre-service teachers, these differences could spark growth in critical reasoning skills as they have to decide the most appropriate teaching styles, instructional strategies, and intentions for their classroom (Grossman et al., 2000). These intentions can be set during their teacher preparation program, as they learn about and observe teaching in K-12 classrooms. For other teachers, these contradictions could force them to relinquish their professional intentions in an effort to persevere through clinical practice and meet their mentor teachers' expectations during student teaching (Wilcox et al., 1992).

Mentor teachers who are thoughtfully and meaningfully paired with pre-service teachers, and who have experience working with pre-service teachers, communicating clear expectations, promoting pre-service teacher autonomy in the classroom, and providing timely feedback to the pre-service teacher can improve the preparation process (Luehmann et al., 2020). By contrast, cooperating teachers who are not formally prepared for the degree of mentoring and support pre-service teachers require could hinder growth and might not be a strong, influential voice in preparing the pre-service teacher (Clarke et al., 2014). Additionally, mentor teachers who are not open to learning from pre-service teachers during field placements can cause conflict when the pre-service teacher attempts to bring new and innovative ideas into the cooperating teacher's classroom (Luehmann et al., 2020). In most cases, though, the cooperating teacher ultimately plays the most prominent role in supporting the pre-service teacher in enacting instructional practices and helping the pre-service teacher develop professional skills through experience (Grossman et al., 2000; Kennedy, 1999).

There are conflicting opinions among teacher educators on what constitutes the most crucial part of university-based learning. Some view the field placement as critically important in developing a teacher's instructional skills and knowledge, even stating that the university's influence is "washed out" by what is learned during the field placement (Zeichner & Tabachnick, 1981, p. 7). Others view the field placement as an essential component but question its timing because pre-service teachers might join the K-12 classroom after the school year begins, sometimes missing activities related to setting up a classroom, building classroom management strategies, and constructing class culture with students (Frieberg, 2002). Still others think that university coursework and field experiences are too disparate from the field placement in a K-12 classroom because pre-service teachers might not observe the research-based strategies that they learned in their teacher preparation (Ball, 2000; Grossman et al., 2009). Regardless of the timing and structure of both university-based learning and field experiences, and which has longer-reaching impacts, providing pre-service teachers with both university-based learning and field experiences can offer them a well-rounded overview and preparation for full-time teaching in the future.

From Teacher Preparation to In-Service Teaching

It can be challenging for teacher educators to feel confident that pre-service teachers are prepared for all they might encounter in their future classrooms (Grudnoff & Tuck, 2003; Loughran et al., 2001). Transitioning from a pre-service teacher to a novice teacher is a stressful and hectic endeavor as novice teachers begin to understand what it means to be teachers on their own (Beauchamp & Thomas, 2011; Wanzare, 2007; Zimmerman, 2017). This transition from university student to full-time teacher is sometimes referred to as *boundary-crossing*—or moving from one distinct system to another (i.e., university to K-12 classroom)—despite considering field placements as an intermediary system (Nguyen, 2020). This transition into a second context for professional learning, from university student to full-time employee in a school, is fraught with practical challenges, such as classroom management and disciplinary decisions, and tests to the novice teachers' socialization within their school communities (Loughran et al., 2001; Steele, 2001). Depending on novice teachers' backgrounds and experiences, including those in their pre-service programs, they might be more or less prepared for these challenges.

First Year of Teaching

The reality of the first year of teaching can be daunting for novice teachers (Huberman, 1989; Veenman, 1984). For beginning teachers, the first several years can be exponentially challenging since teaching is one of the few professions in which the employee is required to take on all responsibilities immediately at the start of their tenure (Grudnoff & Tuck, 2003).

Teachers experience many challenges, and these challenges can overwhelm novice teachers' excitement about teaching (Steele, 2001). New teachers might be so overwhelmed with these challenges that they forget some of the skills and knowledge learned in their pre-service preparation program while they focus on survival through the first year of full-time teaching (Zembal-Saul et al., 2020).

Challenges for Novice Teachers. Although university-based learning and field placements attempt to preview the potential challenges that novice teachers might encounter in their future classrooms, those challenges can be difficult to understand until novice teachers are fully immersed in their first year of teaching. Challenges such as communicating with parents, lack of time for lesson planning, and understanding how to join a new school community are all hard to prepare for until novice teachers are teaching full-time (Kilgore & Ross, 1993; Steele, 2001; Zembal-Saul et al., 2020). University preparation programs can still have a role in easing this transition by explaining the challenges of first-year teaching honestly and helping students to understand that the first-year experience is not representative of all future years of teaching (Humphrey, 2000). Two of the largest challenges that novice teachers face in the first year of teaching include resolving the difference between their previously created intentions for the classroom and the reality of the classroom and how to build relationships with the K-12 school community they are joining.

First, during pre-service teacher preparation, novice teachers create intentions for their future classroom, including how they plan to teach, their classroom management strategies, or even how they will design the classroom space. First-year teachers might not be able to pursue those visions and intentions due to the multitude of demands facing them (Hollingsworth, 2016; Steele, 2001). This does not suggest that these visions and intentions will never be fulfilled

(Grossman et al., 2000), but it might take longer—beyond the first year of teaching—to determine whether novice teachers see their visions and intentions into fruition. A focus on addressing challenges could extend into the first several years of teaching, and often teachers are not established in their careers until the first 5-10 years are complete (Kilgore & Ross, 1993).

A second challenge that influences first-year teachers is the need to focus on building strategies, relationships, and understanding of school policies and cultures (Bezzina, 2006; Frieberg, 2002; Kilgore et al., 1990). Novice teachers need support, and preparation for socialization into a new professional context can be complex for teacher educators to implement (Zembal-Saul et al., 2020). Additionally, novice teachers likely assimilate quickly into *cultural norms,* or behavior and expectations of the members of the immediate school community that are learned through watching and listening to others. This assimilation can happen whether it aligns with their personal beliefs or what they experienced during their university-based learning. Novice teachers need assistance from their experienced colleagues to navigate cultural norms (Bezzina, 2006) and provide company and support to bring them into the school's community. Novice teachers can feel isolated and separated from experienced teachers; they need partnerships with experienced teachers to feel included (Ingersoll & Strong, 2011; Paniagua & Sanchez-Marti, 2018). Unfortunately, there might be a lack of incentives for experienced teachers to take the time needed to mentor novice teachers in addition to fulfilling their own teaching responsibilities, leaving novice teachers feeling unsupported (Sanford, 1988).

The challenges novice teachers experience as they move from student to teacher has been called the "two-worlds pitfall" (Feiman-Nemser & Buchmann, 1985, p. 54), which encompasses the differing perspectives, rules, and social norms between university-based learning through field experiences and field placements, and those inherent in full-time teaching. Teachers can experience this pitfall if they are left unsupported in navigating these challenges, leaving them discouraged and deterred from teaching (Hammerness et al., 2020). But if supported throughout both university-based learning and into full-time teaching, this can be avoided.

A novice teacher's perspectives and dispositions can help them overcome some of these challenges and can be used to predict success throughout their first year. For example, teachers in one study who felt that their vision for teaching was supported in the first year had a firm personal and professional drive to ensure that vision is enacted, a large amount of curriculum knowledge, and a supportive administration (Steele, 2001). Similarly, teachers with professional strengths such as understanding the complexities of teaching, seeing themselves as continual learners, and having a sense of purpose in their teaching were also successful seeing their intentions represented (Kilgore & Ross, 1993; Parsons et al., 2017), as were teachers with a flexible disposition or the ability to adapt to changes quickly (Coolahan, 2002). By contrast, teachers who focused on timing and pacing of curricula and criticized themselves for their developing skills in these areas had a more challenging time maintaining the intentions they set for their classrooms during teacher preparation (Zimmerman, 2017). Also, teachers who found themselves in different school cultures than they imagined they would encounter struggled with implementing their intentions (Grudnoff & Tuck, 2003; Steele, 2001). Some of these challenges have been found to lessen in the second year of teaching, however, when teachers more fully understand school policies and communities and can focus more frequently on student learning needs (Grudnoff & Tuck, 2013).

Support Structures for Novice Teachers. One way to remedy this transition is to involve all stakeholders from the beginning of the teacher preparation process, including university faculty, cooperating teachers, school administrators, and other school colleagues who assist novice teachers. This ensures that all stakeholders have clearly defined roles and open communication in how to support novice teachers throughout this process (Feiman-Nemser & Buchmann, 1985). In addition to clearly defined roles and open communication amongst participants in the teacher preparation process, one of the best support structures for novice teachers is induction and mentoring programs, which have been shown to improve novice teachers' experiences in their first year of teaching, but are not often offered (Ingersoll & Strong, 2011). Induction, as defined earlier, is a process to ease boundary-crossing and helps transition novice teachers from university students to full-fledged teachers (Bezzina, 2006). Induction programs can range from orientation sessions to help novice teachers become familiar with the school's procedures and expectations, to long-term supports like professional development, reduced workloads, and assistance within the classroom (Ingersoll & Strong, 2011; Lovett et al., 2019). A positive experience in the first year of teaching, including preparedness, mentoring, and support from colleagues, can predict success in future years of teaching and reduce the likelihood of novice teachers leaving the profession (Curry et al., 2016; Darling-Hammond, 1998; Noguera & McCluskey, 2017).

Early Years of Teaching

Most research focusing on novice teachers' intentions, challenges, and "survival" (Kardos et al., 2001, p. 282) only follows them during the first year of full-time teaching. Longitudinal studies, including those that focus on the perspectives of early career teachers, should also be conducted to understand more clearly how university-based learning and field experiences influence novice teachers and their abilities to address challenges (Noguera & McCluskey, 2017). Additionally, the perspectives and experiences of first-year teachers are not necessarily the same as what teachers perceive and experience in subsequent years. By looking beyond the first year and into the first few years of teaching, teachers might be found successfully reflecting upon and using knowledge and skills from their university-based learning experiences after overcoming the challenges of administrative tasks and classroom management (Loughran et al., 2001; Noguera & McCluskey, 2017; Pryor, 2006).

Even if teachers are found to be more successful in their second through fifth years of teaching, though, they are still considered novices and can still encounter challenges similar to those of first-year teachers (Noguera & McCluskey, 2017; Paniagua & Sanchez-Marti, 2018). Thus, induction programs and mentoring of novice teachers must continue for the first several years of teaching (Bezzina, 2006). Mentoring in this phase of a novice teacher's career is more advisory than required, as formal induction programs are not commonly offered to novice teachers. In contrast to their field placements, where novice teachers have assigned mentors tasked with observing and reviewing their performance and providing regular feedback, during full-time teaching, mentoring tends to occur less frequently, despite needs for resources, leadership, and continued observation (Kardos et al., 2001). Novice teachers are still learning and developing as full-time teachers, and it could take time for them to feel confident, even with the support of a mentor. This mentoring might come from principals, department heads, and other colleagues, but it could also arrive in the form of support from peers in their graduating class who are undergoing similar experiences (Kilgore et al., 1990). Regardless of where novice teachers find mentorship, support from a mentor or colleague can ensure that the early years of teaching are a positive experience (Kardos et al., 2001; Morrison, 2013; Schuck et al., 2018).

Support Structures for Early Career Teachers

Induction programs, as referenced earlier, are one of the best ways to support early-career teachers (Ingersoll & Strong, 2011). One suggestion is to regard the first 5–6 years of a novice teacher's career as a residency, a time to pilot test strategies and learning activities with more mentorship and less responsibility for the classroom (Paniagua & Sanchez-Marti, 2018). In this way, the residency and the induction are the same, allowing novice teachers to experiment under the guidance of more experienced mentor teachers (Frieberg, 2002). At the same time, this residency could include needed professional development for the novice teacher.

All teachers need continual professional development to grow in their professional skills and their sensitivities to the diverse needs of students in their classroom (Kilgore et al., 1990; Schuck et al., 2018). Although teachers in their early years of teaching often refer to their university-based learning, including coursework, materials, and instructional skills (Grossman et al., 2000), they also need sustained professional development to continue this professional growth.

Unfortunately, novice teachers might not receive the support they need; although many teachers might participate in a formal induction program, they are still not receiving needed support for a sustained period of time (Ingersoll, 2012; Luft & Patterson, 2002; National Center for Education Statistics [NCES], 1999). These programs are offered even less frequently in small school districts (NCES, 1999). If official induction programs cannot be offered, novice teachers should, at minimum, have continual mentoring from experienced teachers where they can observe teachers in their classrooms and have a support system to consult for advice and feedback (Kardos et al., 2001) as they navigate the transition from teacher preparation to early years of full-time teaching.

Across Two Contexts

How well are the two contexts of teacher preparation—the university program (encompassing university-based learning and field placements) and full-time teaching—aligned, and where are they misaligned, if at all? How do those contradictions affect novice teachers in what they can, and choose, to implement in their classrooms? Each context includes different actors, actions, assumptions, and power structures.

Due to the complexity of preparing teachers for work in the classroom, several studies have looked at the influence of these different systems on novice teachers' development and preparation (e.g., Darling-Hammond, 2006; Loughran et al., 2001; G. Ryan et al., 1996). Researchers in each study asked teachers to reflect on their teacher preparation programs and consider what they used in their K-12 classrooms from that experience. This included the challenges and opportunities they encountered within each system of their preparation—the university-based learning and practicum—followed by the transition to their first year of teaching and beyond. Novice teachers reflecting on their teacher preparation and the influences of their in-service teaching offer insights into the two systems and their benefits and challenges (Bezzina, 2006). Some teachers suggested that their field placement experiences far outweighed their university-based learning in preparing them for their future classrooms (Selland & Bien, 2014), giving little credit to the rest of their university programs for preparing them for their roles as teachers (Grossman et al., 2000; G. Ryan et al., 1996). These teachers may suggest an increased focus on practical experiences, but their opinion is based on their individual university program experience, including field placement. Therefore, these contexts would need to be considered when asking novice teachers for their opinions about which aspect of their preparation was more helpful.

By contrast, longitudinal studies following pre-service teachers past the first year of full-time teaching have found that novice teachers do refer to their foundational understanding of teaching from their university-based learning, and they refer to it as pivotal to their success

(Loughran et al., 2001; Pryor, 2006). Therefore, when considering whether university-based learning or full-time teaching experience are more valuable, it is essential to note whether researchers were evaluating novice teachers in their first year of teaching or further into their careers. The debate continues: How much time should be allotted to university-based learning and field placement if the goal is to prepare confident and successful teachers? And how do these systems work in tandem and/or contradict each other?

Even the amount of time spent on practical work within field experiences has been debated. Despite the hundreds of hours that many pre-service teachers might spend under the supervision of their cooperating teachers—observing, co-teaching, and leading classrooms, which could have a more significant influence on pre-service teachers than their university courses (Lortie, 1975; Loughran et al., 2001; Zeichner & Tabachnick, 1981)—some researchers have suggested that pre-service teachers need even more time in their field placements (Darling-Hammond, 2006; Hammerness et al., 2020). Exploring the interactions between these two systems (university-based learning and full-time teaching in a K-12 school), especially from novice teachers' perspectives, can help explain how prospective and novice teachers navigate the two contexts and the challenges, if any, that occurred throughout.

The question remains: What, if anything, do novice teachers bring into their classrooms from their teacher preparation programs to use during and after the first year of teaching, and why? Because most studies focus on the voices of first-year teachers, and do not subsequently follow the novice teacher, novice teachers in their second through fifth years of teaching must also be consulted.

Most previous studies have focused only on the first year of teaching to understand how intentions teachers created during their preparation experiences translated into their classrooms, and only a few generated longitudinal data through the first few years of teaching (e.g., Grossman et al., 2000; Kilgore & Ross, 1993; Steele, 2001). Without longitudinal research to follow pre-service teachers through the preparation process and into their early years of teaching, including contextual information about their schools and communities, it is difficult to know when, how, and if teachers' knowledge, skills, and dispositions change as they begin to teach full-time. To fully understand this journey and the possible disconnect some teachers might find between university preparation and their professional teaching practices, a variety of perspectives involved in teacher preparation must be considered. To explore all aspects of this teacher preparation journey, both systems (the university program and the K-12 school where they teach) must be examined, as well as the transitions and interactions between the two systems (Zeichner & Tabachnick, 1981).

Ultimately, the influences, conflicts, and interactions within and between teacher preparation programs and in-service teaching systems can determine what pre-service teachers use in their classrooms during their first few years of teaching. Novice teachers' professional contexts, both their specific pre-service teacher preparation program and their current K-12 school, as well as the personal commitment and professional strengths of the teacher, can help determine their ability to hone their practices in the K-12 classroom as they progress in their careers (Grossman et al., 2000; Kilgore & Ross, 1993; Steele, 2001). The complexities within and differences between these two systems suggest that a framework is needed to help explore and understand how teacher preparation programs and school contexts experienced during early-career teaching can influence teachers' classroom practices. For this study, I will focus on pre-service teachers' learning and in-service teachers' teaching of environmental education to examine teachers' perceptions of these two sometimes conflicting systems.

Pre-Service to In-Service Teaching: Cultural Historical Activity Theory

To explore the complexities of what teachers retain and implement from their pre-service teacher preparation programs, I will apply cultural-historical activity theory (CHAT) as a theoretical framework. This framework will allow a deeper understanding of the complex systems that teachers work and learn within and between, explaining how pre-service teacher preparation and in-service teaching work individually and together. CHAT enables researchers to focus on how learning is influenced by cultural, historical, and social factors, assuming that learning occurs within communities that embody and respond to these influences. The focus of CHAT is on the individual learner—in this case, the novice teacher—as well as the community surrounding the learner, including other people, their actions, and the tools they use. To understand these complexities, CHAT uses a *systems approach*, which considers all related components within a structure, rather than focusing on a part of the whole, to describe human activity and how it is affected by others and by the culture of the community (Engeström & Miettinen, 1999). For this study, I focused on two systems: university-based teacher preparation programs and schools and school districts where early-career in-service teaching takes place.

Activity Theory and Activity Systems

Activity theory is a way to understand human activity, such as learning or teaching, that assumes that there are internal (e.g., personal motivation and interest) and external (e.g., influences from others) processes affecting that activity (Engeström & Miettinen, 1999; Rizzo, 2003). For example, when eating in a restaurant, a patron's decision of what to order might be affected by what they are craving (internal) and what they see on the menu or what their friend orders (external). Learning can be considered in the same way. It is not entirely individually determined and experienced, but rather "socially-situated and artifact-mediated" (Rizzo, 2003, p.

1), meaning that individual learning is influenced by other people and by cultural artifacts, including tangible items, such as books or digital technology. Even though thinking is an internal process, learning something is shaped by society and other external factors. For example, what a restaurant chef can list on the menu might be affected by their personal preferences, but it could also be influenced by more extensive societal issues, such as supply chain factors that shape what supplies are available at a given time. Individuals learn as part of society, including the "structures, practices, and conventions" of that society, and those factors can shape learning (Bhaskar, 1989). This means that society was established first, and therefore all aspects of our society—how we form community, our societal rules, and cultural norms—affect how individuals learn.

Due to the many factors that can affect learning, it is important to focus on both internal and external factors interwoven in the learning process. CHAT uses the term *activity systems* to describe the complex systems that include both internal and external factors. Revisiting the restaurant example, even when focusing on an individual patron's order, myriad factors and players affect the patron's decisions, including the different roles people play (e.g., chef, waitress, patron); the rules of the establishment (e.g., order at the counter, takeout, table service, where to pay); and social norms (e.g., atmosphere, waiting for the waitress or waiter to take your order).

Although the activity system of a restaurant is a complex system, it is still possible to select one area of focus, or *subject*, to examine in-depth systemically, such as a member of the community or system (Engeström & Miettinen, 1999). In the restaurant example, the subject is the patron, the activity is dining, and the system is the restaurant. For this study, I am interested in the perspectives of individual teachers. Teachers will be the subject, or focus, and could be studied individually, but they are also members of systems (e.g., traditional teacher preparation programs and schools within school districts). The entire activity system will be considered, including how the people (e.g., university faculty and administration), places (e.g., university and K-12 school), and things (e.g., resources) can affect the subject (e.g., teachers). Therefore, the activity system examined will also include other voices and perspectives that are parts of the examined systems, currently and in the past (Engeström, 1987).

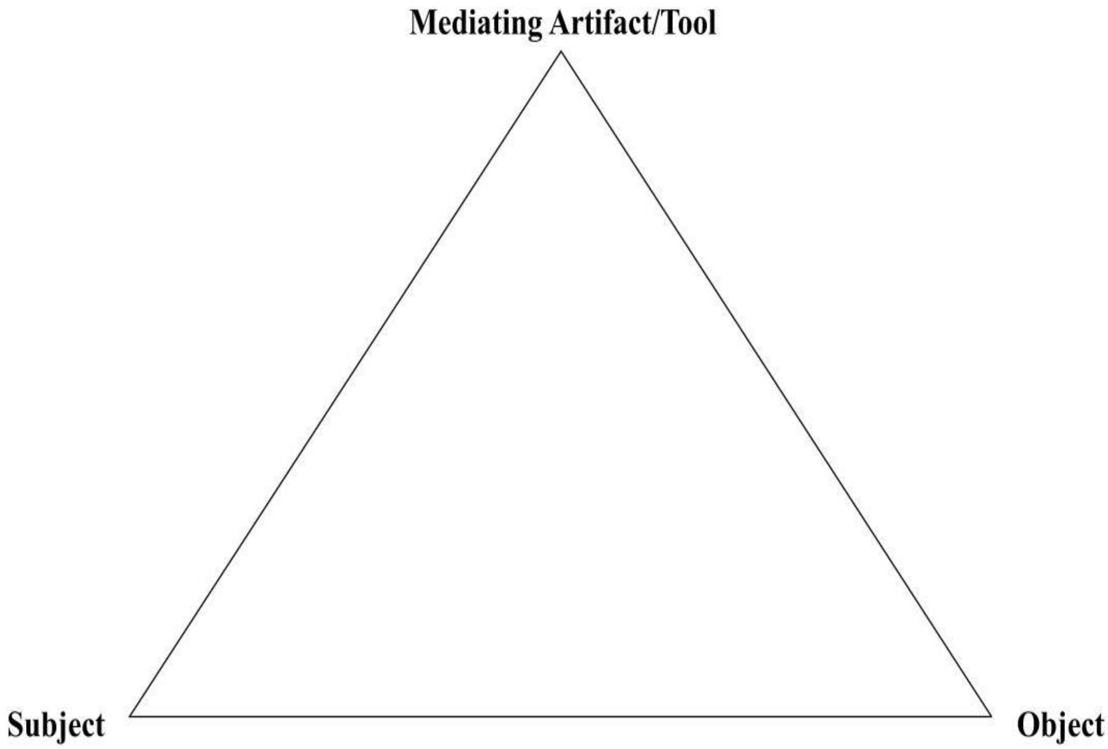
First-Generation CHAT

The CHAT framework is designed to analyze activity systems and is built from Lev Vygotsky's writings, first published in the early 1900s. As his work was translated into English in the 1960s and 1970s, interest in his theoretical musings increased (Engeström, 2001, 2015; Jenlink & Austin, 2013). Activity theory is one of the most important evolutions of Vygotsky's work. It highlights specifically that learning about humans must include attention to people's communities and the cultural and historical influences on individuals (Engeström, 2015; Foot, 2014).

The CHAT framework has undergone several revisions over time, referred to as different generations as it has changed. First-generation CHAT, or *activity theory* as it was called before the term CHAT originated, focuses on three components: the *subject*, *object*, and *artifact*, all within one system (Engeström, 2015). The subject is the individual or the focus of the study. The artifacts are the tools or tangible items that the individual interacts with, and the object can be understood as the motive or goal. First-generation CHAT suggested that researchers cannot fully understand the individual (subject) without understanding their context, which includes the available tools and resources (artifacts; Engeström, 2001). In the restaurant example, first-generation CHAT would examine the individual patron (subject) ordering a meal at a restaurant (object) and any items they interact with to do so, such as the menu (artifact). To illustrate this system, this triad of components is represented as a triangle, with the bottom line connecting the subject and the object (see Figure 1). The subject and object can be considered the subject's internal components, or the components that are personal and individual, such as what the diner is interested in eating. In contrast, the external (to the subject) components (resources and artifacts) are located at the triangle's vertex and represent the connections and influences that the external context has on the individual (Cole, 1996). An example of this could be a picture within the menu of a different dish that entices the diner to order something else. In the restaurant analogy, it is important to note that the artifacts at the vertex of the triangle do not replace the direct association of the patron (subject) ordering their meal (object), but rather showcase opportunities for influences from the context on the patron. For example, a large sign showcasing the special of the day might influence the patron to order something different from what they intended before seeing the sign.

Figure 1

First-Generation CHAT Activity System Model



Note. Vygotsky's (1978) triangle model of activity theory, adapted from Cole (1996), showcases the connections among the subject, object, and any mediating artifacts from the external context. This activity theory triangle is typically viewed as the model for the first-generation of the cultural-historical activity theory (CHAT) framework.

At the time of its creation, first-generation CHAT was radical in its thinking because "the individual could no longer be understood without his or her cultural means; and the society could no longer be understood without the agency of individuals who use and produce artifacts" (Engeström, 2001, p. 134). Returning to the restaurant analogy, the restaurant cannot be understood without considering the patrons, and the patrons eating in the restaurant are affected by many cultural aspects within the restaurant. At the same time, the first generation of CHAT was limited in that it still focused entirely on the individual acting in isolation as a unit of study (Engeström, 2015). First-generation CHAT would only focus on what the patron orders and not how and why the patron ordered as they did.

Second-Generation CHAT

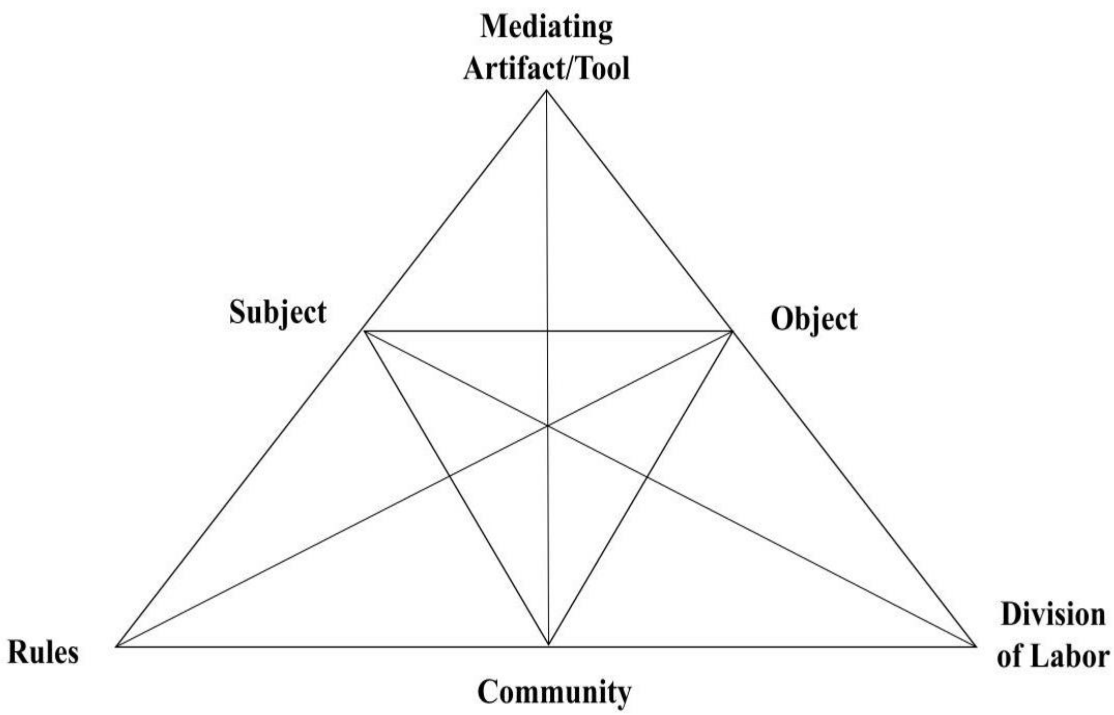
The next evolution of CHAT, at the time still called activity theory, came from Leont'ev (1978, 1981), a colleague of Vygotsky's, who extended the theory to what is now known as CHAT's second generation. Leont'ev considered *community influences* in his model, adding to the triad of first-generation CHAT (subject, object, artifact). Second-generation CHAT includes the entirety of first-generation CHAT but extends the focus from the subject/person and their interactions with artifacts to how subjects/people use those tools and resources to work together within their activity system and with particular rules or social norms in play. Second-generation CHAT also includes the *division of labor*, which refers to the community member's different roles and how various tasks are distributed, including who has more or less power (Cole, 1996; Engeström, 2001; Foot, 2014). The foundational underpinning of second-generation CHAT is that humans work toward an object or a common objective (Jenlink & Austin, 2013).

Leont'ev expanded the previous CHAT model by identifying the complex connections between the individual and their community and the consideration that individuals work together for common goals (Engeström, 2001). Within an activity system, this commonality of purpose (e.g., having a successful restaurant) recognizes that individuals do not exist in a vacuum. Instead, community, rules, and division of labor are included as possible influences on an individual's behavior and objectives. How would this affect our understanding of the restaurant example? Community refers to the others in the activity system who might share similar goals or affect the subject's behavior (Cole, 1996). For example, this could include the influences of a patron's dining companions or the result of the waitress's recommendation on the patron's order. Rules refer to the norms of society and those concepts that influence individual action (Cole, 1996). In the restaurant, a rule might exist that adults cannot order from the children's menu, possibly affecting the patron’s order. There are also divisions of labor within the restaurant, such as who seats patrons at their table, who takes their order, and who cooks their food. Second-generation CHAT brings together these concepts of rules, community, and division of labor with the subject, object, and artifacts from first-generation CHAT to further understand how collective activity is shaped and how it affects the individual.

Leont’ev never graphically depicted second-generation CHAT, but many scholars use a model similar to the one in Figure 2 to understand this framework’s complexity (Engeström, 2001). Again, second-generation CHAT encompasses all of the first generation’s elements, as shown in Figure 1, but also depicts considerations that affect human activity, such as rules or social norms, their community, division of labor, and connections among all of these components.

Figure 2

Second-Generation CHAT Activity System Model



Note. The second-generation cultural-historical activity theory (CHAT) model includes the original activity theory triangle of first-generation CHAT but extends the model to include additional components such as rules, mediating artifacts or tools, and division of labor. This visual depiction is adapted from Engeström (1987, p. 78).

Although second-generation CHAT still seeks to depict an individual's behavior within a system, this can only be done by considering the societal factors that influence the individual (Engeström, 2001; Jenlink & Austin, 2013). Second-generation CHAT brings to light the systems approach to understanding human activity, so that the activity system becomes the focus of CHAT-based study, rather than the individual. By considering all the parts of the system, including the people, resources, social norms, and goals, it is easier to see how they influence the individual and yield a more complete understanding of these complex systems (Engeström, 2015). However, second-generation CHAT does not include how different systems affect each other, which is why third-generation CHAT was established.

Third-Generation CHAT

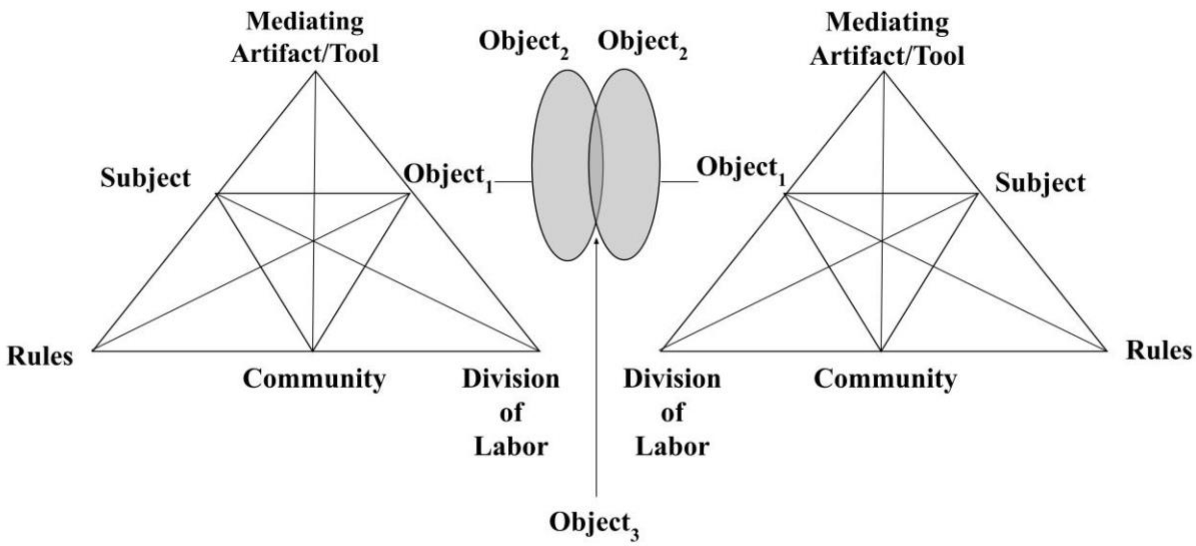
The third generation of CHAT grew out of criticism that the second generation ignored cultural diversity and the influences of different traditions and cultures on individual activity systems (Engeström, 2015). In third-generation CHAT, the first in which the name CHAT was used (DeVane & Squire, 2012), the framework continued to focus on understanding human activity by examining the factors that influence individuals within an activity system (rules, division of labor, artifacts) as it did in its second generation (Engeström, 2001; Jenlink & Austin, 2013). What is unique about third-generation CHAT is the deeper and specific focus on how separate activity systems interact with or contradict each other. In the restaurant example, the researcher would not examine a typical restaurant; instead, they would study a particular restaurant in a specific town. This more intensive focus on context follows a "deep historical approach" (DeVane & Squire, 2012, p. 250), allowing researchers to understand better how history has affected each system over time.

Additionally, third-generation CHAT recognizes the multiple perspectives operating simultaneously within an activity system. The multiple voices within an activity system can represent differing views, traditions, and interests, all bound together by a common motive, or object, such as to prepare future teachers for success in the K-12 classroom. There might be contradictions among members of an activity system's community and between the system's components. In the restaurant example, who decides what the objective of the dining experience is? The objective could be to serve a fine dining experience, to provide patrons with the opportunity to try unique dishes, or to make a profit. This would depend on whose perspectives were the focus of the study. The owner and the customer might have contrasting perspectives on the object, and these multiple experiences must be considered to understand the system entirely.

Another critical difference in third-generation CHAT focuses on contradictions within and across multiple activity systems (Engeström, 2001). A minimum of two activity systems is needed to apply third-generation CHAT, ensuring that the many features within and between the activity systems—including various viewpoints, power struggles, and discourses among individuals in each system—are analyzed (Roth & Lee, 2007). Third-generation CHAT also introduces the notion that multiple activity systems can work in tandem toward a shared object (Engeström, 2015), but that this object can change continually. Third-generation CHAT's comparison of two or more activity systems illustrates how each activity system's objective can be modified as it interacts with another system and its objective (see Figure 3).

Figure 3

Third-Generation CHAT Activity System Model



Note. This figure depicts third-generation cultural-historical activity theory (CHAT), which showcases the interactions of two activity systems with common but separate objectives (Object 1), such as preparing future teachers for the K-12 classroom. Object 2 refers to a common object across both systems, such as producing quality teachers for K-12 classrooms. Object 3 refers to a well-aligned, jointly constructed objective, where both systems work together toward a common goal. The visual depiction of third-generation CHAT was adapted from Engeström (2001, p. 136).

Activity systems can change as they interact with other activity systems, and these interactions can cause what Engeström and others have called *contradictions* (Engeström, 1987, 2001; Foot, 2014). This focus on contradictions among parts of the system, and deeper connections to social and cultural influences upon the subject (e.g., social norms, rules, and power dynamics), make third-generation CHAT unique. There are reciprocal relationships among the different components within the activity systems being examined, such as between subjects and objects or between subjects and tools (Jenlink & Austin, 2013). For example, the restaurant is affected by the patrons and what they order, as well as the patron being affected by what the restaurant offers on the menu. The interconnected nature of an activity system highlights how one change would influence all other components within one system and across more than one system. Returning to the restaurant example, the system is constantly evolving, including hiring of new staff, availability of food and other resources, and competition with other restaurants. Relationships and connections within the system are also ever-changing (Jenlink & Austin, 2013; Selland & Bien, 2014). If a new restaurant opens next door, that system could affect the original restaurant system by drawing customers away.

In the research proposed here, I will apply CHAT to study environmental education in pre-service teacher preparation programs and early-career teaching contexts (i.e., schools). By using third-generation CHAT to study these activity systems, social, historical, and cultural influences within each system could be discovered. These activity systems are not working in isolation and can have profound effects on each other (Plakitsi, 2013). Therefore, third-generation CHAT is better aligned than its previous generations to this study's focus, since it provides a framework to explore both activity systems that affect prospective and novice teachers.

CHAT's Key Principles

Engeström's (2001) third generation of CHAT can be explained with five fundamental principles. I will use a pre-service teacher preparation program as an illustrative example to explain each principle (Stamoulis & Plakitsi, 2013).

Activity System as the Focus. First, an activity system is the focus of the analysis, rather than the individual (Engeström, 2001). Rather than focusing solely on the pre-service teacher, the focus for this proposed research will be on the pre-service teacher preparation program as a system. I will analyze the individual perspectives shared in the study with the activity system in mind.

Multiple Perspectives. Second, multiple perspectives must be addressed within the activity system (Engeström, 2001); not only the pre-service teachers themselves, but also the university faculty, school administrators, mentor teachers, and other colleagues (such as K-12 teachers who have roles within pre-service teachers' field placements)—all of whom influence the learning of pre-service teachers. Exploring these influences on the pre-service teacher will contribute to understanding more fully the actions taken later by novice teachers, in this case with reference to environmental education.

Historical Foundations. Third, an understanding of historical foundations is essential, including how the activity system has changed over time and how historical artifacts have influenced members of the activity system (Engeström, 2001). In my proposed study, an understanding of the participants' specific teacher preparation programs over time, their inclusion of environmental education, and participants' K-12 schools' historical use of environmental education (including current educational reform efforts that have affected either system) should be considered to fully explore the systems and its complexities.

Contradictions. The fourth essential principle of CHAT's third generation focuses on contradictions within and between activity systems (Engeström, 2001). For example, contradictions can occur when new cultural norms affect an activity system, such as a new focus within a pre-service education program or adopting a different model of teacher preparation, such as requiring additional courses or hours for clinical experiences when state licensing requirements change. Contradictions are not necessarily negative influences on the activity system, but they can instead serve as sources of innovation (Engeström, 2001). For example, a new requirement for additional hours in the field placement might translate into better prepared and more highly qualified teachers.

Metamorphosis. The final principle forming the foundation of the third generation of CHAT focuses on how contradictions and questioning the cultural norms of each activity system can bring about a collective metamorphosis of both the individual and the activity system, causing transformation within the activity system. For example, if novice teachers were exposed to a new method of teaching within their university program that contradicts what is allowed and normal within their K-12 school when they are teaching full-time, they might be able to bring about sizable change to benefit instruction at their school by invigorating colleagues with new ideas and practices. These contradictions are foundational to CHAT and can be experienced at multiple levels.

Contradictions. Engeström (2015) describes four levels of contradictions that can occur within each activity system. A first-level contradiction exists solely within one of the main components of the activity system (subject, tools, community, division of labor, rules, or object). For example, a first-level contradiction could be the debate on what better prepares a novice teacher for classroom teaching: coursework or clinical experiences (e.g., Ball, 2000; Frieberg, 2002; Grossman et al., 2009). Pre-service teacher preparation programs might require a set number of hours for coursework and clinical experiences. This debate over which is more powerful in preparing the teacher demonstrates a contradiction. This contradiction is situated within the pre-service teacher preparation activity system's *rules* component, since the university sets requirements for the amount of teaching experience a pre-service teacher receives during their program based on state licensing rules. These rules could positively or negatively affect a pre-service teacher. The pre-service teacher's perspectives on this rule about the amount of time spent in the field placement could be explored in a study using CHAT to see how, if at all, these rules influenced their pre-service teacher preparation experience.

Second-level contradictions can be identified between activity systems' primary components, such as between the community (e.g., university faculty) and the subject (novice teachers) of a pre-service teacher preparation activity system. For example, pre-service teachers generally are motivated to include environmental education in their classroom teaching (Grace & Sharp, 2000). However, a lack of enthusiasm and training in environmental education among university faculty can prevent inclusion of environmental education. University faculty are one of the most influential components in the successful integration of environmental education within a pre-service teacher preparation program (McKeown-Ice, 2000). A previous study using CHAT to understand the integration of environmental education within pre-service teacher preparation found that even if the inclusion of environmental education is mandated, the university faculty's interest in and valuing of this topic are influential in its implementation in the university classroom. This contradiction can be seen as a limitation for pre-service teacher preparation programs. Although this is a limitation, it also suggests an opportunity to hire individuals who are proponents of environmental education (Rosemartin, 2015) and provide professional development to these university faculty (Franzen, 2017). Environmental education standards exist to help university faculty in this area, but the opportunity to learn about them and how to integrate them into preservice education programs could be lacking in a particular teacher education institution (Franzen, 2017; Powers, 2004).

Third-level contradictions occur when the subject tries to move the activity system forward to a new version, but the other members of the activity system reject that idea. An example of a third-level contradiction can occur when pre-service teachers begin teaching in their clinical practice (Tsui & Law, 2007). This transitional time can be a cause of contradictions as the novice teacher is expected to comply with the requirements of their university program while also listening to the advice and expectations of their cooperating teacher. For example, pre-service teachers might be exposed to new instructional practices within the university classroom, such as the Next Generation Science Standards (NGSS), but in their field placement might not experience their mentor teacher teaching with a focus on scientific inquiry and NGSS-recommended science and engineering practices. The novice teacher might try to implement teaching strategies that the cooperating teacher is not comfortable with. Contradictions like this can bring about positive change, such as new and innovative teaching strategies to the mentor teacher’s classroom but can also negatively affect the novice teacher if they are confused and conflicted about which model to follow.

Finally, a fourth-level contradiction can occur when two or more activity systems influence each other’s goals and objectives (Engeström, 2015). An example of this could be if the K-12 school activity system enacted a new policy requiring teachers to include field experiences for their students. If the pre-service teacher preparation activity system did not want to change its program to prepare teachers for this type of work, this could cause a contradiction across systems. CHAT scholars view contradictions as opportunities for positive change (Engeström, 2001). Policies within one activity system (e.g., a K-12 school) can influence another activity system (e.g., a pre-service teacher preparation program), which can push for innovation. In the example above, the innovation could include increased environmental education training for pre-service teachers in their preparation, because they might need to incorporate field experiences in their future teaching.

The CHAT framework has assisted researchers in examining specific activity systems, helping them understand how the systems work individually, and how they interact and conflict with other systems. This understanding of a system, and the interplay among components of the system, are vital to position and understand individuals and their choices within their systems (Saka et al., 2009). Education systems are complex, and the interplay between pre-service teacher preparation and early career teaching is complicated. CHAT can help us understand activity systems more fully (Jaworski & Potari, 2009) and hopefully parse out experiences and perspectives that will enable us to understand the complexities of each activity system and how they interact.

Environmental Education Among Two Activity Systems

To understand the complex systems that encompass teacher preparation programs and K-12 schools, I will focus on how, if at all, these systems influence teachers' implementation of environmental education in K-12 schools. As discussed in Chapter 1, environmental education programs are designed to prepare students to adapt to ever-increasing environmental issues affecting the planet (Burchett, 2015; Coyle, 2005). Students will need environmental literacy to implement solutions to these environmental problems; therefore, educators must help them develop this literacy (Boon, 2016; Franzen, 2017; Reid et al., 2021). Additionally, it has been suggested that environmental education can help to develop knowledge, skills, and dispositions that students need, even outside of environmental education, such as decision-making, problem-solving, critical thinking, leadership, collaboration, communication, concern for others, confidence, and connectedness (Ardoin et al., 2018).

Despite the demonstrated need for it, and some teachers making progress with its implementation in the K-12 classroom, there is a lack of systemic integration of environmental education in formal precollegiate education systems. In a recent study, only 68% of states in the

U.S. had any environmental education policies. Many of those were limited to an environmental education plan, rather than a mandate or requirement (Rosemartin, 2015). Additionally, most teachers who do incorporate environmental education with their students do so with short-term grant-funded initiatives, with little to no training or expertise themselves. These experiences cannot be sustained without the environmental literacy, as well as the strong personal motivation, of the teacher (Ernst, 2007).

I have already discussed how teachers develop new knowledge, skills, and competencies and have demonstrated that teachers' professional learning in the early years of their careers is vital. Therefore, to build educators' environmental literacy, focusing on teachers in their early careers or their pre-service teacher preparation programs is a valuable and potentially underused strategy. Many are looking to this audience to increase the incorporation of environmental education in the formal K-12 school context, especially as teachers (and family members) have been found to have the most significant influence on children's pro-environmental behavior (Chawla, 2009; Duarte et al., 2015).

Pre-Service Teachers and Environmental Education

Increasing environmental education within K-12 schools relies on the preparation of teachers, whether through pre-service teacher training or in-service professional development (Álvarez-García et al., 2015). Much of the environmental education literature published during the past several decades has focused on in-service teacher professional development (Disinger & Howe, 1990). To prepare teachers of all grade levels to be confident and competent in incorporating environmental education into their classrooms from the start of their careers, pre-service teacher training is recommended as the most effective approach (J. T. McDonald & Dominguez, 2010; Rebar & Enochs, 2010; Wakefield et al., 2022). This approach suggests that preparing novice teachers can be more effective than other processes, such as in-service teacher professional development or environmental educators visiting schools to offer programs directly to students. By reaching teachers in their teacher preparation programs and instilling the importance of environmental education early, it could become ingrained in their curriculum planning. These future teachers could reach thousands of students during their teaching careers, increasing the possibility of creating a responsible citizenry who understand their local environments and how to take stewardship action (Boon, 2016; Richardson et al., 2018). Additionally, future teachers generally feel favorably toward environmental education during their teacher preparation programs (Basheer et al., 2023; Grace & Sharp, 2000; Merritt et al., 2018); in one case, 95% of pre-service teachers felt it was appropriate to require this learning during teacher preparation (Lane et al., 1995).

Exposing pre-service teachers to professional learning about environmental education can also help them as they assist their students with solving authentic community problems (Cheong, 2005). Most schools want teachers trained in some aspect of environmental education (Grace & Sharp, 2000), and exposing pre-service teachers to this learning early in their careers can help them implement environmental education's best practices in their classrooms (Bell et al., 2003).

Challenges. Despite the hopes shared previously, environmental education has been removed from teacher preparation programs for many reasons, including program requirements; university policies; and a lack of trained university faculty, time, and resources (Franzen, 2017; Powers, 2004; Tomlins & Froud, 1994). Only four states in the U.S. have an environmental education requirement for receiving a teaching license, and only one of those states (Wisconsin) requires all prospective K-12 teachers to take courses in environmental education (Rosemartin, 2015). The concept of environmental education is appreciated across most universities, but it is still unlikely to be included in the formal curricula of pre-service teacher development (Franzen, 2017; Grace & Sharp, 2000; Wals, 2009). This is primarily due to lack of university faculty interest and stringent program requirements (Franzen, 2017).

University faculty have discussed the lack of an incentive and the complicated nature of pre-service teacher preparation as factors limiting their incorporation of environmental education content (Powers, 2004). Pre-service teacher preparation programs might be a new option for instilling environmental education practices in pre-service teachers, but the actual integration of environmental education within higher education is fraught with challenges, including where environmental education fits within teacher preparation curriculum and understanding how it can benefit the pre-service teacher (Bell et al., 2003; Plevyak et al., 2001).

Several researchers have attempted to quantify the number of pre-service teacher preparation programs that include environmental education. Fewer than 30% of universities in the U.S. implement teacher preparation programs offering dedicated classes for environmental education (Powers, 2004). A more recent survey of environmental education in pre-service teacher education found evidence of it in only 13% of the programs (Rosemartin, 2015). Another study estimated that approximately half of pre-service teacher preparation programs included some aspect of environmental education, but it was unclear to what degree or depth (McKeown-Ice, 2000). Although pre-service teachers might be exposed to environmental education through more informal processes—workshops, guest lecturers, and even field experiences—it is still limited across all teacher preparation programs (Richardson et al., 2014).

The most significant and commonly cited barrier for pre-service programs to overcome is federal and state government regulation relative to preservice teacher education, including accreditation and curriculum standards (Evans et al., 2017; McKeown-Ice, 2000; Powers, 2004).

Higher education policies and politics play significant roles in the limited implementation of environmental education (Evans et al., 2017; Heimlich et al., 2004). The limitations placed on teacher preparation programs, such as accreditation and licensure requirements, can force programs to focus on particular knowledge and skills rather than allowing time for environmental education (Franzen, 2017; Heimlich et al., 2004; Hug, 2010). Additionally, there are no mandates in most states to include environmental education in teacher preparation programs or even in K-12 classrooms, leaving university faculty with low motivation to include it (Powers, 2004); if it is included, the decision is often driven by individual teacher educators who are passionate about the topic (Wals, 2009). This leads to haphazard implementation over time at best. If environmental education is not part of an adopted curriculum, implementation could stop completely if faculty members who include it in their teaching leave their universities.

Therefore, university faculty play a key role in determining whether environmental education is included or excluded from pre-service teacher preparation programs, and there is a lack of university faculty who are knowledgeable about environmental education overall (Franzen, 2017; McKeown-Ice, 2000; Powers, 2004). Like K-12 teachers and students, university faculty need time outdoors and professional training to become comfortable with the concepts of environmental education, and most have limited experience with this type of professional learning (Powers, 2004). The multidisciplinary nature of environmental education can also confuse where to best place courses within the existing structure of pre-service teacher preparation and which university faculty would be responsible for teaching it, especially as programs can be siloed by content area (Ernst, 2007).

University faculty members' interest in environmental education can also be a barrier to its inclusion, with some faculty viewing it as an optional enrichment opportunity, rather than a potential avenue for teaching scientific investigation methods and the nature of science (Franzen, 2017; McCrea & deBettencourt, 2000; Minott & Minott, 2023). Additionally, lack of national accreditation for environmental education and a lack of time to include all of the required components of teacher preparation (such as the NSTA requirements for science teacher preparation: content knowledge, content pedagogy, learning environments, safety, assessment, and professionalism) are cited as barriers to the inclusion of environmental education within teacher preparation programs (Ernst, 2007; Franzen, 2017; McKeown-Ice, 2000; Powers, 2004). To remedy this, university faculty need support, such as resources and training, and awareness of national curricula and standards to organize courses and content for pre-service teachers. University faculty can learn how to approach these challenges by studying examples of successful environmental education within pre-service teacher preparation (e.g., Franzen, 2017; Heimlich et al., 2004; Inwood & Jagger, 2014).

Examples of Success. Despite these challenges, several examples of pre-service teacher preparation programs have successfully incorporated long-lasting environmental education programs. Wisconsin was the first in the U.S. to include and mandate environmental education in their teacher preparation programs in 1985 (Rosemartin, 2015). Pre-service teachers in Wisconsin can fulfill that requirement through approved courses at universities and through partnerships and trainings offered through approved environmental education organizations. Pre-service teachers in Wisconsin have reported valuing the knowledge, skills, and dispositions of environmental education in building responsible citizenship in their students (Lane et al., 1995; Plevyak et al., 2001). Other states have followed Wisconsin, and currently, 15 have a certification option for environmental education (NAAEE, n.d.-b).

Pre-service teacher preparation programs vary in their models of environmental education integration, however. Some include environmental education across the curriculum in a *multidisciplinary* approach, where the content is dispersed across various disciplines. By contrast, others offer a dedicated course for a specific audience (e.g., science students only), which can be either mandated or offered as an elective (Evans et al., 2017; Grace & Sharp, 2000; Heimlich et al., 2004). Many use national environmental education standards to provide a framework for university faculty to follow for teaching related strategies and evaluating pre-service teachers' competencies in this field (Franzen, 2017).

University faculty who do include environmental education in their courses and programs often use place-based education, outdoor experiences, role play, and solving community-level environmental issues as instructional strategies (Cheong, 2005; Evans et al., 2017). University faculty also take advantage of national environmental education curricula like Project WILD, a wildlife-based environmental education curriculum offered to teachers by the Association of Fish and Wildlife Agencies, which provides faculty members with background knowledge and pre-made lesson plans to share with pre-service teachers (Heimlich et al., 2004; Nelson, 2010). Participation in Project WILD training has increased pre-service teachers' knowledge of ecology and environmental education practices and use of hands-on activities and critical thinking instructional strategies (Nelson, 2010). Other organizations, such as the University of Toronto, have also attempted to create resources specifically for Canadian university faculty that can help incorporate environmental education into pre-service teacher preparation programs (Inwood & Jagger, 2014).

However, despite the resources available and sometimes used, how environmental education has been embedded in teacher preparation is still unclear and limited (Wals, 2009). Some integration might be one-off experiences for pre-service teachers, or appear only within elective courses, and not embedded fully into programs (Merritt et al., 2018; Summers et al., 2005). Additionally, the inclusion of environmental education in pre-service teacher preparation does not ensure that implementation will happen in novice teachers' first years of teaching, because support from the K-12 school is also needed (Plevyak et al., 2001).

Early Career Teachers and Environmental Education

Even less is known about incorporating environmental education in a pre-service teacher's field placement and in early years of in-service teaching, especially related to the techniques and resources that teachers learned about during their pre-service preparation and brought into their classrooms. In my review, I found only one study that quantified the number of environmental education materials used in early career teachers' classrooms. In this study, 82% of participating early career teachers reported using some aspect of an environmental education course from traditional pre-service preparation (Merritt et al., 2018). Without the course, they noted they would not have had the necessary background information to incorporate environmental education into their teaching. It is likely that novice teachers face challenges in the incorporation of environmental education, as they are already adapting to full-time teaching, facing issues such as lack of time, lack of alignment between environmental education and the current curriculum, and lack of school support for the incorporation of environmental education.

Support plays a critical role in early-career teachers' experiences, especially as they incorporate new modes of instruction that might not currently be included within their school community. Without support from administrators and mentor teachers, novice teachers might be less likely to implement environmental education (Richardson et al., 2014). Although early-career teachers have high motivation to bring innovative materials to the K-12 classroom, that incorporation hinges on support, such as resources, colleagues and administrators, and continual training (Merritt et al., 2018; Scott, 1996). This encouragement is similar to the support they need for all aspects of their teaching, from their cooperating teachers during their field placements, mentors in their early years of teaching, or administrators in either system. Unfortunately, these mentors might also lack knowledge and expertise in environmental education (Boon, 2016), but they could still provide support in finding funding, professional development, and resources to fulfill the novice teacher's desire to include environmental education in their future classroom (Plevyak et al., 2001).

Looking Forward

Environmental education provides opportunities for students to gain knowledge and skills important for addressing current and future environmental issues. Despite initiatives within the fields of education and science, the lack of increased adoption of environmental education within K-12 schools over time (Ernst, 2007) demonstrates a need to explore the systems that influence its implementation. With a push toward pre-service teachers as the future of environmental education (J. T. McDonald & Dominguez, 2010), it is necessary to explore, through the lens of environmental education, the complex systems they participate in, the lived experiences of early career teachers, and their use of environmental education in the K-12 classroom.

Few states mandate exposure to environmental education within pre-service teacher preparation programs (Franzen, 2017), but if they do, what roles do those pre-service preparation programs and K-12 schools play in shaping implementation? There is little research on why K-12 teachers use environmental education with their students and even less about the perspectives of early career teachers on this topic. Therefore, I proposed to examine early-career teachers' views on including environmental education in their classrooms, and their experiences across the two activity systems of their teacher preparation and the early years of full-time teaching. I have gained some insight on where the knowledge, skills, and dispositions to incorporate environmental education originated, if at all, and what challenges, if any, were incurred.

CHAPTER 3

METHODS

As I suggested in Chapter 2, few studies have explored how an introduction to environmental education within pre-service teacher preparation influences the implementation of environmental education after novice teachers are in their own classrooms. Additionally, little is known about how the differing activity systems of teacher preparation and in-service teaching influence teachers' integration of environmental education into the K-12 classroom. In this study, I explored the lived experiences of early career teachers, the associated perspectives from school administration and university faculty, and the meaning-making they constructed during their participation within and between the activity systems of their teacher preparation programs and their K-12 schools. Although I began with a focus on these two systems, throughout data generation, a third system emerged in nearly every participant interview: the state's department of education. This third system greatly influenced the teachers and their inclusion or exclusion of environmental education in the K-12 system. Therefore, the state's system was included in the study as a third system to examine, but because it emerged in interviews, it is not represented in the original research questions. In addition to the meaning making early career teachers constructed within and among these systems, I sought to understand any reported sources of conflict for teachers' integration of environmental education—both within and as they transition between activity systems—and how, if at all, they were able to overcome those challenges.

Therefore, my study addressed the following:

- Related to environmental education, what is the nature of the participants' experiences within and between teacher preparation and in-service learning systems?
- Related to environmental education, how, if at all, do these systems shape the participants' pre-service and in-service learning?
- How, if at all, do these two activity systems influence selected pre-service teachers' integration of environmental education into their in-service teaching?
- What is the nature of the conflicts early career teachers perceive, if any, in integrating environmental education into their classrooms, and how did the teachers respond to these conflicts, if they encountered any?

I explored the experiences of early career teachers, university faculty, and K-12 administrators in implementing environmental education within university and school curricula. Through participants' written responses, interviews, and analysis of relevant university and school materials, I learned more about how environmental education is incorporated into each of these systems and the challenges of this process for early career teachers.

Paradigm

To answer these research questions, a nonpositivistic approach was appropriate (Creswell & Poth, 2018) as I sought to discover participants' experiences within and between these two systems, including any conflicts they experienced. Nonpositivistic research is, at its core, interpretive in nature (Rossman & Rallis, 2003) and focuses on the description and analysis of participants' worlds. Four assumptions undergird nonpositivistic research. First, there is no one reality, suggesting that every person has their own experiences and interpretations of those experiences. Secondly, within nonpositivistic research, the researcher must interact closely with participants to understand each of their realities relative to the study's focus. Additionally, the researcher's perspective is vital to the nonpositivistic study. The participants' realities are the focus of the study, but the researcher plays a crucial role in interpreting those realities. Lastly, the methods for conducting this type of research are "inductive, emerging, and shaped by the researcher's experience," demonstrating how the researcher's perspective played a role (Creswell, 2013, pp. 21-22).

Research paradigms within nonpositivistic research vary and "serve as lenses, not blinders" (Guba, 1990, p. 41) through which researchers examine and build their understanding of the world (Glesne, 2006; Rossman & Rallis, 2003). My research was conducted in the interpretivist paradigm, which suggests that knowledge is personal, but that researchers can attempt to make sense of interactions and commonalities of individuals' perspectives (Glesne & Peshkin, 1992). This paradigm also suggests particular research methods for data generation and analysis that align with this worldview.

Interpretivism focuses on participants' descriptions of their experiences and does not allow for statistically generalizable findings because knowledge is seen to be subjective, and each individual's experiences are unique (Ashworth, 1997; Glesne, 2006; Guba, 1990). Interpretivism suggests that individuals' constructed meanings of particular events and experiences are also unique and there can be multiple perspectives regarding a single phenomenon (Creswell, 2013). Rather than generalize perspectives, interpretivism seeks to "understand, explain, and demystify" (M. Z. Cohen et al., 2000, p. 19) phenomena through examination and description of the experiences and perspectives of individuals. Interpretivist studies seek commonalities of experiences around phenomena and across participants; therefore, through analysis of the similarities and differences among participants' expressed experiences and perspectives, I sought to understand how specific phenomena were experienced by each participant, despite interpreting it within their unique contexts and situations (Rossman & Rallis, 2003). The interpretivist paradigm was appropriate for this study because I interpreted data from participants about their experiences as both pre-service teachers and during their early years of in-service teaching. My role as the researcher in an interpretivist paradigm was to interpret and understand the participants' realities related to these phenomena or teaching-related activity systems.

Approach

I chose phenomenology as my research approach in order to understand the lived experiences of participants (Gentles et al., 2015). Rather than looking to summarize or generalize results to a larger population, phenomenology aims to understand a phenomenon's meaning in the eyes of its participants (Ashworth, 1997; Vagle, 2018; Valentine et al., 2018). This meaning comes about from intersections among "people, things, and the world they live in" (Valentine et al., 2018, p. 462) that are described in detail to the researcher, whose role is to understand selected phenomena through the experiences of research participants (Ashworth, 1997).

Phenomenology

Phenomenology is the study of a particular phenomenon, including any human experience (Vagle, 2018). There are two main types of phenomenology: descriptive and interpretive (Lopez & Willis, 2004). Descriptive phenomenology requires the researcher to *bracket*, or completely set aside and separate, their own perspectives and, in some cases, not consider previous literature before conducting research so as to enter a study without any presuppositions related to their prior knowledge or understanding of the phenomenon being examined. Additionally, descriptive phenomenologists seek a common *essence* within their findings, or a commonality amongst the perspectives and experiences of all participants, which can define and represent the phenomenon. Instead, I used heuristic or interpretive phenomenology, which encourages the researcher to *bridle*, but not wholly bracket, their prior experiences with the phenomenon, recognizing that the researcher is a part of the research study. Therefore, the researcher's perspective can influence the study's results as they interpret, rather than describe, participants' perspectives.

In phenomenological studies, the researcher is actively involved and might have experiences and values connected to the phenomenon. The researcher co-constructs data with research participants and then interprets it (Ashworth, 1997; Ponterotto, 2005). For this study, my perspective and lens as an environmental educator and an adjunct university faculty member for pre-service teachers helped my interpretations of the data generated with participants and shaped my meaning-making of this phenomenon. I used the *Researcher as Instrument Statement* to describe my experiences and perspectives about the study's focus (Appendix A), and a reflexive journal (Appendix B) to track my influences throughout the study.

The reflexive journal provides a space for researchers to take notes, including a record of research decisions throughout data generation and analysis; more importantly, it provides a history of personal reflections throughout the study as the researcher aims to interpret data (Creswell & Creswell, 2018). Qualitative researchers use reflexivity throughout the research process, considering their experiences and backgrounds and how these might affect their interpretations of the data generated (Watt, 2007). The journal provides a space to document these reflections on the study's methods and processes, data generation, and analysis (Vagle, 2014). I used a reflexive journal to track logistics and schedules, communication with participants, methodological decisions, my initial reflections, personal *memoing* (i.e., note-taking and reflections throughout the data generation and data analysis process), and any emerging patterns from the analysis of emerging data. The reflexive journal served as a starting point for data analysis through my reflections and interpretations of the data as they were generated.

In this study, I explored the phenomenon of teachers' engagement with environmental education during their pre-service teacher preparation program and during their early career in-service teaching experiences. This included professional development workshops, complete or partial courses dedicated to environmental education, guest speakers, and participation in outdoor education instruction. By examining individuals' lived experiences through direct interaction with them (Creswell & Creswell, 2018), I could better understand the nature of interactions between both activity systems as the teachers shared their experiences about environmental education. To understand these lived experiences, I sought to hear about the phenomenon "not as it is thought to be but as it is lived" (Richards & Morse, 2013, p. 68). The process included continual reflection within my reflexive journal, as each participant's experiences represented varying contexts (Vagle, 2018), such as unique university teacher preparation programs and various K-12 schools where they taught full-time. Also, to ensure that the focus of the study remained on the participants and not on my personal experiences, I bridled my perspectives, acknowledging that they existed, but setting aside any assumptions that I had about the experiences being studied (Vagle, 2010). Bridling did not dismiss my experiences, but instead encouraged me to reflect on those experiences and how they might help during the research process.

I also relied on my theoretical framework, cultural-historical activity theory (CHAT), to ground the study and frame my work with participants and their associated activity systems. CHAT was applied as a lens to generate and analyze data describing participants' experiences and related artifacts (Engeström, 2015; Roth & Lee, 2007) to understand both activity systems explained in Chapter 2, as well as the third system of the state's department of education, which emerged from data analysis. This third system's influences were experienced indirectly through the other two systems, which is explained in Chapter 4. The research design reflected the components of the activity systems using third-generation CHAT, including the subject, object, artifacts, division of labor, community, and rules, all of which were used to assist during data analysis. CHAT also informed participant selection and data analysis.

Sampling

Stemming from my participation in the Sea Change project—a pseudonymous professional learning program for pre-service teachers focused on how to conduct meaningful outdoor experiences with K-12 students—I was interested in learning more about teachers' experiences and perspectives on learning about environmental education during their teacher preparation programs, and the successes and challenges they encountered if they attempted to incorporate environmental education into in-service teaching. The Sea Change project worked in various capacities with five universities within a U.S. state, including undergraduate and graduate students preparing to be elementary or secondary teachers.

Through my participation in Sea Change as an instructor, I became aware of the complexity of integrating environmental education within pre-service teacher preparation programs, both within the participating Sea Change universities and through discussions with representatives from other universities in the state that include environmental education within their teacher preparation programs. My interests were situated specifically with secondary teachers who had in-depth science content knowledge but might still lack the content-based pedagogy to include environmental investigations in their teaching. Additionally, middle and high school students receive far fewer field experiences than their elementary counterparts (Muse et al., 2010), suggesting that environmental education might be less frequently incorporated within secondary classrooms. There is also less empirical literature about teachers' use of environmental education within secondary science than there is describing its use within elementary classrooms. For these reasons, I chose to examine secondary teachers' experiences throughout their teacher preparation and as they implemented environmental education in their K-12 schools.

Research completed within the Sea Change project provided some preliminary understanding of how pre-service teachers responded to an introduction to environmental education, such as valuing their participation in this type of learning opportunity. Additionally, after participating in the project, pre-service teachers increased their content knowledge, self-efficacy, and pedagogical knowledge on this topic. To examine this phenomenon further, I was interested in constructing a deeper and more comprehensive understanding of the perspectives of novice teachers, including the diversity of environmental education experiences across varying universities and the experiences both in university and in-service teaching. The successes and challenges that early career teachers face when attempting to include environmental education in their classrooms are foundational elements of this study because integration is based not only on knowledge, skills, and dispositions gained through university preparation (Van Petegem et al., 2005), but also their schools' contexts and the challenges teachers face within them (Ernst, 2007).

I sought secondary science teachers in their early careers who were willing to reflect with me on their pre-service teacher preparation and their transitions to full-time teaching regarding environmental education. Early career teachers include those within the first 5 years of teaching (Paniagua & Sanchez-Marti, 2018). During these first few years of teaching, teachers are still considered novices and are faced with challenges similar to their first year of teaching (Noguera & McCluskey, 2017; Paniagua & Sanchez-Marti, 2018), while also developing the experience to successfully implement knowledge and skills from their university-based learning experiences (Loughran et al., 2001; Noguera & McCluskey, 2017; Pryor, 2006).

Participant Selection

I used purposeful sampling to select participants who could give in-depth perspectives related to my research focus (Gentles et al., 2015; Patton, 2015). I began with the Sea Change university faculty who worked within secondary science pre-service teacher preparation in one U.S. state. I asked those faculty, via email (Appendix C), for contacts within their universities who might have information on recent graduates who fit the description above, and who could approve access to potential participants' contact information. Additionally, at a 2022 meeting of the state's science education leaders, faculty from seven universities within the state informally expressed interest in sharing information about this study with their recent graduates, including faculty from some universities that did not participate in Sea Change. I also contacted these university faculty members.

After compiling a list of recent graduates across the universities, I sent the invitation to participate in the study directly to early career teachers via email (Appendix D), referencing the university faculty member who shared their contact information (with permission). I included a short survey to gather pertinent demographic and background information (Appendix E), including verification that the potential participant was currently teaching in a secondary science classroom, was within their first 5 years of full-time teaching, and was exposed to environmental education within their teacher preparation program.

Additional questions in the survey about the participants' experiences allowed me to select for maximum variation of participants. Maximum variation sampling, a form of purposeful sampling, enables the researcher to select participants for maximum heterogeneity, allowing participants' diverse backgrounds and current contexts to be explored relative to the focus of a study (D. Cohen & Crabtree, 2006; Patton, 2015). Participants in this study represented various universities attended; in-service school types (e.g., rural, suburban, urban); grades taught; and science discipline. Considering these criteria across the pool of potential volunteers helped me select participants representing maximum variation. In total, 19 teachers began or completed the survey and were contacted for possible participation in the study. A maximally variable subgroup of 10 teachers who met the study's criteria and were each teaching in a different school during the 2022-2023 academic year was invited to participate. Their diverse perspectives and experiences allowed for a deeper understanding of the phenomenon being studied and how it is experienced in multiple settings (Patton, 2015). I will explain more details about the selection of the participants a following section.

Triads

In the survey, I also asked each of the interested teacher participants to share the names and contact information of (a) the university faculty member(s) who facilitated their environmental education experiences during teacher preparation and (b) a current school administrator (e.g., principal, assistant principal, department head) who was familiar with the environmental education opportunities in the teachers' current schools. These university faculty members and school administrators would form a triad, or a set of three, with the teacher participant, to ensure that multiple perspectives about environmental education within the two systems were generated and analyzed.

Each teacher participant's perspective was supplemented by the viewpoints of a pre-service education university faculty member and a K-12 school administrator to understand the systems better. The participating university faculty members provided their reasoning for including environmental education in the teacher preparation program, their expertise and motivation for doing so, and any policies or challenges that may have influenced the integration of environmental education into their university classroom. The school administrators provided information on the school culture, policies, and regulations regarding environmental education. Some administrators were also able to provide an historical perspective of professional development and support for teachers interested in including or limiting environmental education in their classrooms.

Forming Triads. Before contacting any potential participants who had completed the survey, I sought and obtained approval from the institutional review board. After receiving approval, I reached out to the interested teacher participants to confirm their interest and collect consent forms. Several willing participants were unable to participate in the study due to their school districts' approval processes, which would have extended beyond the time the study was taking place. Additionally, some teacher participants did not meet the study participant criteria (currently teaching secondary science in the study state, exposed to environmental education within teacher preparation, and within the first 5 years of teaching) or could not find an administrator to participate with them.

After teachers confirmed their interest and submitted the signed consent forms (Appendix F), I contacted the university faculty and the school administrator they named to seek their willingness to participate in the study (Appendices G and H). If one triad member was not interested or available to participate, I asked the teacher participant for another suggestion. Typically, this was the case for the school administrator, since all university faculty who were asked to participate were willing. For some triads, a school administrator could not be secured, and therefore I notified the teacher that they could not participate. No data generation within a specific triad occurred until all triad members had confirmed their willingness to participate, and all three signed consent forms were returned (Appendices I and J). This process allowed me to form nine triads of participants. To form the 10th triad, I used snowball sampling (Creswell & Poth, 2018) to access one additional teacher participant. I did this by asking teacher participants from other triads to identify teachers in their districts that might meet the study's criteria.

All triad participants in the study were from the same U.S. state. Some participants attended the same university for their teacher preparation program, but all taught in unique K-12 schools. Additionally, some teacher participants shared a common school district, and therefore a common district-wide administrator, but taught in different K-12 schools. In total, there were 24 participants in the study. Table 1 displays the full participant list in groupings of triads, demonstrating where overlap occurred with university faculty or administrators. For example, two teacher participants had the same administrator in their triads, and several teacher participants had the same university faculty in their triads. All names have been changed to pseudonyms to protect the anonymity of the participants.

Table 1

Overview of 10 Participant Triads

Triad No.	Teacher	Years Teaching	District	Administrator	Faculty Member	University
1	Josh	4	Carlson	Robert	Lily	McCarthy
2	Kayla	4	Yates	Kate	Lily	McCarthy
7	Anne	3	Wesley	Tim	Kim	Crane
6	Melinda	3	Wesley	Tim	Lauren	Parsons
8	Phoebe	3	Carlson	Jonathan	Gretchen	Harrington
5	Chris	2	Carlson	Carmen	Drew	Padilla
4	Kathy	2	Bonita	Freddy	Lily	McCarthy
10	Shelley	2	Faulkner	Heidi	Lily	McCarthy
9	Lindsey	1	Welch	Maddie	Lily	McCarthy
3	Ray	1	Wesley	Miranda	Drew	Padilla

Note. Arrangement of 24 participants within 10 triads, including their current K-12 school district and each participant's teacher preparation program university. Participants are displayed from greatest to least years of teaching experience.

The participants engaged with the study separately, with all responses kept anonymous, and with the explicit reminder that the administrator and university faculty participants were not offering assessments of the teachers' implementation of environmental education, but were instead helping me to understand better how environmental education is included in the university pre-service program and K-12 schools. The following sections provide more information about the school districts and universities where the teachers, administrators, and faculty worked.

School Districts. To provide more context about each individual participant, and to reflect the CHAT framework of activity systems, I will first describe the school districts included in the study. In total, the 10 triads represented six school districts in one U.S. state.

Three of the teacher participants (Anne, Melinda, and Ray) taught in Wesley County Public Schools, a large school district with nearly 50,000 students. In total, 15% of schools in Wesley County were under review for accreditation, meaning that one or more school quality indicators were below the state standard, and the school had to submit an improvement plan. If the school improves that indicator, it can receive full accreditation (Miller, 2023). Wesley County Public Schools was inclusive of near-urban, suburban, and rural areas. Another three participants (Chris, Phoebe, and Josh) taught in Carlson County Public Schools, a small district serving over 15,000 near-urban and suburban students. All of the schools in Carlson County were accredited at the time of the study. All of the other districts (Yates, Bonita, Welch, Faulkner) had one teacher participant each. Kayla taught in Yates County Public Schools, a county encompassing mostly suburban and some rural areas. Yates was the smallest district in the study. Only one school in the district was not fully accredited. Kathy taught in Bonita County Public Schools. This district was the largest in the study and one of the fastest growing counties in the state at the time of the study. All of the schools in this district were accredited at the time of the study. Lindsey taught in Welch County Public Schools, a larger district, and the school district in the study with the largest percentage of schools accredited with concerns Welch County Schools included over 25,000 students at the time of the study in mostly urban and suburban areas. Finally, Faulkner County Schools was another small district with over 10,000 students, and all schools were accredited. Shelley taught in Faulkner County. Table 2 illustrates the distribution of teacher participants by the school district they are associated with.

Table 2

Distribution of Teacher Participants by School District

Participant	District	Administrator
Anne	Wesley	Tim*
Melinda	Wesley	Tim*
Ray	Wesley	Miranda
Chris	Carlson	Carmen
Josh	Carlson	Robert*
Phoebe	Carlson	Jonathan
Kathy	Bonita	Freddy
Kayla	Yates	Kate
Lindsey	Welch	Maddie
Shelley	Faulkner	Heidi

Note. Participants and associated K-12 school districts where they taught. Multiple teachers in the sample taught in the same district.
*Denotes administrators located at the district level and not within the same school as the teacher participant.

Universities. The study's teacher participants graduated from teacher preparation programs in five different universities. All universities were located in the same state and were therefore subject to the same state regulations and accreditation processes. McCarthy was a medium-size public university. Parsons University was also public, and the second largest in the study. Padilla University had the second-highest number of teacher participants represented in the study's sample but was the second-smallest university in total student population. Crane University was an urban university, and the largest in the study. Finally, Harrington University was the smallest of the represented universities, and the only private university in the study. Table 3 illustrates the distribution of participants, both teachers and university faculty, and the university they are associated with.

Table 3

Teacher Participants With Associated Universities and Faculty

Participant	University	Faculty
Josh	McCarthy	Lily
Kathy	McCarthy	Lily
Kayla	McCarthy	Lily
Lindsey	McCarthy	Lily
Shelley	McCarthy	Lily
Chris	Padilla	Drew
Ray	Padilla	Drew
Melinda	Parsons	Lauren
Anne	Crane	Kim
Phoebe	Harrington	Gretchen

Note. Participants and universities they attended for teacher preparation program, including associated faculty members who included environmental education within the program. The table demonstrates the overlap of universities and university faculty members by some participants.

The sampling process allowed for a maximally variable group of participants. Each of the 10 triads consisted of an early career teacher, a school or district-level administrator, and a university faculty member After sampling was complete, data generation began within each triad. Multiple triads were participating in data generation at the same time.

Data Generation

Phenomenology relies on first-person accounts that are generally obtained through participant interviews (Gentles et al., 2015). Other phenomenological data generation methods can include observations, artifact analysis, and participant narratives (Vagle, 2018). The best way to understand a person's lived experience is to hear directly from them how they experienced and created meaning around the phenomenon. I used interviews with teacher participants as the primary data type for this study. Vagle (2018) recommended using unstructured interviews as the best way to gain insight into participants' lived experiences in phenomenological studies but acknowledged that researchers might feel more comfortable using a list of guiding questions to ensure that particular topics are addressed with all participants. Therefore, I used semi-structured interviews, which offered more flexibility because specific questions were created before the interviews, but the path for getting to those questions could be fluid throughout the interview (Edwards & Holland, 2013; Vagle, 2018). For example, at times a participant's response to one of the pre-determined questions led me to request additional clarifications or ask follow-up questions to arrive at a deeper understanding of the participant's experiences and perspectives. As such, the semi-structured interview had some conversational aspects, and all questions were not pre-determined. Semi-structured interviews also allow the researcher to delve into one topic more deeply than others, depending on how the interview develops (Edwards & Holland, 2013). For this study, I conducted interviews with multiple participants (teacher, university faculty, K-12 administrator) to garner the perspectives of all triad members.

Teacher Interviews

Because I sought perspectives from professionals in three different roles (teachers, university faculty, and K-12 administrators), I conducted interviews with each participant individually. The first interview in each triad was always with the teacher to determine a baseline understanding of their environmental education experiences in their pre-service programs and in the context of their current school district and school. Additionally, by interviewing the teachers first, I was able to reassure participants that no evaluative information about them would be sought or included, as stated in the survey. I conducted two interviews with each of the teacher participants, estimated between 1–1.5 hours each; the second interview served as a follow-up after I interviewed their corresponding university faculty member and administrator.

Before the first interview, I asked teachers to generate a brief list of environmental education experiences from their pre-service teacher preparation program to bring with them. This list was a starting point for the semi-structured interview (see guiding questions in the list that follows). I also asked for a copy of the list for later data analysis. The first interview focused on what the teacher remembered from their pre-service preparation related to environmental education. I also focused on environmental education, or lack thereof, in the school where they currently teach. Guiding questions were drawn from the CHAT framework, and the order of questions was flexible, since participants' responses often prompted particular follow-up questions.

The guiding questions for the first interview with teacher participants were:

- How did you learn about environmental education, if at all, during your pre-service teacher preparation program?
- How, if at all, is environmental education addressed in your current school and/or district?
- How, if at all, has the environmental education that you learned about in your pre-service program been incorporated into your classroom practice?
- How, if at all, have you experienced professional learning regarding environmental education during your time as an in-service teacher?
- What are the obstacles, if any, to integrating environmental education in your teaching?
- What is your decision-making process for deciding whether, and if so, how to include environmental education as part of your teaching?
- What is your school's decision-making process for deciding whether, and if so, how to include environmental education as part of your teaching?

The second interview included a specific, tailored list of questions for each teacher-participant, derived in part from the content of their responses in the first interview. It also included any questions or clarifications needed from the teacher after interviewing the university faculty and school administrator.

Administrator and Faculty Interviews

Next, I conducted interviews with each teacher participant's recommended current school administrator and pre-service program university faculty member who was responsible for sharing environmental education with them during teacher preparation. Each of these interviews was approximately 1 hour, with either the university faculty member or the school administrator interviewed first, as their schedules dictated. School administrator interviews focused on the particular school and district's culture, history, and available resources related to environmental education. The specific teacher participant was not discussed; instead, the interview focused on the activity system of the school and district and the administrator's perspectives on environmental education within their school and district. I did not use the term *activity system* or spend time defining it for administrators who had not studied CHAT.

University faculty members' interviews focused on understanding the integration of environmental education within their pre-service teacher preparation programs: how it was included and to what degree. During these interviews, I focused on the motivations and expertise of the university faculty members to teach environmental education, the specific ways that they incorporated environmental education—such as coursework, guest speakers, fieldwork, and other opportunities—as well as any obstacles they faced as university faculty in incorporating environmental education within their pre-service programs.

The following are guiding questions that were used during interviews with university faculty and school administrators:

Administrator

- From your perspective, how, if at all, is environmental education addressed in your school and/or district? How has this changed, if at all, over time?
- From your perspective, how does your school or district decide whether to include or exclude environmental education?
- From your perspective, how, if at all, do teachers in your school and/or district experience professional learning regarding environmental education during their tenure?
- From your perspective, what facilitating factors, if any, are available to teachers in your school and/or district related to environmental education?
- From your perspective, what are the obstacles, if any, to integrating environmental education at your school or in your district?

University Faculty

- From your perspective, what academic preparation or experiences, if any, do you have to teach environmental education?
- From your perspective, how, if at all, do you offer environmental education in your courses and/or programs at the university for teacher preparation?
- From your perspective, how do you decide whether to include or exclude environmental education from the courses and/or pre-service teacher preparation programs?
- From your perspective, why, if at all, did you choose to incorporate environmental education into your courses and/or programs at the university?

- From your perspective, what facilitating factors, if any, does your university provide for integrating environmental education within teacher preparation?
- From your perspective, what are the obstacles, if any, to integrating environmental education in your teaching?

Interviews took place where they were most convenient and accessible for the participants (Edwards & Holland, 2013). Because my participants were mainly located far from me, I used Zoom for the interviews. With some school districts restricting teachers from participating during school hours, teachers and administrators were asked to conduct their interviews with me off-site and outside of school hours. Additionally, I ensured via the consent form that all participants consulted with their school district to determine whether official permission to participate in this study was needed. Most of the participants consulted with their principal or science department head to ensure they had permission to participate. Three of the participants were required to go through their district's research coordinator for district-level approval to participate.

All interviews were recorded and transcribed, and I sent written summaries of the information communicated during each interview to the participants for member checking. Member checking allowed each participant to insert any missing information or correct inaccurate pieces of information in what I provided (Creswell, 2014; Maxwell, 2009). I asked participants to review and correct, as necessary, summaries of the perspectives they shared at several points during the study—during the interview through clarifying questions, after the interview in written form, and when the study results were drafted. Anonymity was preserved throughout each interview, as pseudonyms were assigned for all names and locations and used on all documents, including interview data. I assured all participants that their personally identifiable information would not be shared with other study members or in the final manuscript. Study results were stored in a secured computer.

Artifacts

Although interviews served as the primary type of data for this study, analysis of physical objects can add depth to other data generation, allowing for a deeper understanding of the "values, ideas, attitudes, and assumptions of a particular community or society, usually across time" (O'Toole & Were, 2008, p. 617). By examining artifacts from each activity system, in addition to the lived experiences of community members, I discovered additional information related to my research focus. Artifact analysis includes tangible objects or texts (O'Toole & Were, 2008) representing the activity systems. For this study, I examined any programmatic information related to environmental education within the participants' teacher preparation programs and K-12 schools and districts, including the lists of environmental education experiences teachers provided from their pre-service teacher preparation programs. I explored these resources online, requested more context about them from university faculty or school administrators, and collected additional information directly from teacher participants. Resources included state mandates requiring or limiting the teaching of specific materials for environmental education; websites advertising particular programs, courses, or professional development opportunities; and the state's learning standards.

I also examined the universities' and school districts' web pages for mention of environmental education within the information for their teacher preparation programs and K-12 schools. I gathered any school, district, and state requirements for the inclusion of environmental education within K-12 schools and university settings, including professional development or training opportunities related to this topic offered to pre-service or in-service teachers. Analyzing multiple data types from multiple perspectives allowed me to construct a deeper understanding of how environmental education within teacher preparation programs was being implemented within the participants' K-12 classrooms.

Data Analysis

Data analysis is a method of "identifying, analyzing, and reporting patterns (themes) in data" (Braun & Clarke, 2006, p. 79). In phenomenological studies, data analysis consists of locating the most meaningful statements from participants, assigning short phrases or codes to describe those sections of data, and then grouping those codes into larger and similar groups of codes from which interconnected themes will emerge to convey meanings within the data (Creswell, 2013; Saldaña, 2021). Coding qualitative data is an interpretive process, allowing the researcher to reflect on the meanings of the data generated (Saldaña, 2021). Several data analysis methods exist for qualitative data. I used the six-step thematic analysis process identified by Braun and Clarke (2006) for this study, which includes "familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report" (p. 87). Thematic analysis was appropriate for this study because it provides a means of finding and analyzing patterns within the data that can help the researcher develop an understanding of and meanings within participants' stated perspectives (Braun & Clarke, 2006), which aligns well with phenomenological studies focused on the experiences and perspectives of participants experiencing a phenomenon.

Getting Familiar With the Data

The first step in this thematic analysis process was to familiarize myself with the data. I first read through the data several times, including complete interview transcriptions, collected artifacts, and the teachers' memories of environmental education within their pre-service teacher preparation. I also listened to some recordings of the interviews multiple times to listen for tone and emphasis from the participant's voice. This first step in data analysis was a "process of immersion" (Braun & Clarke, 2022, p. 35). During this step, I used my reflexive journal, memoing about the individual data being analyzed and the entire data set, carefully reflecting upon and bridling my own experiences and values related to the phenomenon. I also noted particularly meaningful sections of the data pertaining to my research focus for later analysis by highlighting passages within the transcripts or artifacts. Only reading and memoing occur at this data analysis stage; no codes are generated.

Generating Initial Codes

The second step in Braun and Clarke's (2006) thematic analysis process is to generate initial codes, understanding that these codes could change and be condensed throughout data analysis. Codes are words or short phrases that assign labels to the data and are a way to sort the data for interpretation (Creswell, 2013; Saldaña, 2021). Braun and Clarke (2022) have suggested identifying parts of the data that "appear potentially interesting, relevant, or meaningful for [the] research question" (p. 35) and then applying descriptive codes.

I first used a deductive coding process for my study, beginning with a list of *a priori* codes, or codes created before data generation, that were directly related to my theoretical framework. Although Vagle (2014) cautioned against using a priori codes too strictly, I recognized the value in first searching the data for a priori codes developed through CHAT, such as *object* (motivation/inclusion of environmental education in the classroom); *tools* (materials or resources used to achieve that goal); rules ("need to," "have to," school culture); *division of labor* (roles and responsibilities, assignment of tasks, and communities); *outcomes* (reflections of success, end product); and *tensions* (challenges or inequities within components of the system).

However, a priori codes could not account for all of what surfaced related to the study's focus during data analysis. Therefore, I also used inductive coding to allow emergent codes, or codes that addressed ideas beyond the CHAT-specific a priori codes, to be created, explored, and analyzed (Creswell, 2014). I developed a code book with over 65 specific codes as I analyzed each interview and artifact.

Searching for and Reviewing Initial Themes

Next, Braun and Clarke (2006, 2022) suggested searching for and constructing initial themes within the data. Themes are concepts or extended phrases constructed by the researcher as interpretations of the data, specifically in how it relates to the research focus (Braun & Clarke, 2022). Themes describe the data and tell a story about it. I examined the codes generated previously to determine how they could be grouped into categories of similar codes, which later became themes that collectively formed the story of my data. I used my research questions and the theoretical framework to guide story formation. For example, codes such as *program structure, top-down rules, district-level support,* and *placement of environmental science within the science curriculum* were grouped together as a theme of *K-12 systemic influences related to environmental education having a specific place within the environmental science classes*.

The fourth step in the thematic analysis process is to review the initial themes and their relationships to the entire dataset, refocusing them as necessary to ensure that the themes address what the study was designed to reveal (Braun & Clarke, 2006). As both coding and theme generation are iterative, this step was essential to ensure that no codes or themes were missed as additional data were analyzed (Braun & Clarke, 2022). Additionally, I considered whether each identified theme had enough "meaningful data" (p. 99) to support it, and that the theme was not too broad to tell a straightforward and meaningful story. I reviewed my initial themes in these ways, including whether I had relevant quotes, memos, and literature for each, to ensure that I had high-quality, relevant themes before moving on to the next step of data analysis.

Defining and Naming Themes

Step 5 of Braun and Clarke's (2006) thematic analysis includes reviewing, defining, and naming themes. After reviewing and adjusting, as necessary, the initial themes deduced, I ensured that each theme could be explained clearly and that all underscored the most relevant patterns in the data related to the research focus. I often revisited themes, and some were not used in the final report of the study's results. For example, *new teacher fears and challenges* was reclassified and grouped within a larger theme of *K-12 system influences*, with specific reference to CHAT's division of labor and how novice teachers' roles differ from experienced teachers. Finally, I provided names for each theme group that clearly described its focus.

Themes become study results as the themes' interrelationships are examined, and the connections to the relevant extant literature are investigated (Braun & Clarke, 2006). I used the same thematic analysis process for all three types of data generated in the study: interview transcripts, teachers' written summaries of their recollections of environmental education within their teacher preparation program, and artifacts (Braun & Clarke, 2006). As I coded data and constructed themes (using member-checked data to ensure accuracy), I compared themes to determine relationships among them. For example, themes such as *structure of environmental education programs* and *attitudes, support, and awareness toward environmental education* were compared and streamlined into larger system themes where the systems' (K-12, university, and state) programs and their influences on the participant could be specified. Grouping the themes in this way also aligned with CHAT's focus on activity systems. The data analysis process was guided by a set of quality standards, explained in the sections that follow, for conducting this type of research to ensure that other qualitative researchers can trust my findings.

Producing the Report

The final step in thematic data analysis is to bring the story of the study results together as themes become study results (Braun & Clarke, 2006). For this step, I determined the order of the study results to tell a compelling story, allowed the themes to build upon each other, and shared my interpretations of the study results and how they compare to extant literature. I examined how university and K-12 activity systems influenced and shaped teachers' perspectives on integrating environmental education into their classrooms, as well as how the third system that emerged (the state's department of education) influenced teachers' perspectives throughout the other two systems.

Quality Criteria

The quality criteria that I used in this study are Tracy's (2010) "big-tent" (p. 840) criteria, which name eight components of "good" (p. 838) qualitative research. Quality criteria showcase the components of excellent qualitative research and help position nonpositivistic work as a valuable type of inquiry to those who might not understand it. Tracy's criteria include methodological skills that the qualitative researcher can use to generate quality work, including selecting a *worthy topic* studied with *rich rigor.* According to Tracy, qualitative researchers should conduct research with *sincerity* and *credibility,* and studies should be written to create *resonance* with the reader. The research should provide a *significant contribution* to the field and be conducted *ethically*. Finally, the researcher aims for *meaningful coherence* in remaining true to the focus of the study. I will describe each of these criteria in more detail in the sections that follow, including how they were addressed in my research.

Worthy Topic

Tracy (2010) defined a worthy topic as something significant and not well-established in extant literature. As stated in Chapter 1, there is a timely and vital need to understand and mitigate the impacts of global environmental issues (American Association of Colleges and Teacher Education, 2010; Franzen, 2017). Despite this need and the fact that schools might be the best venue to prepare citizens to make systemic changes in the future, teachers might feel unprepared to teach their students about these issues (Ham & Sewing, 1988; J. T. McDonald & Dominguez, 2010). In addition, with continued interest in pre-service teachers providing pathways for environmental education to expand, more interest is currently focused on pre-service teacher preparation (J. T. McDonald & Dominguez, 2010). These points demonstrate that the focus of the study was timely and worthy of additional research.

Rich Rigor

Rich rigor ensures that sufficient time is spent in the field generating an acceptable amount of data to interpret and make claims about the study's focus (Tracy, 2010). I ensured rich rigor by interviewing teachers multiple times, as well as interviewing the other members of their triads to complete in-depth research from three different perspectives on the study's focal phenomenon, reaching thematic saturation—a point where there are no new topics or patterns revealed within the generated data (O'Reilly & Parker, 2012; Tracy, 2010). In addition to spending sufficient time generating data, rich rigor can be achieved using appropriate analysis procedures (Tracy, 2010). As described earlier, I used Braun and Clarke's (2006, 2022) steps for thematic data analysis, including a holistic reading of each data type, followed by coding, generating initial themes, developing and reviewing themes, refining themes, relating themes to each other, and writing the report. Throughout this data analysis process, I used deductive coding (using a priori codes from CHAT) and inductive coding to examine emerging ideas.

Sincerity

Tracy (2010) suggested both self-reflexivity and transparency by the researcher to ensure sincerity. Self-reflexivity, or the practice of considering your own perspectives and experiences as they relate to the research topic, is an essential component of any qualitative research approach. Self-reflexivity builds trust with the reader by explaining the researcher's experiences, beliefs, biases, and values, and how those perspectives could influence data generation and analysis, presenting challenges to research results. My transparency of connections to the Sea Change university faculty and my experiences both in environmental education and pre-service teacher education demonstrated sincerity and self-reflexivity.

Transparency includes a truthful explanation of the research process, including how decisions were made and how the research project changed over time (Tracy, 2010). I created self-reflexivity and transparency in my research process by using a reflexive journal, in which reflections and research decisions were recorded for future reference. My role as both an environmental educator and a course instructor for a pre-service preparation program suggests that I came to the study with beliefs, biases, values, and experiences related to the phenomenon examined in the study.

Credibility

The credibility of a qualitative research study expresses the trustworthiness of the results, meaning the reader feels confident in the researcher's interpretation of them (Tracy, 2010). Credibility can be achieved through thick description of the data and the study's written results, triangulation, and member checking. Thick description is the plentiful and in-depth description of participants' lived experiences, to the point that the reader can almost imagine themselves as a participant (Carlson, 2010). The goal of thick description is to illustrate the contexts and meaning making of participants for the reader to understand the complexity of the study's results and how those results were formed (Tracy, 2010). I have provided in-depth descriptions of participants' experiences related to environmental education through written summaries and direct quotes in Chapters 4 and 5.

Triangulation of data, although not a requirement for qualitative research, can also build credibility as the reader sees that more than one source and type of data were used to assemble a conclusion (Daniel, 2019; Tracy, 2010). In my study, data triangulation by source was achieved through triads of participants who generated three data types to analyze: interview transcripts, teachers' memory documents, and artifacts. Incorporating these multiple data sources and types allowed me to explore multiple aspects of the phenomenon (Tracy, 2010), including the manifestations of varying activity systems.

Finally, member checking was used to determine the accuracy of data analysis (Maxwell, 2009). I conducted member checking in three ways—during all interviews by summarizing participant statements and asking participants clarifying questions to ensure my understanding, after each interview by sending the participants a written summary of the interview to correct as necessary, and near the end of the study by sharing a draft of my results and asking for corrections and edits. By asking the participants to review and provide commentary during data generation and analysis, the research was shared between us. It became more of a collaboration than a researcher's description of the phenomena and study results (Tracy, 2010).

Resonance

Resonance is the researcher's ability to draw the reader into the topic of the study and inform their perspectives on both the topic and the study's findings. Tracy (2010) suggested that resonance could be built through "evocative representation, naturalistic generalizations, and transferable findings" (p. 840) or by describing the study's results in engaging ways so that the reader is interested and can identify with the topic within their own experiences and perspectives. Through a narrative writing style and in-depth descriptions of the experiences of each participant, I have aimed to build resonance with readers (Tracy, 2010). One way to strengthen the resonance was ensuring that participants' perspectives were heard through the study's results, providing a balanced storytelling of describing the phenomenon and the participants' perspectives on it, using examples from what they shared with me.

Significant Contribution

Another quality criterion for qualitative research is the researcher's ability to contribute to the field with the results of the study (Tracy, 2010). Tracy described four types of contributions: theoretical, practical, moral, and methodological. This study's results contribute both theoretically and practically. First, the study applied an existing theory—CHAT—to a relatively under-researched phenomenon. Although CHAT has been used to look at environmental education in general (e.g., Jayme et al., 2011; Krasny & Roth, 2010; Robertson, 2016), very few studies have used this theoretical framework to examine pre-service teacher preparation and in-service education activity systems related to environmental education. Additionally, this study could be helpful to others working with pre-service teachers to expand the reach of environmental education, as it might suggest particular opportunities for alignment across the systems of teacher preparation and in-service teaching that were previously not considered and illuminate challenges across the field.

Ethics

Research involving human volunteers requires regard for the ethical treatment of those participants. Tracy (2010) illustrated several potential ethical concerns, including procedural, situational, relational, and existing ethics. Participants must be aware of the focus and goals of the research before participating. They must also understand that they are not required to answer every question asked and may remove themselves from the study at any time (Wiles, 2013). Additionally, all information that could potentially identify the participants must be anonymized, including names and locations.

In this study, several aspects of ethics were implemented. First, the institutional review board conducted a proper review, and all necessary school district permissions were acquired before data generation began. Second, all personal information was secured and only accessible to me. Pseudonyms were provided for all names, places, and programs to protect participants' identities (Wiles, 2013). One of the specific ethical concerns was the teacher participants' understanding that any discussions with their direct supervisors (school administrators) were not assessments of the teachers' work but were instead used to gain a deeper understanding of the activity systems of pre-service teacher preparation and in-service learning.

Meaningful Coherence

Tracy (2010) described the last quality criterion as meaningful coherence, or the study's alignment with its stated goals, and clear connections to prior literature. To ensure meaningful coherence, I chose a research design (phenomenology) that aligned with my research focus. Phenomenology provided a straightforward approach to understanding participants' lived experiences. Throughout the data analysis and results-surfacing stages, I ensured that my actions related to my research questions, paradigm, theoretical framework, and approach remained aligned. As described in the data analysis section, I relied on my theoretical framework to group and align themes to demonstrate their interactions in and across systems, as well as focused on identifying components of CHAT (community, rules, artifacts, and division of labor) throughout the data analysis and results-surfacing stages. Additionally, I ensured that the study results in Chapter 4 were situated within relevant extant literature.

Conclusion

The literature synthesized in Chapter 2 suggests that teacher education is a complex process as pre-service teachers transition from being university students to classroom teachers (Cochran-Smith, 2003; Riedler & Eryaman, 2016). Unfortunately, little is known about how the corresponding three activity systems (K-12, university, and state) in the two educational contexts (K-12 schools and universities) that teachers experience affects their incorporation of environmental education into their classrooms. Using the CHAT framework and interpretive phenomenological methods, I explored selected secondary science teachers' experiences in their early years of teaching related to environmental education, focusing on how their exposure to environmental education in their pre-service preparation shaped their current teaching. I used interviews, teachers' written summaries of their recollections of environmental education, and artifact analysis to better understand the phenomenon of exposure to environmental education in pre-service teacher preparation and the potential challenges and successes novice teachers experience when implementing environmental education in their classrooms. Although the results of this study are limited to the interpretation of the perspectives and experiences of only the participants involved, the findings shared in Chapter 4 illuminate how pre-service programs and K-12 school activity systems influenced participants' experiences of integrating environmental education materials and resources into their teaching practices. The study also highlights what sources of conflict might exist for other early career teachers in implementing environmental education and how some have overcome these conflicts.

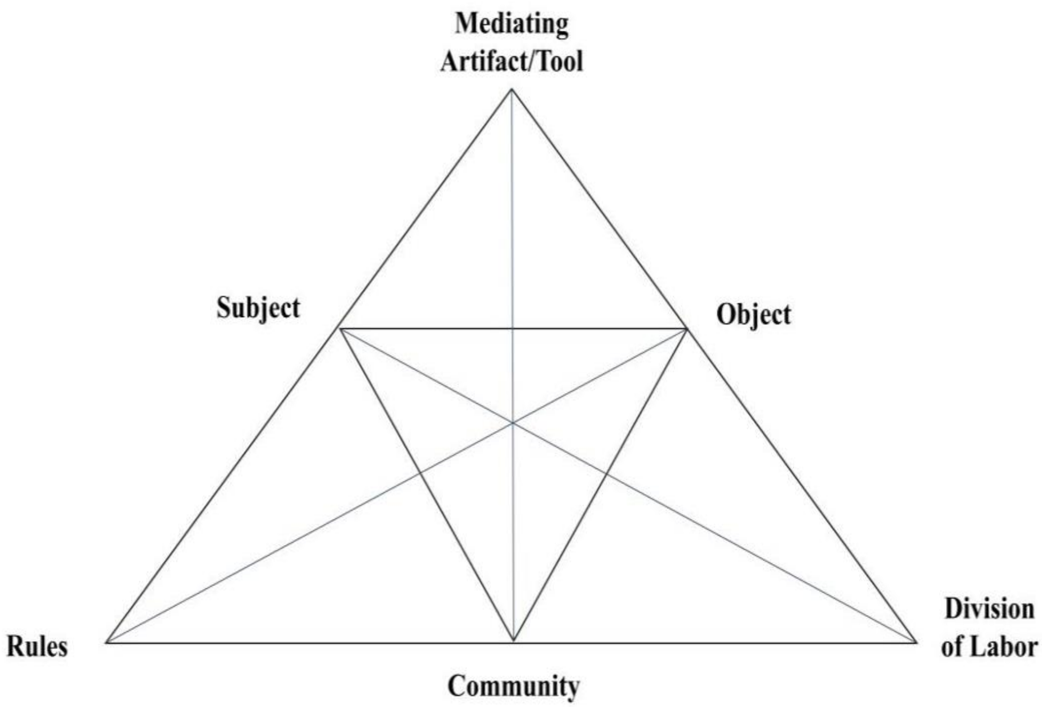
CHAPTER 4

FINDINGS

This study investigated the lived experiences of early career teachers and associated perspectives from school administrators and university faculty as they relate to environmental education. I focused on the meaning-making that all participants constructed during their participation within and among the activity systems of teacher preparation, K-12 schools, and the state education system. Recall from Chapter 2 that *cultural historical activity theory* (CHAT), which guided this study, uses activity systems to examine complex systems such as those that teachers work and learn within and among (Engeström, 2015). CHAT requires analysis of the internal and external factors comprising a system, such as the artifacts, rules, and division of labor shown in Figure 4, as well as the multiple perspectives of the community operating simultaneously within the activity system.

Figure 4

CHAT Activity System Model



Note. The second-generation cultural historical activity theory (CHAT) model includes the original activity theory triangle of first-generation CHAT but extends the model to include additional components, such as rules, mediating artifacts or tools, and division of labor. This visual depiction is adapted from Engeström (1987, p. 78).

To illustrate these three interacting systems, I will first provide an introductory story about Melinda, one of the teacher participants in the study. This story showcases the three systems and how the study's participants perceived the CHAT-related influences that existed and affected each other within and among the systems. Melinda's story is in italics; my explanation of how the story highlights CHAT and activity systems appears in plain text.

Systems in Action Example

Melinda attended a university to obtain an undergraduate degree in science. During her undergraduate program, Melinda participated in several informal science education programs, and began to have an interest in pursuing education as a career. At the same time, Melinda's *required science courses were fostering a sense of environmental appreciation within her through participation in a plethora of outdoor labs. Melinda began taking a few education courses. After completing her science courses, and receiving an undergraduate degree in biology, Melinda joined the fifth-year master's program at her undergraduate institution to receive a degree in science education.*

In this story, Melinda's experiences within the university system influenced her future career path. As she began her undergraduate degree program, her interest was solely within the sciences. Through experiences at her university, including with influential faculty, she developed an interest in education.

While in her teacher preparation program, Melinda discovered that the state department of education required a higher final grade in one of her science courses than what she had received. The grade Melinda had earned in her undergraduate course met the university's requirement for graduation with a science degree, but it was not high enough to meet the state's requirements for a teaching license. Melinda had to retake one of her science courses to receive a qualifying grade.

In this part of the story, the perceived influences from the state department of education are highlighted. The rules for one system did not align with the rules for a second system, and Melinda had to navigate the rules for both as she worked to receive her degrees.

Throughout her master's program, Melinda reported receiving instruction on the environment woven throughout her education methods courses, through workshops and field experiences, and in self-directed projects. According to Lauren, one of Melinda's professors from her teacher preparation program, the inclusion of environmental education in pre-service teacher education depended solely on the professor, because it was not explicitly required for *teaching licensure. Therefore, although its inclusion was not mandated, Melinda was exposed to it. Eventually, Melinda graduated with a license to teach biology. No licensure option was available for environmental science, despite Melinda's background and interest in that field.*

Throughout Melinda's story, different experiences are illustrated, from undergraduate courses that inspired her environmental appreciation, to education faculty in her teacher preparation program. Additionally, the rules of the state and university systems are evident—Melinda was forced to retake a science course to meet a requirement for her education master's degree. Also, Melinda was limited in the license specialty she could receive; despite an interest and many experiences in environmental science, no licensure option in that specialty was available.

Now, Melinda is a third-year teacher working in an urban high school, where she teaches environmental science and Advanced Placement environmental science. Melinda's district places mostly first-year students in her environmental science classes, and the course is geared specifically to prepare students for a required biology course the following year. The environmental science course is a non-tested course, meaning there is no state mandated end-of-grade assessment. This provides Melinda with additional flexibility, since her curriculum is not as specified as it is in required courses like biology. Melinda has the flexibility to incorporate topics that are of interest to her and her students, and to teach the course's topics in a sequence that she chooses. Despite this flexibility, Melinda still faces challenges, such as a lack of district-provided, content-specific professional development. She strives to continue to learn best practices for teaching the environmental science course, but little support is given.

As a novice teacher with her own classroom, Melinda is heavily influenced by the K-12 and state systems. She is early in her career, searching for support from her school and district, often through professional development opportunities that could build her knowledge and skills in the classroom. Additionally, within her district, environmental science is offered to first-year students who struggle with science and also do not have many positive experiences in nature. Although her class is focused on the environment, Melinda struggles with taking her students outside for field experiences.

In contrast to the flexible, non-tested environmental science course, Melinda also teaches Advanced Placement environmental science. This course has a rigorous curriculum and a standardized test that all students take at the end of the year. In this course, her students are in upper grade levels and Melinda feels more confident in taking these more mature and responsible students to off-campus field experiences.

During her third year of teaching, Melinda's district applied for a grant to partner with an external environmental education organization to provide field experiences for students. Teachers were not included in the decision to write this grant, nor in the content of the project. Melinda received an email announcing the project and her mandatory participation, and she excitedly accepted without many details about the project. She was surprised that the planning for a 1-day canoe trip took months. Parents would not return permission slips, and she had to convince students that it would be a fun experience to spend the day outdoors. Eventually, Melinda was able to take about half of her class—those who completed and returned the permission slip—on the trip. They enjoyed the canoe trip, but Melinda still had to make plans for the students who would remain at school, such as creating substitute teacher lesson plans.

The K-12 system's reported influences, including those at the district level, are demonstrated here. Schools and districts often apply for external funding to support field experiences for students, because funding is a limiting factor for environmental education (Dring et al., 2020; Ernst, 2007). Teachers, although critical to implementing the grant programs, are often not experienced in grant-writing, leaving the planning and writing of grant applications to school and district-administrators (Lovaas, 2015).

This year, Melinda also discovered that her district was planning to build a district-wide environmental education center. This center would provide a location for all teachers in the district to bring their students for field experiences with little cost to the teachers or students. Melinda was conflicted. The idea of environmental field experiences was exciting, but she knew that it would be a struggle to get all of her students to participate. She suggested that funds to support environmental education be sent to the district's individual schools, where similar experiences could occur with more frequency and less challenges and planning for the teacher.

Despite these challenges and more, Melinda remains motivated and interested in including locally relevant environmental topics in her teaching. She retains a positive attitude toward her environmental science course and wants to build the course into something that will strengthen her students' skills. She believes that the environmental science course can improve her students' understanding of environmental science, while also preparing them to be successful in future science classes. She remains focused on facing the challenges presented among the systems and working with her administrator to promote environmental education to her students.

Within the K-12 school activity system, several key members of the community in the story were influential, such as district administrators and external partners. Although Melinda is not receiving the support that she needs from the district in terms of professional development, she does have a curriculum framework that outlines the course and district-wide curriculum writers who offer curricula addressing environmental issues. In addition, she is receiving support from the district in securing external partners for field experiences. Despite this, Melinda is solely responsible for the logistical details of taking students off campus, which limits her ability to conduct field experiences.

The state department of education's influence is also present throughout Melinda's story. The state's enactment of regulations is apparent in how it sets the framework for any class Melinda teaches. Melinda's class is full of students who struggle in science and school in general. Therefore, in addition to focusing on environmental science topics such as those included in the state's curriculum framework, Melinda often has to work on basic school, study, and relationship strategies that her students are lacking. The placement of the course as an introductory course is challenging, and these challenges sometimes prevent Melinda from providing meaningful environmental content for students.

Melinda's story highlights the different activity systems that influenced participants' actions and perspectives within this study. In this chapter, I will provide a more complete overview of the three systems, highlighting each system's CHAT components, and how they interacted with each other. Following the systems' descriptions, I will share the contradictions within and among systems. Recall from Chapter 2 that contradictions are "clash[es] between individual actions and the total activity system" (Engeström, 2015, p. 66). Contradictions are not necessarily limited to challenges within the system that affect the participant in a negative way; they can also include sources of innovation or places where the activity system can evolve (Engeström, 2001). By examining the activity systems' influences within teacher preparation, K-12 education, and the state education system, I will explore my findings of the perceived influences on selected early career teachers that might affect their inclusion of environmental education with their classrooms. Findings are supported with data summaries, stories and quotes from participants, and artifacts collected from participants and online sources. First, I will provide a summary of the CHAT components as a reminder from Chapter 2.

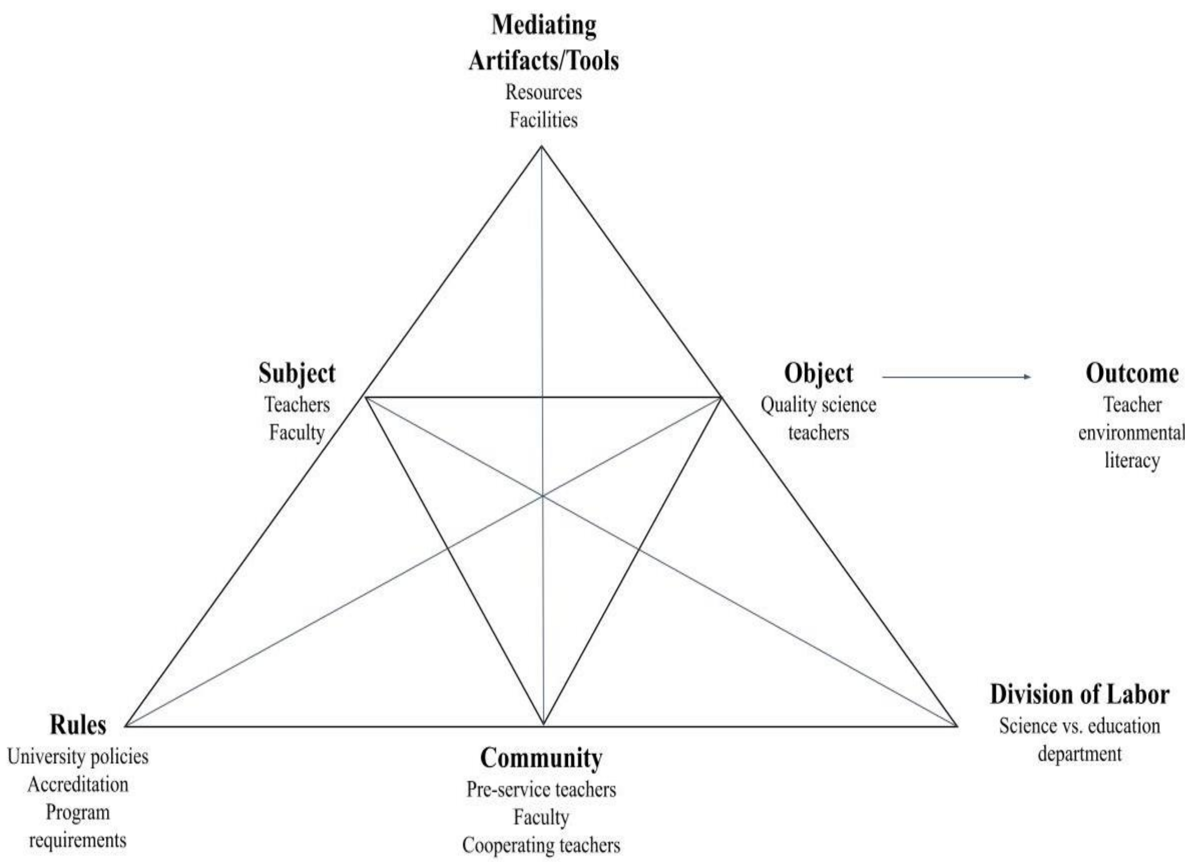
CHAT Overview

Recall from Chapter 2 that CHAT provides a method of analysis for complex systems, rather than a focus solely on individual participants (Engeström, 2001). CHAT recognizes the multiple perspectives within a system, and considers the influences of the community, artifacts, rules, and division of labor within a system on the subject. CHAT was appropriate for this study about early career teachers' inclusion of environmental education in the K-12 classroom because teacher participants had to navigate both systems to learn about environmental education and implement it. Using the university system as an example, I will explain each CHAT component, and additional information about the university system from the study's results is included in subsequent sections.

The university as an activity system can be seen in Figure 5. On the left-hand side of the figure, the subject of the activity system is illustrated. The *subject* is the area of focus that is being examined in-depth, such as a member of the community or system (Engeström & Miettinen, 1999). Within the university system in this study, the subjects were the teachers and university faculty who participated in the study. On the right-hand side of the figure, the object and outcome are shown. The *object* (or objective) is the goal of the system, as it relates to the study's focus. In this case, the objective was quality science teachers who have been exposed to environmental education. The *outcome* of an activity system is the end product or desired result (Foot, 2014). Relevant to this study, the outcome of the university system was teachers' environmental literacy. Recall from Chapter 1 that environmental literacy is a collection of knowledge, skills, attitudes, and behaviors that assist the individual with making informed decisions that will benefit the environment (Bey et al., 2020).

Figure 5

Teacher Preparation Programs Represented as a CHAT System



Note. The cultural historical activity theory (CHAT) model for the university system, as reported by study participants, highlights the influencing factors of artifacts (resources and facilities), rules (policies, accreditation, and program requirements), and division of labor (location of university faculty member) as well as the system's community, object, and outcome.

CHAT also requires examination of the community, artifacts, rules, and division of labor within an activity system. The *community* in CHAT refers to the members of the activity system that the subject interacts with, in this case the pre-service teachers themselves, faculty (both undergraduate and graduate), and cooperating teachers in teachers' field placements. In some cases, the subject of the study can also be a part of the community. For example, university faculty are subjects of the study, and were interviewed for their perspectives on teacher preparation, but they also served as community members who influenced pre-service teachers, the other subjects of the study.

Other components of the CHAT framework I examined were *artifacts*, *rules*, and *division of labor*. Artifacts include any items that the subject interacts with, such as funding, physical resources, facilities, or curriculum. *Rules* include the policies and requirements present within an activity system that might influence either or both of the activity system's subjects (teachers or university faculty) in their inclusion of environmental education in the K-12 classroom. In this system, the rules included university policies, program requirements, and accreditation regulations. *Division of labor* is the organization of the system, and how different members of the community took on particular roles and tasks. In the following section, I will describe the university system in more depth using CHAT to guide this description and analysis, highlighting each of these components in more detail.

University System

Chronologically, the university was the first activity system with which participants interacted as they completed their teacher preparation programs. The goal of teacher preparation programs is to prepare future teachers for work in the classroom, including both knowledge and practical skills (Shaughnessy & Boerst, 2018). Universities aim to prepare future teachers for all that they might encounter within the K-12 environment, while carefully considering the limited time that pre-service teachers are enrolled in their programs (Darling-Hammond, 2006; Shaughnessy & Boerst, 2018). University programs could include coursework, observation of teachers in K-12 classrooms—including their cooperating teacher—and field placements where the novice teacher works in their cooperating teacher's classroom for observation and teaching opportunities (Darling-Hammond, 2006). Recall from Chapter 2 that universities are not the only pathway to receiving a teaching license, although all participants in this study attended a university program for teacher preparation. All but one participant received their teaching license through their university program. This final participant received their teaching license after obtaining teaching experience post-graduation and completion of the Praxis exam.

Recall that the objective relevant to this study for this activity system was quality teachers. As seen on one university's webpage, the university's mission was to prepare the next generation of teacher leaders. Environmental education was not the primary focus of any of the university programs included in the study, but university faculty were interested in including environmental education in their courses. University faculty had their own perspectives on the need for an environmental outcome. Kim, a professor at Crane University said,

> We all live in our greater environment. And there are a lot of issues that, if we don't solve, are…well their grandchildren are going to really suffer. I think it's a topic that kids resonate with…and I think they see it in the news every day. What are we doing to our environment that's causing these other things to happen? So, I think it's a natural hook.

To understand these perceived influences on early career teachers, I asked selected teachers about their experiences prior to full-time teaching that influenced their implementation of environmental education. Previous researchers have suggested that these experiences prior to full-time teaching affect teachers' inclusion of environmental education (Blatt & Patrick, 2014). In the current study, all of the teacher participants were selected because environmental education was included in their teacher preparation in some capacity. Although I did not intend to reach into participants' experiences prior to their teacher preparation program, many shared that they perceived their undergraduate program significantly influenced their thinking on environmental education. Therefore, undergraduate and graduate experiences, such as coursework, interactions with university faculty, and experiences within their field placement, are included in this system. By also discussing the university system with university faculty participants, a deeper understanding of the rules, division of labor, and artifacts that encouraged or curtailed teachers' inclusion of environmental education was developed. The community, artifacts, division of labor, and rules of the university system influenced the novice teachers as they were building their knowledge and skills related to environmental education.

Community

The community in CHAT refers to the members of the activity system that the subject interacts with—in this case the pre-service teachers themselves, university faculty (both undergraduate and graduate), and cooperating teachers in teachers' field placements. Although the subject of this activity system included both the pre-service teachers and the university faculty of the teacher preparation programs, the main study focus was on teachers' perspectives as they interacted within each system.

Pre-Service Teachers. Early career teachers in this study (Josh, Kayla, Ray, Kathy, Chris, Melinda, Anne, Phoebe, Lindsey, and Shelley) reflected on their teacher preparation programs to assess where there were perceived influences on their inclusion of environmental education in their classrooms. Some teacher participants (Kathy and Phoebe) shared family and childhood experiences with environmental or informal science education organizations as prominent influences on their pursuit of environmental education within their teaching. Phoebe mentioned a specific 10-day field experience she participated in as a middle school student as the start of her excitement for environmental education. Kathy shared that environmental education was a lifelong passion at least since her high school career. Not all of the early career teachers shared such formative experiences, but many mentioned a strong foundation for their interest in environmental education developing as they pursued a science degree within their undergraduate institution. Chris mentioned a specific field experience visiting a living shoreline and seeing the restoration work firsthand as influencing his interest in the inclusion of environmental education in his classroom. Melinda had similar experiences in her undergraduate program in courses such as her ecology lab, where they spent much of their time outdoors conducting fieldwork and building environmental science skills.

As the novice teachers in my study began their teacher preparation programs with this intrinsic or developing interest, they sought ways to include environmental education through choice and self-directed projects. Anne, for example, stated, "The only opportunities for environmental education [during teacher preparation] were ones that I sought out." Melinda agreed and shared

> I don't know how much I learned about environmental education in a really formal sense. I can't recall in any of my methods courses if we talked specifically about environmental education, but a lot of the…extracurriculars that I did, like being part of NSTA, running my own herpetology outreach program, that…taught me a lot about environmental education through practice.

Some of the teachers were exposed to environmental education through their field placements, further solidifying not only their interest in environmental education but in the practical skills needed to implement it within a classroom. For example, Ray shared that his 70-hour practicum in a high school focused on environmental science and biology helped prepare him for the use of outdoor space in his teaching. In addition, teacher participants shared that they were exposed to environmental education through readings, self-directed projects, guest lecturers, and field experiences within teacher preparation. Although there were a variety of types of experiences, all teacher participants had some interaction with environmental education during their teacher preparation program.

Pre-Service Program Faculty. In addition to the pre-service teachers, other key members of the university system's community were the university faculty within the teacher preparation programs (Lily, Drew, Lauren, Kim, and Gretchen). The university faculty, representing five universities, had unique backgrounds with environmental education and individual ways of incorporating environmental education into their courses. None of the university faculty had formal education or work experience within the field of environmental education. Recall from Chapter 3 that Gretchen, one of the university faculty participants, had a Ph.D. in a related field—sustainability education. However, Gretchen admitted a lack of work experience in the field of environmental education. Other university faculty (Kim and Lauren) had attended limited informal trainings on environmental education curriculum, and Lily had previously created an environmental science course for elementary pre-service teachers. None of the three (Kim, Lauren, and Lily) felt they had expertise in this area, though. This lack of knowledgeable university faculty aligns with previous research suggesting this is a challenge for the integration of environmental education within university systems (Franzen, 2017; McKeown-Ice, 2000; Powers, 2004).

Despite a lack of formal training or work experience, university faculty participants were motivated to include environmental education in their curriculum. Phoebe, for example, shared that one of the university faculty members in her teacher preparation program was highly influential and that she “learned from her that…educating people about the environment was a really good way to try and make an impact on bettering the environment.” Many university faculty recognized that they could do more to include environmental education in their courses. They shared that they assumed undergraduate experiences provided pre-service teachers with the environmental science content that early career teachers needed. University faculty were clear that this science content was not covered in the pre-service preparation program, and they relied on external experts or grant-funded initiatives to bring environmental education into their courses. Whichever method was used, the university faculty’s inclusion of environmental education had reported influences on the novice teachers’ inclusion of environmental education.

Undergraduate Faculty. Undergraduate experiences were not the focus of this study; however, early career teachers mentioned their experiences in their undergraduate science degree programs as fostering their environmental appreciation. Often these experiences focused on the undergraduate faculty who influenced the early career teachers’ interest in, and use of, environmental education in the classroom. Shelley stated that, “the things I look back fondly on in college…the things that I enjoyed doing the most tended to be outside or hands-on.” The teachers reported that authentic connections with their local environment or real-world issues affecting their local environment had the most influence. For example, Anne took part in a class specifically focused on environmental impacts on urban environments, and her university was located in an urban setting, making it more meaningful for her.

Although I did not purposefully seek out undergraduate faculty to participate in the study, some of the university faculty participants taught both in the science undergraduate program and the teacher preparation program (Drew and Gretchen). Therefore, the undergraduate faculty perspective was included in the study as these two university faculty participants reflected on their experiences working with both science undergraduates and pre-service teachers. Drew taught some of the study participants in both undergraduate science courses and in teacher preparation courses. I will discuss the placement of university faculty within the science department or education department, and the implications for environmental education, in a later section.

Cooperating Teachers. The final members of the university system's community I considered in my study were cooperating teachers, the teachers who served as on-site mentors during the pre-service teachers' field placements. Some participating novice teachers reported positive experiences with their cooperating teachers in demonstrating hands-on learning and environmental experiences for students. For example, Kayla shared that her cooperating teacher showed "how important hands-on [work] is with students, and one of those things was the fieldwork." Josh also shared that his cooperating teacher was part of a grant-funded environmental education project where students went canoeing and conducted water quality testing at a lake. Josh took part in this field experience during his practicum, which gave him experience for his own classroom later. Lastly, Ray shared that his practicum prepared him for teaching outdoors when he observed his cooperating teacher lead nature observations and photography lessons and help students look for environmental trends and patterns over time. This was not the case across all participants; some teacher participants reported that they did not observe any environmental learning during their time with their cooperating teacher. Previous research suggests that a lack of alignment between what the novice teacher is learning about in the university classroom and what they observe in their cooperating teacher's classroom can cause conflict when deciding which model to follow (Windschitl et al., 2020).

In summary, early career teachers interacted with many different perspectives, including university faculty and cooperating teachers, within the university system's community. These perspectives in undergraduate and graduate courses and within their field placement influenced the pre-service teachers' reports of their integration of environmental education.

Artifacts

Another component of the CHAT framework I examined was artifacts. Artifacts within the university system were items such as training, resources, facilities, and even funding that university faculty used to include environmental education in their courses. For example, Gretchen was highly motivated to include environmental education, but transportation and facilities to take students off-campus for field investigations was lacking, which derailed her ideas and discouraged her from including these types of experiences in the future.

Another important artifact within the university system were standards for environmental education. Recall from Chapter 2 that the North American Association for Environmental Education (NAAEE) provides national environmental education standards that form a framework for university faculty to follow for teaching environmental education strategies and evaluating pre-service teachers' competencies within this field (Franzen, 2017). Unfortunately, additional research conducted about university faculty's inclusion of environmental education suggested that faculty were often not aware of these resources and needed training to support their inclusion within the university classroom (Franzen, 2017; Powers, 2004). University faculty members in this study who had the opportunity to participate in environmental education training were more likely to share environmental topics with their pre-service teachers. One university faculty member, Kim, participated in an environmental education training that built her confidence in the subject. She said, "I introduced [my students] to the whole process of an [environmental field experience], and we go out, and we plan one. That's one of their assignments that I continued [after the grant].” However, the opportunity to attend environmental education training was limited among the university faculty participants, and only 2 of the 5 faculty mentioned relying on training or national environmental education curriculum (e.g., Project Wet) to build their understanding and confidence to teach environmental education. National curricula can provide pre-made lesson plans to share with pre-service teachers and serve as a starting point for university faculty to include environmental education in their courses (Heimlich et al., 2004; Nelson, 2010).

If participating university faculty were able to attend a training, another challenge they encountered was a lack of the physical resources (e.g., water testing equipment; nets; sampling gear; field gear, such as life jackets or waders, etc.) to implement activities from the curriculum. Physical resources were another example of artifacts within the university system. This limited university faculty’s inclusion of environmental education within their courses. Specifically, fieldwork tools and transportation to get to field sites to conduct investigations was mentioned as a limitation. For example, Kim stated, “The university has provided nothing. Most of what we’ve got, we’ve bought off of several different grants.” University faculty were forced to rely on grants to purchase field supplies, and even if they had the supplies, there were little to no transportation options to get students off-site. Gretchen reiterated that the logistics of planning experiential learning for her students was very challenging, and that to do so she had to consider “what I’m willing to go above and beyond for.” With classes lasting only 2 hours, and often in the evenings, field experiences became difficult or impossible to implement. Similar challenges were noted in prior research stating that planning and logistics were the most often reported barriers to integration of environmental education (Kim & Fortner, 2006), along with lack of funding (Ernst, 2007).

As stated previously, from the teacher participants' perspectives, the opportunity to participate in environmental education within their undergraduate careers, such as through field work, was especially meaningful in influencing their interest in including environmental education in their K-12 classroom. Field work within undergraduate courses often takes place in environmental centers that several of the universities had. These final *artifacts* in the university system could have served as experiential learning sites, but they had their own challenges. Drew and Gretchen both spoke of environmental centers that were part of the university, but that were located off campus. In Gretchen's case, the center was 30 minutes from campus, and there was no way to transport students to the site. Drew's university had an environmental education center, "a building that has an open space with the classroom and sinks and a mud room, and then research lab areas." Despite the center being only a mile from campus and part of Drew's department, he stated that "it is vastly underutilized" due to restraints within the curriculum he is expected to offer to students. Drew mentioned that, because his course does not focus on a particular discipline of science that would more closely align with the environmental education center, such as environmental science, he is less likely to use the center.

To summarize, these challenges and limited artifacts to support university faculty's inclusion of environmental education often led to a lack of implementation. Even when universities had the artifacts to support environmental education, such as environmental centers, the rules of the university (discussed in the next section) often took precedence in influencing whether university faculty could use them.

Rules

A second CHAT component I used to examine the university system was rules—the policies and requirements that allowed or discouraged university faculty from the inclusion of environmental education in their courses. From a university perspective, there were many rules and norms that faculty were expected or required to follow within their respective programs. For example, Lauren shared that university faculty were able to include environmental education in their courses as long as the core competencies of that course were still met. Additionally, she shared that the lack of environmental science explicitly in the teacher licensure regulations limited university faculty's inclusion of it at the university level, because there were other topics that required priority. Previous researchers have described university rules as program requirements, university policies, or mandated courses or content from other disciplines with stronger champions (McKeown-Ice, 2001). Additionally, at the university level, only some states mandate environmental education within pre-service teacher preparation programs (Franzen, 2017), leaving university faculty to adhere to their university's policies and priorities. Unfortunately, the pressures placed on university faculty to offer particular topics or courses often causes environmental education to be removed from higher education (Franzen, 2017; Powers, 2004; Tomlins & Froud, 1994).

Interestingly, in the region where this study took place, there was a mandate for teacher preparation programs to cover environmental education, but none of the university faculty mentioned it as guiding their inclusion of it in the university classroom. Instead, two of the university faculty listed the mandate as part of their accreditation process, but not as a factor that motivated them to include environmental education in their courses, such as their personal interest or valuation of environmental education. Further, in the state where the study took place there was no science teaching license pathway specifically for environmental science. This affected whether universities and university faculty felt it was their responsibility to teach environmental education to pre-service teachers. For example, Drew wanted to add an environmental science pathway to his university's program because he had students interested in teaching in this discipline. He shared that he

> had two students in the past couple of years who were interested in teaching environmental science. And the best we could do was have them major in biology but also take a lot of environmental science classes and then take the [licensure test] in earth science.

Drew's university administrators were not interested in developing a new program for environmental science, despite the university already offering most of the classes that would be needed for this pathway. Drew shared that his department "just doesn't have much appetite for it," despite Drew's willingness to devote his time to it. The university directed much of what the faculty could do. Lily also shared that if her university wanted environmental science integrated into the teacher preparation program, she would do it. Lily even said that her university "could be a hallmark for communicating data about environmental education to the general public," but that the university was not promoting that initiative. Lily shared that if she wanted to include it in her classes, she would be supported. She also noted that while supported, it was not a university-wide initiative, but rather a personal interest of hers to include in her courses. These stories demonstrate the university faculty's limitations stemming from their university's rules, regulations, and interests.

In addition to the universities' requirements for teacher preparation programs, some faculty participants struggled with how important environmental education was when compared with all that they must prepare future teachers for during the teacher preparation program. For example, Gretchen shared

> A lot of it is my perception of what I think students need in order to be successful in

> formal…secondary education classrooms. So, I wrestle a lot, not just with environmental education, but just sort of experiential learning in general. That's really my ideology is to emphasize environmental and experiential outcomes and pedagogy. But I don't actually think that's what formal classroom teachers need to be successful when the success is determined by [the curriculum standards].

Despite a background in sustainability education and an ideology focused on experiential learning, Gretchen was an example of how the rules of the university and the state, discussed in subsequent sections, outweighed her interest to share these topics with her students. The rules of the university system weighed heavily on whether university faculty included these topics, in addition to whether there were artifacts (tools, transportation) available. In summary, the rules of the university system influenced the types of exposures to environmental education novice teachers received in teacher preparation programs.

Division of Labor

Division of labor, the final CHAT component of the university system to examine, is the organization of the system, and how different members of the community took on particular roles and tasks. Within the university system, one of the most important divisions of labor to note was the faculty's placement—either within an education or science department. Two of the study's university faculty participants were located within their university's science department, while three were located within a school of education. Depending on the university faculty's placement, the perceived responsibility to include environmental education for students varied, along with the particular rules faculty must follow and the resources available to support it.

Two university faculty participants (Drew and Gretchen) stated that being in the science department presented challenges as they taught students in the pre-service teacher preparation program. They lacked connection with the education program and the rest of the teacher preparation program, including the other courses pre-service teachers were required to take. Their perception of the community, artifacts, and rules were lacking compared to the university faculty working directly within the education department. The education university faculty (Lily, Kim, Lauren) were more aware of the requirements from the state for teacher preparation. For those university faculty within the education schools, there was also a greater assumption that all science content was included within the pre-service teachers' undergraduate programs. However, the education faculty were not clear on what experiences students were actually getting there. Gretchen, a science faculty member, stated that "school of education faculty generally do not have the science expertise to teach for those [curricula]," leaving education faculty with missing information on what specific science content students receive in science undergraduate courses. In contrast, university science faculty were tasked with teaching education courses without having a background in education themselves. These diverse backgrounds and situational placements of university faculty within the university influenced the amount of environmental education that faculty members felt they could incorporate, and the extent to which they felt comfortable and knowledgeable doing so. This, therefore, influenced the amount of environmental education that the early career teachers were exposed to during the university system.

To summarize, the university was a complex system that had the capacity for inclusion of environmental education despite the challenges that university faculty encountered through the university's artifacts, rules, and divisions of labor. University faculty members appeared highly motivated to include environmental education in some capacity, and overall, the pre-service teachers were interested to learn about environmental education as well. University faculty experienced challenges, such as lack of tools and support from the university, which affected their integration of environmental education into the university classroom. Additional discussion of the challenges and contradictions both within this system and among the subsequent systems (K-12 and state) are addressed in later sections.

K-12 System

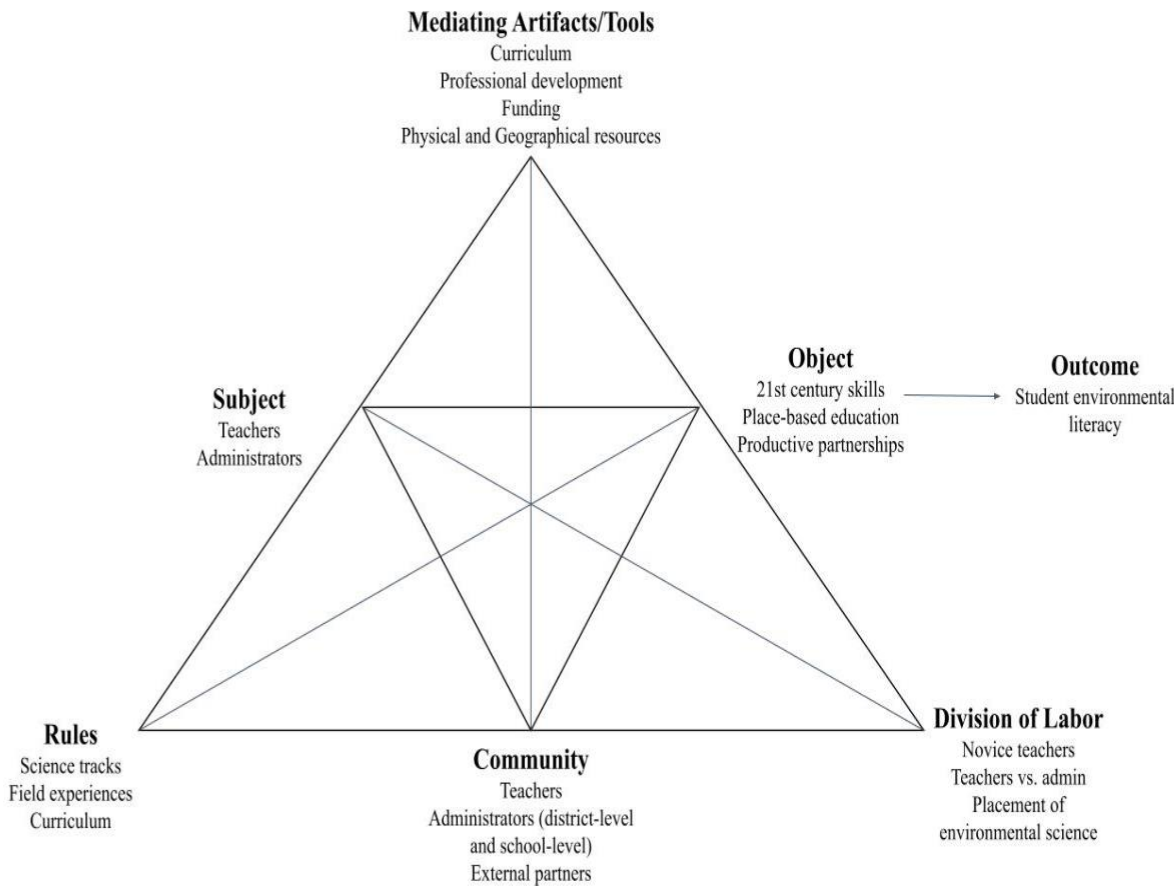
As novice teachers completed their teacher preparation programs and began teaching in K-12 schools, they encountered the second system examined in this study. The K-12 school and district in which they taught heavily influenced early career teachers' inclusion of environmental education.

Recall from Chapter 2 that science teachers are focused on the Next Generation Science Standards (NGSS), a list of core competencies for students to demonstrate their understanding of science (NASEM, 2015). Additionally, teachers of all subject areas are focused on building students' 21st century skills (critical thinking, creativity, communication, collaboration, character, citizenship, and computational thinking; Pellegrino & Hilton, 2013). Both sets of core competencies are incorporated into the state standards within the context of this study, and help the student to act as a scientist, building the knowledge and skills to do so. Therefore, the goal of this system specifically for science teachers was to promote both the NGSS and 21st century skills. Ultimately, the outcome of this system with respect to environmental education was environmental literacy for all students.

Early career teachers can be influenced by the K-12 school system in which they work, including school-level influences (e.g., other teachers, school policies) and district-level influences (e.g., district initiatives, funding; Kardos et al., 2001; Kilgore et al., 1990). The K-12 system might have been the most complex of the three in this study, likely due to the teachers' current and in-depth involvement with it. Using CHAT to understand the complexity of the system, Figure 6 illustrates the perceived influences of community, artifacts, rules, and division of labor on the early career teachers' inclusion of environmental education.

Figure 6

K-12 Schools Represented as a CHAT Activity System



Note. The cultural historical activity theory (CHAT) model for the K-12 system, as reported by study participants, highlights the influencing factors of artifacts (curriculum, professional development, funding, and resources); rules (science tracks, field experiences, curriculum); division of labor (novice teachers, teachers and administrators, placement of environmental science); and the system's community, object, and outcome.

One of the K-12 system's primary objectives is to prepare students with the 21st century skills they need to be productive citizens, as seen in several schools' mission and vision statements. Regarding environmental education, the K-12 system also strives to include place-based education into the curriculum and build productive partnerships with external partners who can assist with these efforts. These environmental education objectives were identified through discussions with school and district-level administrators. To meet these objectives, the K-12 system includes many different individuals in differing roles, known as the system's community.

Community

The community of the K-12 system included both the main subject of the system, pre-service teachers, as well as other perspectives they encountered within that system. The primary study focus remained on the teachers' perspectives, but administrators also provided historical and cultural information about the system that, in some cases, the teachers did not have. During interviews with both teachers and administrator participants, it was clear that the *community* of the K-12 system expanded to include classroom teachers, school-level administrators, district-level administrators, and external partners.

Classroom Teachers. Teachers play crucial roles in the inclusion of environmental education within their classrooms as the decision-makers and implementors of curriculum (Goldberg & Houser, 2020; Winther et al., 2002). Teachers' motivation and preparation for this inclusion can determine whether it occurs in the K-12 classroom. For this study, secondary (middle and high school) science teachers were the focus. Most teacher participants shared an interest in environmental education and in including more of what they learned during pre-service preparation concerning environmental education within their K-12 classroom. This was important because (as Tim, a district-wide administrator said) environmental education "is mostly based on...the teachers'…passion for it."

The teachers represented a wide variety of backgrounds and disciplines that additionally influenced their inclusion of environmental education. Part of this stems from their preparation as scientists. Most of the teacher participants majored in biology for their undergraduate degrees, with a few focusing on environmental science, and one on neuroscience. But just as there are different foci within biology, teachers who taught biology had different backgrounds. Kathy, for example, received a degree in biology but noted that the other biology teachers at her school had training and interest in anatomy, physiology, and microbiology rather than the ecology background and interest that she had. In addition to their science preparation, Table 4 illustrates the specific courses taught by teacher participants, with most teachers focused on biology.

Table 4

Science Courses Taught by Participating Teachers

Course	No. of Teachers
Biology	7
Environmental Science	3
6th grade Science	2
Ecology	1
Oceanography	1
Earth Science	1
Marine Biology	1
7th grade Science	1
Biomedical Science	1
AP Environmental Science	1

Note. Number of teachers who teach particular science courses in secondary schools. Each teacher taught more than one course type in the study year. AP = Advanced Placement

For this study, it was also important to note that the teacher participants were all novice or early career teachers. Recall from Chapter 3 that all participants had been teaching for 4 years or fewer, which is considered early career (Noguera & McCluskey, 2017; Paniagua & Sanchez-Marti, 2018). Novice teachers represent a subset of the entire teacher population in their school communities. Several school administrator participants noted the number of new teachers at their schools, ranging from two to four teachers out of the entire school. The schools and districts provided induction or mentoring programs for these new teachers. Miranda and Jonathan (school-level administrators) both shared that their school offered a new teacher mentor program where the novice teacher was paired with a more experienced member of the school community. Unfortunately, most of these mentor programs ended after the first or second year of teaching, leaving some early career teachers without support. Anne mentioned that she is “not considered new, so I don’t get that privilege. I still feel like I’m new because I’m only a third-year teacher. I feel like every year has been new for me.” Additionally, the mentor programs at most participating schools did not necessarily match the novice teacher with an experienced teacher in the same discipline. For example, Phoebe spoke very highly of her mentor, a special education teacher, but said she could not help her with anything specific to science teaching.

Whether or not early career teacher participants had a formal mentoring or induction program at their school, the teachers reflected on their ability to bring new ideas to their science departments. There were mixed reviews from the teachers about their colleague teacher and administrator communities listening to their ideas. For example, Ray expressed that he would have 100% support, “because it’s all centered around best practices. So as long as I’m able to show that it is within best practices, they’re ready to see innovation, especially with my environmental science classes.” In contrast, Shelley felt that her department would listen to her ideas, but not implement them, citing teachers set in their ways as a challenge to bringing in new concepts. In previous research, these challenges for novice teachers negatively influenced their ability to fully realize their specific passion or incorporate all that they learned about in teacher preparation (Zembal-Saul et al., 2020). In addition to challenges participating teachers encountered with bringing in new ideas, they might face challenges described in Chapter 2, such as communicating with parents, lack of time for lesson planning, and understanding how to join a new school community—all of which are hard to prepare for until novice teachers are teaching full-time (Kilgore & Ross, 1993; Steele, 2001; Zembal-Saul et al., 2020). One particular component of the school community that novice teachers had limited engagement with were school-level administrators.

School-Level Administrators. School-level administrators, such as school principals, department heads, and curriculum specialists, were also critical members of the K-12 school community and influenced the inclusion of environmental education in the K-12 classroom. Of the study's 10 administrators, 7 were school-level administrators (Kate, Miranda, Freddy, Carmen, Jonathan, Maddie, and Heidi). Overall, teacher participants shared that school-level administrators often understood the individual environmental education initiatives less than the teachers and district-level personnel. For example, Lindsey participated in a grant-funded project with an external organization and shared, "I do not think our principal…really knows that we do it." The exception to this was Maddie, a participant in the study and a department head with a vast understanding of science education initiatives happening at the school from both the teacher and district-level perspective.

In addition to a need for more understanding of high-level initiatives, teachers viewed school-level administrators as separate from their work as science teachers. Several noted that their administrators did not have much science education training. Phoebe, reflecting on her principal's role in environmental education and the new outdoor classroom being built at their school, shared, "no, my principal was an English teacher. I don't think she really cares much about science. I don't think she's very invested in science…improving science education." Other research suggests that this misalignment in content specializations between principals and teachers is common. Often, principals rely on instructional coaches or district-level science coordinators with content expertise to guide teachers in particular content areas (Lorentzen, 2022). For this reason, teacher participants often shared that they had a closer connection to their district-level science supervisors who had a shared content expertise.

District-Level Administrators. A third member of the K-12 system's *community* were district-level administrators who served as the science supervisor or science curriculum specialist for the entire district, and therefore had a much deeper understanding of the environmental education initiatives within their district. Two district-level administrators (Robert and Tim) participated in the study. District-level administrators supported science teachers in many ways, from sharing resources, providing district-level curriculum, and helping train new teachers. One of the most significant roles teacher participants shared in how their district-level administrator connected with them was sharing resources, such as community events, training opportunities outside the district, prospective grant funding, and curriculum ideas. Tim shared that he tried to send out a newsletter regularly but was challenged in maintaining timely and regular distribution. These newsletters were shared directly with teachers and included many teacher opportunities, but they might be missed by the teachers who receive them. Anne, a teacher in Tim's district, stated, "I am sure there's some [newsletters] that I'm probably not even aware of, but I try to keep up with it. But there are so many emails and messages that it's hard to keep track of." In addition to resources sent directly to teachers, district-level websites also provided resources for teachers. On one district's webpage, I found examples of field experiences, a youth conservation camp, a leadership institute, and student opportunities like the Envirothon, poster contests, and student scholarships.

Additionally, district-level administrators often provided district-wide curriculum and training to teachers. The curriculum was reported as especially helpful and even necessary, especially in courses without state-wide standards such as environmental science (discussed in subsequent sections). For example, Ray spoke of the curriculum writers in his district as an especially helpful resource for the environmental science course, and shared that professional learning was also provided for that content. Chris also spoke positively of his science supervisor and said, "he calls himself the professional science nerd of the county," noting that his district was "very unified in the goal of the county to get us doing more active investigations." Chris stated that his district science supervisor worked toward that goal across every department to ensure implementation. Previous studies have emphasized the need for champions such as this within K-12 schools to offer training, support, and leadership to build teachers' confidence to lead environmental education activities (Rieckenberg, 2014).

District-level administrators, along with mentor teachers, can provide the necessary support to encourage novice teachers to implement environmental education (Richardson et al., 2014). Tim, one of the district-level science supervisors who participated in the study, was previously a teacher in the district for many years. Recently, Tim transitioned to the district-level administrator role. When asked how, if at all, the district's historical perspective on environmental education had changed over time, Tim stated, "it was more of a kind of a nice to have…I think we're starting to realize that environmental literacy is a need to have for any student moving forward." Both district-level administrators who participated in the study agreed that the focus on environmental literacy had increased over time.

Although many teacher participants cited examples that district-level administrators provide for their district, others felt that the administrators' descriptions of district-wide initiatives differed significantly from what schools saw. For example, Miranda said,

> I think…if you talk to Tim, or anyone at the central office level about environmental education, they would definitely tell you it was going really well. And I don't think it's bad, but I don't think it's as…big of a push as we say it is. We're heading in that direction.

Similarly, Melinda stated that

> I'm sure that [the district] would say it's really important and something that they want to see more of. But in terms of the decisions being made, and the supports that are given that make that doable? Not seeing a lot of it.

The variety of perspectives on district-level administrators showcased the significant perceived influences administrators had on participating teachers' implementation of environmental education, and whether they had the support and resources to do so.

External Partners. The final member of the K-12 system community that emerged from analysis of the interviews with teachers and administrators was external partners. External partners like the one Lindsey worked with provided additional environmental classroom instruction and field experiences for students, as well as professional development for Lindsey and other participating teachers. Many teachers rely on grant-funded opportunities to include environmental education in the classroom when the teacher does not have the expertise or capacity to offer it on their own (Ernst, 2007). Tim, a district-level administrator, stated, "we have partnered with as many different local partners as we can…in order to…expand the [students'] horizons and the possibilities." Some authors have suggested that these partnerships between formal education schools and nonformal environmental education organizations are highly advantageous to the inclusion of environmental education in the classroom, putting knowledgeable staff in front of students and providing education opportunities that teachers might not otherwise be comfortable with (Greer, 2022). Both Kayla and Melinda, for example, shared positive experiences with external partners. Kayla discussed a grant-funded project during her first year of teaching providing her with the science content and civic engagement piece she felt she was missing in her classroom. The project also provided professional development that she felt she needed and was not receiving from her rural school. Similarly, Melinda had a positive experience with a different environmental education provider who offered field experiences for her environmental science students. Melinda's district science supervisor applied for a grant to partner with the organization and then shared the opportunity with Melinda and the other teachers.

Although both teachers had a positive experience overall, each also noted inherent challenges with partnering with an external group. Kayla shared that she enjoyed the project as a first-year teacher but that others in her position might have found the time commitment and extra expectations overwhelming. Melinda shared that the amount of paperwork required was time intensive, but she and her students enjoyed the experience, which outweighed the negatives. Several other participants noted challenges within these partnerships, such as a need for greater understanding from the partner's perspective on the K-12 school context and the needs of the school's teachers and students. Participants also were discouraged with the limited capacity of partners to provide experiences for all students. Maddie (school-level administrator) and Lindsey (teacher) worked at the same school, and both were involved in a project with an external partner through a grant-funded opportunity. They both shared challenges in working with the partners in the first year of the grant. They stressed a significant learning curve on the partner's part in understanding the school's needs and the best practices for working with that particular student population. Maddie even shared that they had to give some training to the partner on how to better work with their students. Lindsey echoed Melinda's comments about the time required for paperwork like field trip permission forms, but she added that the program also took the students away from valuable classroom time. In this case, the partnership cost the teacher instructional time through paperwork, required training, and planning for experiences both on and off campus.

In summary, external partners brought opportunity and expertise to the school community, but these partnerships also brought challenges that must be considered. External partnerships will be discussed later in the chapter as a possible contradiction within and among systems. External partners, along with the other members of the K-12 system's community (including teachers and school and district-level administrators), influenced participating teachers' inclusion of environmental education.

Artifacts

Like the university system, the K-12 system had artifacts, or resources, that influenced novice teachers' inclusion of environmental education within their classroom. Schools and districts had varying levels of support for environmental education, and these reported influences, such as physical and geographical resources, funding, and professional development, affected the teachers.

Physical and Geographical Resources. Resources available to teachers influenced their decision to include or not include environmental education in their classrooms. These resources, or artifacts, included physical items (e.g., curriculum, field experience materials) and natural spaces (e.g., trails, ponds, outdoor classrooms). Physical resources were essential to teachers, especially curricula that allowed them to see where environmental education fit into their instructional plans. Ray, for example, stated that "it's a huge deal. There's a ton of curriculum resources for it. We have like entire pages and groups dedicated to it." Participants also discussed at length other physical supplies, such as those needed to conduct field investigations, and many participating teachers stated that there were supplies but no instruction on how to use them. Other teachers noted that they only knew of the supplies physically located in their individual classroom. One administrator explained that the supplies in the school were not inventoried well because individual teachers often received supplies through external professional development and other opportunities, rather than through district-provided training. These supplies were therefore not known by the other teachers in the building, and sometimes were even left behind as teachers retired or left a particular school, leaving supplies for others to find with no instructions or context.

Additionally, participants frequently mentioned natural spaces like outdoor classrooms, trails, ponds, lakes, and woods accessible from the school property. Teachers discussed taking their students outside for field investigations within the school grounds. One teacher even mentioned miniature mesocosms, a small self-contained example of an ecosystem, built by Robert (a district-level administrator) on each of the schools' grounds within his district. These mesocosms are enclosed environments that allow students to observe an ecosystem without leaving the school site. Robert's mesocosms are constructed for teachers to collect water-quality and weather data and conduct biodiversity experiments without leaving the school site. Having natural spaces on or near the school property allowed teacher participants to use the outdoors more in instruction. Similarly, some authors found that schoolyard experiences increased student enthusiasm for environmental education (Dring et al., 2020). Teachers in the study who had accessible natural spaces and support from administrators in using those spaces noted more frequent and varying uses of the outdoors during instruction. For example, Phoebe noted access to a pond, walking trails, and the mesocosm created by Robert, her district-level administrator.

Unfortunately, some teacher participants were unsure of their ability to use outdoor spaces. For example, Shelley knew of trails behind her school connecting to a local park. As a new teacher, no one in the school community told her about this resource; rather, she heard about it from her students. She was unsure whether she was allowed to take her students on the trail during science instructional time. Another teacher participant, Melinda, noted the safety concerns of taking her students outdoors due to the location of her school on an outdoor campus. Melinda shared "you're going outside, and you're still surrounded by the school, so if [other students are] skipping [class], they're also outside with you." This was a deterrent for Melinda to take her students outdoors.

For many other participants who were able to take students outdoors, there were additional safety requirements, such as alerting staff to their whereabouts and borrowing a school radio or cell phone to be in constant contact with the school's main office. These challenges to using outdoor spaces, even those directly in the school property, negatively influenced these teachers' implementation of environmental education. Shelley and Melinda shared that they limited their use of outdoor space due to these challenges. In addition to the challenges identified by study participants, prior research suggests a lack of administrator support and lack of professional development on how to use outdoor spaces as an explanation for their limited use (Dring et al., 2020).

Funding. Funding, another artifact in the K-12 system, is often cited as the largest challenge for teachers who want to include environmental education in the classroom (Ernst, 2007). Participants noted that funding was often required for field trip support, such as renting buses and paying for substitute teachers, in addition to purchasing classroom and field supplies to support environmental education efforts. In general, for participants who did take students on field experiences, the district covered all expenses related to the trip, whether through district funding or grant writing. The teacher participants did not state funding was a significant limitation from their perspective, but administrators noted funding as a consideration when approving or declining teachers' requests for field experiences. Many teachers in the study's sample participated in environmental education programs with external partners, funded through grants their district was awarded.

Grant Writing. Often, environmental education projects require supplemental funding to support travel, supplies, and program fees (Lovaas, 2015). Participants frequently noted that their districts' ability to secure external grants supported their inclusion of environmental education. These grants were typically written by district-level administrators, because grant writing is a specialized skill that most K-12 teachers lack (Hite & Milbourne, 2022). Several participating teachers (Kayla, Melinda, and Lindsey) were told after the grant was secured that they were to participate. Because this removed a burden (i.e., administrative tasks, grant-writing, forming partnerships) from the teacher, it suggested that teachers were not involved in planning the grant-funded program—district-level administrators were. Although this could be viewed as support for teachers and protecting teachers' time, if grants were not tailored to meet teachers' needs, they could also be viewed as an additional obligation for teachers to fit into their existing curriculum. However, one benefit to grant-funded environmental education programs, such as those that Kayla, Melinda, and Lindsey participated in, was the coinciding teacher professional development that was offered.

Professional Development. A third and final artifact within the K-12 system that heavily influenced participating teachers' inclusion of environmental education was professional development. Professional development is typically offered within the school district for the teachers working within it (King & Newmann, 2001). One of the district science supervisors shared that what was offered within their district for professional development was most frequently focused on school-based policy and general education information like classroom management strategies. Melinda (a teacher) agreed, “a lot of our county-provided professional learning is not content specific.” This lack of content-specific professional development was consistently noted across participants, and some district-level administrators also admitted disappointment that they were not able to provide the amount and quality of professional development to teachers that they would have liked.

Specific to environmental education, teachers need increased understanding and confidence to enhance inclusion in the K-12 classroom (Kim & Fortner, 2006). This is especially true for early career teachers who might be highly motivated to bring new ideas to the classroom but require continual training and support (Merritt et al., 2018; Scott, 1996). This aligns with Kate’s suggestion that training teachers was an “obstacle” to including environmental education. This type of professional development did not appear to be occurring within participants’ schools. Participants instead shared that their districts highly encouraged external professional development, which was shared through district-level administrators directly to teachers. These types of professional development opportunities required teachers to opt in and often required extra time on the part of the teacher. Teacher participants expressed that they lacked the time or energy to search for or attend external professional development in addition to their school responsibilities and required district trainings. Overall, professional learning related to environmental education was lacking in the K-12 school systems in this study, and teachers who were attending content-specific professional development were doing so through external groups. The exception was professional development that was included in grant-funded systemic projects, such as the one Miranda participated in.

In summary, the availability of artifacts influenced teachers' perceived ability to offer environmental education to their students. Physical resources, natural space, funding, and professional development influenced whether participants could include environmental education within their K-12 classrooms. When participants had access to these materials, training, and resources, they included more environmental education in the K-12 classroom compared to those who did not have access. However, artifacts were not the only influence on the early career teachers. They also were subject to the rules of the K-12 system.

Rules

To further understand the K-12 system, CHAT suggests considering a system's rules. The K-12 system had a vast array of school- and district-level rules, such as when in their program of studies students took particular courses and how teachers must plan field experiences for students. One such rule that influenced environmental education was the challenge of various tracks students could take during their high school career and the variety of courses they could take to meet graduation requirements. For example, Kate stated,

> I would say a plan like [the district environmental education plan for systemic implementation] works super well at the elementary school level. And even at the middle school level. The problem is, once you get to high school, there's such a branching-off, and not every kid is taking like the same courses anymore.

The flexibility for students to choose their path in high school allows for more personalized instruction based on their interests but makes it more difficult for systemic environmental education to ensure that all who graduate have had particular experiences to build environmental literacy. In addition to systemic environmental education, rules about the scope and sequence of particular courses were governed by the state department of education. I will discuss these rules further in the subsequent system's section.

Rules also affected participating teachers' ability to plan field experiences. Getting field trips approved was a challenge participants cited repeatedly. Kathy, for example, shared many ideas for field trips, but settling on one option, finalizing buses, and completing paperwork impeded implementation. Kathy's school had a seven-step process for planning field trips which dampened Kathy's interest in planning a field experience for her students. Miranda agreed that "the planning process has been nuts…It's more a logistical difficulty than an admin support issue," suggesting that the rules at play within the school and district to plan and implement a field experience hindered teachers' interest in conducting one. Consideration of the artifacts (e.g., location, funding) for field experiences further compounded this challenge.

In summary, rules for the study's participating teachers deterred even the most impassioned teacher wanting to include environmental education in the classroom. Previous studies have also suggested that rules influenced novice teachers even more than experienced teachers because novice teachers often felt they could not challenge existing rule structures (Lockton & Fargason, 2019). Even when teachers had physical resources easily accessible to them, rules sometimes impeded their ability to use those resources for instruction. Rules also extended into dividing power between members of the community.

Division of Labor

The final CHAT component to examine was the *division of labor*. This component refers to the community member's roles and how various tasks were distributed, including the power dynamics across those roles. These roles and tasks influenced participating teachers' incorporation of environmental education. Analysis of the division of labor in the K-12 system identified issues with the role and support of administrators, the specific challenges that novice teachers experienced, and the responsibility for teaching environmental education.

In previous sections, I described the separate roles of K-12 teachers and school- and district-level administrators. This division of labor alone influenced teachers' inclusion of environmental education. A supportive administrator who provided grant-writing assistance, hands-on equipment for school-based field investigations, or professional development focused on environmental science encouraged participating teachers to include environmental education in the K-12 classroom. In contrast, an administrator lacking understanding of science concepts, dismissing requests for outdoor learning, or even writing grants for programs without teachers' input discouraged teachers from including environmental education.

In addition to the supportive efforts of administrators, the difference in teachers' and district-level administrators' understanding of environmental education efforts across the district influenced teachers' inclusion of environmental education in the classroom. Chris, for example, was aware of an environmental field experience effort that would happen but had no idea how it connected with his curriculum. He stated that he would likely learn the details of the field experience the week it took place. All that Chris had heard about the field experience so far was that some of his colleagues had negative feelings about the same experience that took place during the previous year. Similarly, Phoebe did not have a complete understanding of district-level initiatives and said that her district "doesn't do any [field experiences]. If I wanted to do it…a teacher has to do it. It's not already provided for the county," despite her district-level administrator citing several examples within the district. Teacher participants had a much more limited understanding of the district-wide initiatives for environmental education than participating administrators and often did not feel that they were part of the planning of these experiences. It is possible that interactions between administrators and classroom teachers, and the perceived influences this division of labor created, were exacerbated for participating teachers who lacked the historical perspective of environmental education within the district or school.

Novice Teachers. As previously discussed, novice teachers are more likely to assimilate into the cultural norms of the school community than their experienced colleagues (Zembal-Saul et al., 2020). Moreover, without support from administrators and mentor teachers, novice teachers are less likely to incorporate environmental education in their classrooms (Richardson et al., 2014). These are typical challenges of novice teachers and are not unique to environmental education. Shelley stated that she did not include the environmental education she learned about in teacher preparation "because I sort of just fell in step, in line, with the rest of the people in my school. I did what seemed like appropriate based on what everyone else was doing." This desire to maintain the status quo was common among teacher participants and encouraged them to follow their more experienced colleagues' plans of how to teach particular courses. One example of staying within the confines of the course they were teaching surfaced when I asked the teachers where environmental education took place within their school.

Placement of Environmental Education. In addition to the challenge of being a novice teacher, many participants shared challenges related to where environmental education was taking place within their school or district. This was frequently noted as the environmental science course, a new course gaining popularity within high schools across the state. More details about this are provided in a subsequent system description. Many participants felt this was the one designated course where environmental education was and should take place. Kayla, for example, stated that environmental education only had a place if you were teaching "those" classes (e.g., environmental science, ecology, Advanced Placement environmental science, field biology). Josh also validated this idea, saying, “we have a lot of other content to talk about in the biology classroom. We’re not environmental science, we’re not earth science, or ecology,” suggesting that there was little space for environmental education outside of those courses. Even still, some participants saw potential for environmental education regardless of the course. Josh, a biology teacher, was inspired during his interview and brainstormed where he could teach environmental education within his biology course (e.g., using environmental examples when teaching about microscopes).

In summary, the division of labor in K-12 schools both encouraged and discouraged novice teachers to include environmental education in their classrooms. Lack of understanding district-wide initiatives, the placement of environmental education within the curriculum, and the pressure that participating teachers felt to maintain the status quo negatively affected integration of environmental education. Rules also influenced these examples of division of labor within the K-12 system, such as those placed by the state on the scope and sequence of particular science courses (described in the following section). In summary, the K-12 system was complex with many perceived influences on early career teachers. The contradictions within and sources of innovation for this system are discussed later in the chapter.

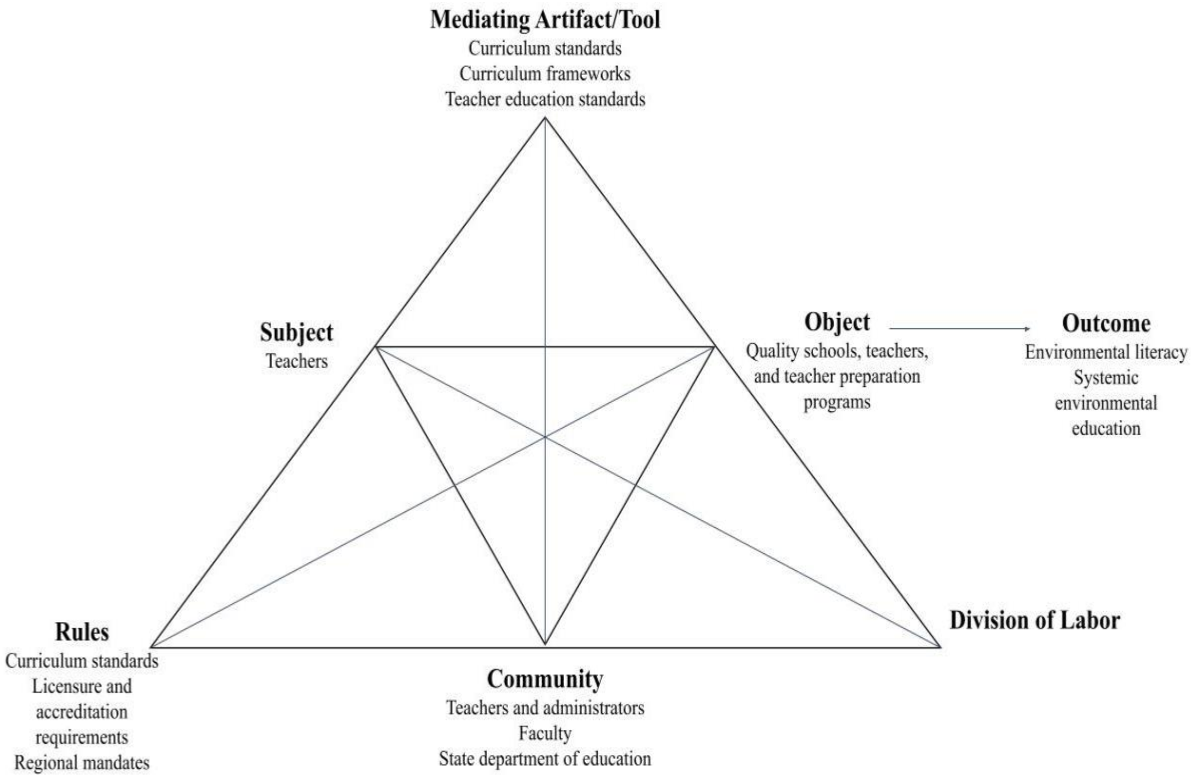
State Department of Education System

The final system that arose as a perceived influence on early career teacher participants was the state department of education. State departments of education had prominent perceived influences on science education—the scope and sequence of the curriculum, the requirements for receiving a teaching license in the state, what universities must do to prepare quality teachers to teach in that state, and more. In addition, the influence of the federal department of education was included in this section, as it was minimally mentioned in teachers' perspectives, mostly focused on school accreditation regulations.

The goal of the state department of education was ultimately to offer quality learning and teaching to all students within the state. Regarding environmental education, the state promoted a goal of environmental literacy, and aimed for systemic implementation of environmental education. The goal was for all students to have the knowledge and skills to act responsibly to protect and restore their local environment, as noted on the state's department of education website. To achieve systemic environmental literacy across the state, there were many factors involved, including the complex systems that have been discussed in previous sections. In this section, I describe influences participants perceived, mostly from the state department of education, as expressed through the CHAT components of community, artifacts, and rules (Figure 7).

Figure 7

State Department of Education as a CHAT Activity System



Note. The cultural historical activity theory (CHAT) model for the state and federal departments of education system, as reported by study participants, highlights the influencing factors of artifacts (curriculum and teacher education standards); rules (curriculum, licensure and accreditation, regional mandates); and the system's community, object, and outcome.

The state system's goal is to prepare quality schools and teachers, which also entails ensuring future teachers have access to quality teacher preparation programs. With quality schools, the state can then work to promote environmental literacy for all students. The work of the state system included several different key stakeholders, known as the system's community.

Community

The community of the state department of education system included all of the teachers, administrators, and university faculty previously included in the K-12 and university systems, as they work to move the state toward its goals of quality schools and environmental literacy. Additionally, this system included the members of the state department of education, specifically those focused on science education and teacher licensure. As it relates to this study, the science education members of the state department of education focused on developing the state science standards, overseeing state universities' teacher preparation programs, setting and enforcing licensure requirements to teach in the state, and overseeing accreditation processes for both K-12 schools and universities providing teacher preparation programs. Additionally, to prepare and assist in developing quality teachers, the state department of education offered instructional and assessment resources, including professional development. During every interview with early career teachers, the state's perceived influences on the teachers' implementation of environmental education arose.

Artifacts and Rules

The artifacts and rules that influenced early career teachers' inclusion of environmental education in the K-12 classroom overlapped within this system. The state provided particular artifacts or resources as well as guidelines or *rules* for the K-12 teacher to follow, such as the state's curriculum standards. Because of this, I will describe the artifacts and rules as one section, including state science standards, licensure procedures, accreditation, and regional mandates.

Science Standards. The artifacts study participants most often discussed were the state curriculum standards. In the state where the study took place, the curriculum standards guided teachers in planning their instruction. The standards both identified places in the curriculum with direct ties to environmental education and, in some cases, limited the integration of environmental education because teachers felt they must follow the standards without deviation. Regarding environmental education in the curriculum standards, Miranda said, "It exists in the curriculum; it's not significant," suggesting that other topics took precedence during instruction.

The state department of education has a dedicated webpage to its environmental literacy efforts. These efforts include information on the regional (across multiple states) mandate for field experiences, the connection with the standards, and the state's program to promote sustainable schools. The webpage also includes links to environmental education resources and professional development opportunities offered by external partners. The curriculum standards that connect directly to environmental literacy efforts are listed in a table to show where the best connections can be found. At the secondary science level, there are curriculum standards in 2 of the 3 middle grades, as well as biology (1 standard), earth science (1 standard), and environmental science (5 standards). This is not an exhaustive list of possible connections to environmental education, but rather it shows where the state has highlighted the best alignments between the standards and environmental literacy efforts.

Teachers used the state's curriculum standards to guide their instruction and curriculum for the courses they taught. Miranda shared her viewpoint on the importance of the curriculum standards and how environmental education fits into the standards,

> But at the end of the day, if that's not on the standards, and those kids need the [end-of-course test] to graduate, and we need the [end-of-course test] for accreditation, we're going to teach the things that are in the standards. Those are going to take priority. And understandably, we will incorporate other things, but unfortunately, they are not the priority.

At the end of some courses, the state requires students to take end-of-course summative assessments. These assessments, provided by the state, became the focus of many schools, districts, and teachers. As Lindsey stated, "The goal is [end-of-course] tests." Nearly every participant both in the K-12 and university system mentioned the curriculum standards as a driver for what they did in the classroom.

End-of-course tests limited the frequency environmental education was included in particular classes. For example, in biology, environmental topics were included in the ecology unit, scheduled to be taught just before the end-of-course test. The pacing guide for biology from one participant's district suggested that the ecology unit was the third longest in the entire biology curriculum. Despite this, instead of teaching this unit, teachers often used the time for end-of-course review. Teachers justified this shortening of the ecology unit by saying that their students could relate better to the environmental topics, and that these topics were more accessible for students to grasp than some of the microbiology topics included in the biology curriculum; therefore, teachers did not need to spend as much instructional time on ecology topics. For example, Miranda shared,

> For biology, there is an ecology unit. It's usually allotted 3 weeks. We usually spend 2 or 3 class periods on it because it's the one that comes right before the [end-of-course test], so it just kind of gets all crammed together.

Unfortunately, for advocates of environmental education, this ecology unit was the one place in the biology curriculum with the largest environmental focus. Kate shared that environmental topics like evolution might be addressed elsewhere in the curriculum. However, ecology was mainly covered through topics such as ecosystems and human environmental impacts. From Kate's perspective as a school administrator, "Ecology gets completely downplayed because they're just trying to get them to review and pass the [end-of-course test] at that point."

To summarize, participants perceived the state curriculum standards as having significant limiting influence on their inclusion of environmental education in the classroom, possibly the most substantial influence of all. Previous researchers have similarly suggested that state testing and education standards are two of the top four barriers for K-12 teachers to include environmental education in the classroom (Ernst, 2007). The standards and the end-of-course tests bind teachers to particular content as a way to ensure their students are proficient in these courses (Kim & Fortner, 2006), but in doing so can restrict teachers' inclusion of environmental education.

Curriculum Frameworks. Another resource that the state provided to participating teachers was the curriculum framework, or the suggested order and timing of teaching particular topics within a specific course. Several teachers discussed this scope and sequence of topics, as suggested in their pacing guide. As previously stated, for biology teachers, the ecology unit was typically offered at the end of the year. This placed ecology in direct competition with preparing for the end-of-course tests. Additionally, study participants brought up the order of content. Some districts deviated from this suggested order and instead taught the curriculum topics in reverse order. For these districts, ecology was taught first, as a familiar topic to ease students into biology. For example, Lindsey shared that ecology was taught at the beginning of the school year. This offered her more opportunities to include environmental education because she had the time at the beginning of the year within the ecology unit versus other districts where ecology competed with review time for the approaching end-of-course tests. The timing of offering ecology, whether at the beginning or the end of the year, influenced whether field experiences or outside learning could take place because of time of year, temperature, and the unavailability of field experiences during end-of-course testing.

Curriculum frameworks were also important for early career teachers teaching an elective or a non-tested course, such as ecology. In contrast to the participants who shared that curriculum standards can be limiting, the flexibility that teachers felt they had when teaching a non-tested course greatly increased. These courses allowed teachers to bring in more of what they experienced in their undergraduate and teacher preparation programs. Moreover, while Tim shared that “the tests are kind of driving what schools are doing,” teachers in his district who taught a course like environmental science without an end-of-course test, had increased opportunities to bring in environmental education. In these non-tested courses, curriculum writers in the districts provided suggestions, but individual teachers chose what content to cover.

Environmental Science Course. One particular non-tested course, environmental science, came up repeatedly as a significant influence on environmental education. Several years before this study, the state board of education approved the addition of environmental science as a course that could satisfy high school graduation requirements. This changed the requirement from earth science to environmental science. At its adoption, the environmental science course came with documents provided by the state to help teachers and administrators understand the new course offering. These documents included content guidelines containing an extensive section on human impact, global climate change, and civic responsibility. The state also provided information on potential course pathways within science for districts to decide when and how to offer environmental science.

Most participants viewed environmental science as a course without an end-of-course test that helped students prepare for biology. Kate shared,

> The impetus for it was this push to try to have a place where kids could go, where they didn’t have to take an [end-of-course test]. That was literally the biggest push because kids were coming in never having passed an [end-of-course test] in their entire middle school.

From Kate's perspective—and many others shared similar viewpoints—it was "a science to kind of get their feet wet in high school before they have to have an [end-of-course test] attached to it." Melinda shared this perspective, saying that the environmental science course was treated more like a pre-biology course, focused on teaching students the skills needed for biology, like reading science content, analyzing graphs, and conducting laboratory experiments. Tim, an administrator participant, shared his fear that environmental science was being used to prepare students for biology rather than including the environmental science content that should be taught.

However, not all participants' districts offered environmental science this way. Some retained earth science in the middle school grades, while others saved environmental science for upper-level students at the high school. For example, Kim shared her perspective on this change and the rules from the state, "I have to keep coming back to thinking that the state [guidelines] are recommendations. They're not mandates." Others expressed their concern about the change from earth science to environmental science. Heidi was concerned about the breadth versus depth of science offered in most high schools in the state, as physical science was nearly removed completely from the curriculum. Previously, students would take earth science, biology, and chemistry to meet graduation requirements. However, with the new course options, students could take environmental science, biology, and a science elective of their choice. This allowed students to complete their high school degree without a physical science course. With earth science being phased out for the new environmental science course, there were opportunities for increased environmental education. However, without curriculum standards in this course, topics offered to students varied widely.

Miranda, for example, shared that there was much talk about environmental education in her school leader meetings and with the science specialists for the county. At the school and district levels, environmental education was a frequent topic of discussion and an initiative the district was supporting. Despite this, Miranda saw a lack of change in the testable standards, which limited the teachers in her district from deviating from them. Furthermore, she stated that, until teachers and students were not evaluated on those standards, the instruction within end-of-course tested courses would not shift as much as her district suggested that it would. In summary, participants felt that curriculum standards, frameworks, and specialty courses had direct influences, both negative and positive, for early career teachers' inclusion of environmental education.

Teacher Preparation and Licensure. Another artifact/rule that influenced early career teachers' inclusion of environmental education was the process for receiving a teaching license in the state. In addition to overseeing the K-12 system, the state department of education also administered regulations governing teacher preparation programs to ensure that teachers enter the classroom with content knowledge and instructional skills aligned with the curriculum standards and other objectives for learning and achievement.

For example, for middle grades science education, biology, earth science, chemistry, and physics, the state department of education specified that teacher preparation programs should include field investigations for all students using the school grounds and community resources. The exact phrase from the state department of education was also found in Drew's syllabus, and when asked about it, he shared, "The source of that verbiage is the [state] accreditation documents. It's [a competency] for the four secondary science disciplines." Finding this specification in the state's regulations for universities was in direct contrast to several studies (e.g., Franzen, 2018; Powers, 2004; Tomlins & Froud, 1994) that stated that environmental education had been removed from higher education nearly entirely for several reasons, including program requirements. In contrast, in the study's state, it was explicitly listed as a competency for pre-service teachers to learn about during teacher preparation, despite most university faculty participants not mentioning that as motivation for including environmental education in their pre-service teacher preparation courses. The regulations for teacher preparation programs not only served as artifacts for university faculty to refer to when designing programs, but also were rules enforced for universities to maintain their teacher preparation programs.

Teacher licensure was another process overseen by the state education department, ensuring that high-quality, licensed teachers were available to all students in the state. Teachers preparing to teach science must meet the requirements for a license, including taking specific courses, receiving an undergraduate degree in their field of science, and passing a standardized licensure test. The state department of education sets these standards and monitors teachers' applications for teaching licenses to ensure that they have met all of the requirements from the state. In this way, the licensure information served as an artifact for university faculty and as a rule for the early career teacher.

Accreditation. The federal department of education also influenced early career teachers' inclusion of environmental education through school accreditation regulations. Although the state department of education publicized the accreditation of K-12 schools, the actual accreditation process was a combination of state law and federal requirements. One way that school accreditation affected teachers' inclusion of environmental education in the classroom was the requirement for students to pass the biology end-of-course test for the school to remain accredited. For example, Kate said,

The thing that the federal government is looking at to judge us on our achievement is our

> biology [end-of-course] scores. This is why every single kid has to take biology to graduate. That's the one that they've decided is the required science.

Freddy also shared, "[Biology] is the only federally required [end-of-course] course. They are required [to take] three science courses, or four for an advanced diploma." Maddie's school was on academic review for accreditation, and even the teachers teaching the non-tested environmental science course felt the pressure of accreditation—the district was checking the environmental science unit test scores to ensure students were being adequately prepared for biology the following year.

Concern with accreditation also influenced resources available to science teachers. Science is only one curriculum standard, and students are tested much more frequently in math and language arts than science (NASEM, 2015). Carmen shared, "I think if you're looking at budget…it would make sense that language arts and math would have more support than other contents because they're tested more often. And we need those for accreditation." This focus on language arts and math in unaccredited schools translated to increased support for teachers from district-level personnel. Anne shared that her school was not fully accredited, so everything was focused on getting that accreditation. This affected environmental education because if it was not seen as related to a standard, the school and district were unwilling to push for it. Their priorities were on the courses needed to pass end-of-course tests and become accredited again. Universities faced similar requirements for accreditation. As stated in Chapter 2, teacher preparation programs in the U.S. must undergo accreditation every 7–10 years by the Council for the Accreditation of Educator Preparation (2020) to ensure the program's quality. These rules for accreditation also served as artifacts for both K-12 schools and universities to build programs around, serving as a key resource.

Regional Mandates. The final rule that emerged in the study related to the state system was a regional mandate for environmental education mentioned by name by only one participant. This agreement contained many environmental mandates for schools located in the region and therefore had direct implications for education. For example, the agreement stated that all students should have environmental field experiences several times throughout their K-12 years. These programs would offer students hands-on experiences investigating local environmental issues and, through data collection and analysis, implement real-world solutions to help mitigate these issues (Sprague et al., n.d.).

Robert was aware of the mandate as a rule supporting field experiences in the state and used it to justify multiple field experiences for students as they moved through their K-12 careers. A few other participants mentioned that field experiences were requirements without stating the exact regional mandate. Carmen stated, “I know they do [field experiences] here because it’s a state requirement.” Kate also knew that it was a graduation requirement and that “in theory, they were supposed to have [field experiences],” despite not doing it. Regional mandates like this had strong implications for teachers and administrators in advocating for environmental education in their schools. Additionally, for university faculty, this mandate was a justification for the inclusion of environmental education in teacher preparation programs, because it was part of what teachers would be required to conduct in the classroom.

To summarize, the rules of the state-level system affected teachers’ integration of environmental education in the classroom. The standards, the accreditation process for all educational organizations, and the state licensing requirements (artifacts and rules) helped the state education department ensure quality teachers, and regional mandates provided written justification for environmental education. The complexity of all three systems, including the components of CHAT within and among the systems, created and allowed for contradictions to the inclusion of environmental education which are the focus of the following section.

Discussion

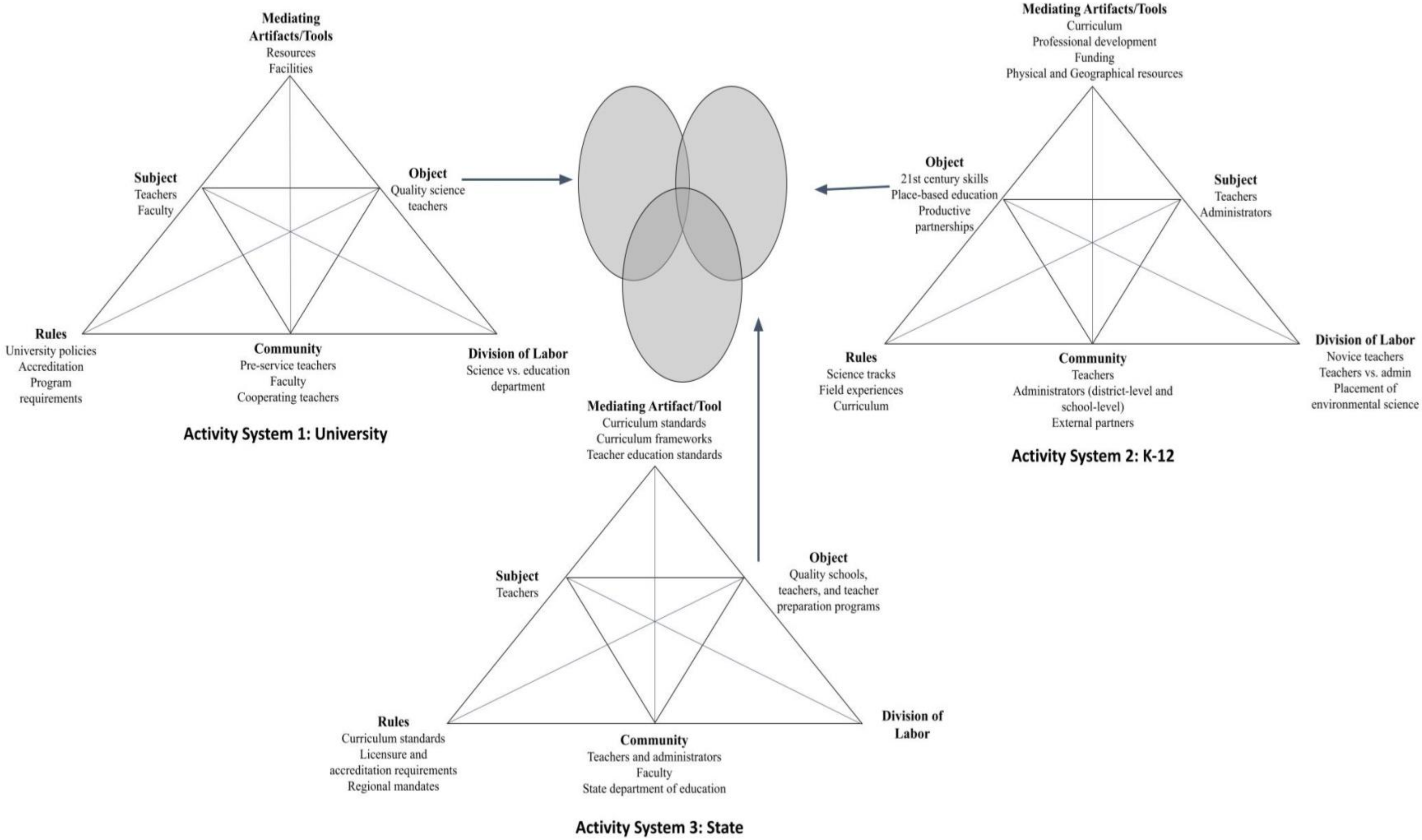
Previously in Chapter 4, I examined the complex systems influencing participating early career teachers' integration of environmental education, focusing on descriptions of the systems via the CHAT components (community, artifacts, rules, and division of labor). Throughout interviews with early career teachers, administrators, and university faculty, participants shared examples of how these particular components influenced their perceptions and inclusion of environmental education in the classroom. In the following sections, I will present the overarching themes from the findings and examine how contradictions within and among those systems caused both challenges and opportunities for environmental education within the context of the study.

If each activity system is considered as a structure of interconnecting pieces, contradictions are the tensions among those pieces that are inevitable within a complex system. There are competing priorities, required resources, varying viewpoints, and power dynamics that can influence a complex system. The activity systems include multiple perspectives (community), rules, division of labor, and artifacts; therefore, conflicting perspectives are also inevitable. CHAT recognizes these conflicts as challenges, but also as places for the system to grow and develop in innovative ways (Foot, 2014). As each system addresses and resolves the contradictions, the activity system as a whole can evolve. Therefore, contradictions are not necessarily signs of fragility in the system, but rather opportunities for innovation (Foot, 2014).

Figure 8 illustrates how overlapping activity systems can have conflicting or adjacent objectives. For example, the state and university system have similar, or adjacent, objectives to prepare quality teachers. The university system and the K-12 system can have conflicting objectives since the K-12 system is focusing on place-based education, while the university might not. The center of Figure 8 displays potential overlap of objectives where the systems are in alignment. Recall from earlier in Chapter 4 that objectives are the goals for the system as it relates to the study's focus. Through innovation, a unified objective can be created for both systems. An example of this could be the university system's objective to prepare environmentally literate teachers, while the state system's objective is to prepare quality teachers. A possible source of innovation or evolution between these two systems could be a new objective to create a formalized environmental education endorsement for interested teachers to receive during teacher preparation. A formalized endorsement could ensure that teachers receive quality preparation for teaching environmental education in the K-12 classroom.

Figure 8

Overlapping Objectives Among Represented Activity Systems



Note. The third-generation cultural historical activity theory (CHAT) model demonstrates the overlapping nature of activity systems.

Some of the challenges participants identified were not contradictions in the sense of the CHAT framework. For example, a commonly cited challenge for K-12 teachers wanting to include field experiences for their students was a lack of funding. This was a challenge, and one that could easily be remedied with additional grant writing or other financial support, as seen in several school districts. Therefore, this challenge was not necessarily a source of innovation within the system. In the following section, I outline commonly identified challenges within and among the systems through four topics—motivation versus implementation, contradictions within systems, across-systems challenges, and champions—and focus on the contradictions that showcase potential areas for innovation.

Overview: Motivation Versus Implementation

Motivation versus implementation of environmental education repeatedly surfaced in discussions with all participants. First, I generally describe the theme of motivation versus implementation and how it arose in conversations with study participants. Then, I describe each of the three systems and how motivation versus implementation was expressed within each system.

Previous research suggests that most teachers have positive attitudes related to the environment (Ko & Lee, 2003; Shahnawaj, 1990). Consistent with those previous findings, participants in my study shared the importance of environmental education (e.g., “conserving native species” [Melinda], “understand their impact on environment” [Anne], “real-world context” [Gretchen]), as well as how the challenges to incorporate it into their curriculum (e.g., school culture, standardized tests, curriculum standards) continued to overpower some of those intentions. Those who did implement environmental education had a strong passion for it, such as Anne, who stated

> If anywhere I can put in some type of environmental education or impact, then I try really hard to put it in there…Even though we have a lot of great resources from the county, I will find additional resources that I can add to it or change a lesson so that it fits the things that they're required to learn, but also gives them more insight into how they're impacting the environment.

The university faculty had similar viewpoints about environmental education. Despite none of the selected university faculty being experts in the field of environmental education, they were still motivated to include it in their university courses. To varying degrees, they all recognized the importance and benefits of environmental education and were interested in finding ways to include it into their teacher preparation programs. These university faculty might be in the minority nationally, though, as previous research suggests the most common reason for the lack of inclusion in university classrooms is a lack of faculty interest (Franzen, 2017).

I did not speak directly with anyone within the state department of education, although examples of motivation versus implementation at the state level were uncovered from my discussions with participants about the implementation of the state's regulations, specifically the curriculum standards, licensure options, and curriculum frameworks. The state system supported environmental education based on statements from district-level administrators, the promotion of a new environmental science course, and online resources to align curriculum standards with environmental literacy efforts. Tim, an administrator participant, shared that the state department of education "is obviously pushing environmental literacy." However, some teacher participants had contrasting viewpoints. Melinda stated:

> I'm sure that [district- and state-level administrators] would say it's really important and something that they want to see more of. But in terms of, like, the decisions being made,

and the supports that are given that make that doable? Not seeing a lot of it.

This comment from Melinda highlights a larger issue across participants. Although district and school-level administrators were motivated and recognized the benefits of environmental education, the implementation of it was hindered by the complexity of the systems. For example, Tim's comment about the district-level push for environmental literacy did not align with the implementation of environmental education that Melinda saw taking place at her school. Another example from Robert's district, as described earlier, was his installation of mesocosms at all schools to allow for environmental education without leaving the school grounds. Despite the accessibility of these structures, teacher engagement with them was limited due to lack of professional development on how to use them with students. The CHAT components of rules, artifacts, and division of labor highlighted the challenges expressed in motivation versus implementation within each system.

Motivation Versus Implementation Within the University Systems

In the university system, issues of motivation versus implementation arose during my conversations with university faculty about their inclusion of environmental education. Within the study, the most commonly cited challenges university faculty encountered were lack of training and time. All of the study participants shared candidly that they had little to no expertise or training in environmental education. Additionally, a significant challenge that university faculty faced was the time allotted to their courses—both the total amount of content that needs to be covered in a course and the time of day that courses are offered. University faculty noted the many pressures from the state and their university related to requirements for teacher preparation (e.g., courses they must offer, skills and content that had to be included, etc.). University faculty also shared that due to pre-service teachers needing to complete a teaching practicum while taking courses, the courses were sometimes offered in the evenings, limiting the opportunities to take pre-service teachers in the field for hands-on environmental education. Previous studies supported these findings. Powers (2004) similarly suggested that even when university faculty were motivated to include environmental education or work toward more inclusion of it, there were often barriers or a lack of incentive to do so. One of those barriers is a lack of knowledgeable university faculty on environmental education, one of the largest challenges for its inclusion at the university level (Franzen, 2017; McKeown-Ice, 2000; Powers, 2004). In the university system, the reported challenges affected participants' implementation, even among those very motivated to include environmental education.

Motivation Versus Implementation Within the K-12 Systems

Similarly, in the K-12 system, even when teachers and districts were motivated, there were challenges—such as a lack of confidence in outdoor classroom management, a lack of time to cover all required content, a lack of connection to the course they were teaching, the time of year a course focused on the local environment, the resources available, and challenges related to being new teachers in an established school community. Recall from Chapter 1 that logistical barriers, such as managing students outside, are among the barriers to environmental education teachers most frequently reported (Ernst, 2007; Kim & Fortner, 2006). Additionally, the lack of time to include any program or topic that teachers felt deviated from the course curriculum can be a significant barrier (Ernst, 2007; Winther et al., 2002). Shelley stated, "what got in the way of me doing more things that I wanted to do was my confidence." Phoebe echoed this, stating that she had "all this content I need to give them, and I need to make sure that they understand it so that they can at least pass their [end-of-course test]." In Phoebe's example, the perceived influences of the state and the rules put in place by that system and the K-12 system influenced her motivation to include environmental education in the classroom.

Motivation Versus Implementation Within the State System

Finally, within the state system, the state department of education was promoting environmental literacy statewide, but the main objective of the state system as shared on their website is to provide quality education to all students in the state. As stated previously, quality schools require quality teachers (Feiman-Nemser, 2001). To do this, teacher education programs are motivated to prepare novice teachers for all they will face in the profession (Darling-Hammond, 2006), not just within environmental education. Prepared and quality teachers would help the state with its goal to have students progress in their education, develop scientific inquiry skills, and graduate from high school. The many components of a quality teacher and a quality school can compete for priority, and environmental education sometimes did not take priority over other topics, as seen in the teacher participants' challenges to incorporate environmental education in the classroom.

These examples demonstrate that, although motivation was prominent across systems and among participants, implementation of environmental education did not always occur. In the following section, I further explore the contradictions of motivation versus implementation and possible areas for innovation within and among the systems. I also share findings from the contradictions that arose for each individual system and across all systems.

Contradictions Influencing Motivation and Implementation Within Systems

Recall from earlier in Chapter 4 that activity systems may have conflicts between the multiple perspectives within them, but that these challenges can be sources of innovation for the system to evolve (Foot, 2014). The following sections will describe the contradictions identified within each system as well as the contradictions found between systems that led to, or could lead to, innovation for the inclusion of environmental education in K-12 schools.

University System Contradictions

As discussed in Chapter 2, there are several commonly cited challenges for the integration of environmental education within teacher preparation, including university faculty expertise, limited time and resources, conflicting priorities, and rules and regulations of the university and program (Franzen, 2017; Powers, 2004; Tomlins & Froud, 1994).

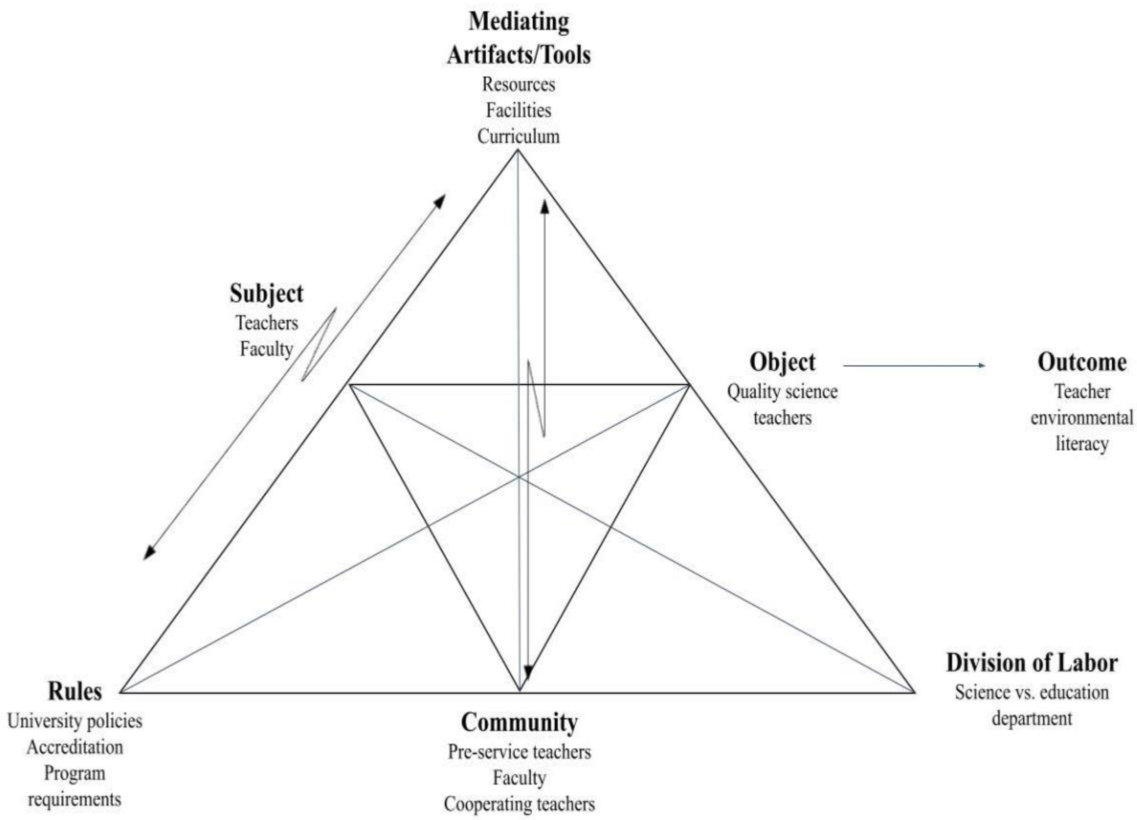
Despite this, participating university faculty saw potential benefits for the inclusion of these topics in their coursework, encouraging pre-service teachers with personal motivation toward environmental education, and connecting them directly to local environmental education efforts. Additionally, participating university faculty overall supported those who came to the program or their specific course with a pre-determined interest and motivation to include environmental education in their teaching. Kathy, for example, remembered, “In our educational psychology class, you could pick a topic that you felt passionate about in education, and that would be your research project for the semester.” Kathy chose a project focused on environmental and place-based education because it aligned with her passions. Lily (university faculty) supported Kathy’s interests by allowing for student choice on the project. Similarly, Drew, a university faculty participant at a different university, mentioned that in each of his courses, the primary assignments were project-based to allow pre-service teachers to incorporate environmental topics if they were interested.

Teacher participants noticed this desire to overcome challenges and include environmental education in the pre-service teacher education programs. Several participants (Phoebe, Ray, Chris) talked about being inspired during experiences with university faculty to include environmental education. For example, Ray shared that his university faculty not only included field experiences within his science undergraduate courses, but also connected these experiences to how to share similar concepts with K-12 students. University faculty members connected science and education within undergraduate and pre-service teacher education courses, and teacher participants wanted to do the same.

Recall from earlier in Chapter 4 that within the CHAT framework, contradictions are not only challenges, but also potential sources for innovation and opportunities for the activity system to evolve (Engeström, 1987, 2001; Foot, 2014). Within the university system, three contradictions arose that led to innovation for the inclusion of environmental education within teacher preparation programs. Figure 9 illustrates the locations within the university system where contradictions occurred (jagged arrows), including using environmental education as a neutral content area, using partners to bring in environmental education expertise, and demonstrating the challenges in planning field experiences as similar between university classrooms and K-12 classrooms.

Figure 9

Contradictions Within Represented University Activity Systems



Note. The cultural historical activity theory (CHAT) model for the university system, as reported by study participants, includes contradictions between rules and artifacts (environmental education within teacher preparation curriculum) and between the community and artifacts (challenges implementing field experiences, partner resources).

Discipline Variety. First, pre-service teachers from a variety of science disciplines (e.g., physics, chemistry, biology) attended methods courses taught by university faculty participants. Gretchen, for example, stated that her classes were “a real mixed group [of disciplines].” Because of this diversity, and because environmental education might not have a specific location in the regulations (rules) governing teacher preparation programs in the state, environmental education could serve as a neutral curriculum topic within science methods courses and curricula (artifacts). None of the teacher participants were preparing for licensure specifically on environmental science, therefore it could be used as a neutral example within the course. Additionally, Lily felt that environmental science was a topic most pre-service teachers could relate to, had some experience with, and could be a point of reference in considering pedagogical skills related to that content. This implementation of environmental topics, despite none of her pre-service teachers focusing specifically on this discipline, was an example of innovation within the university classroom and a way to increase environmental education within Lily's teacher preparation courses. It was a unique perspective that Lily shared—instead of dismissing environmental science due to a lack of licensure focus in her state, Lily saw opportunity to use the focus area to engage students in thinking about both environmental education and other instructional strategies she could teach through environmental education. The innovative idea is one that could be shared with other university faculty as a way to include environmental education despite a lack of students specializing in environmental science.

University External Partners. Second, the lack of expertise among university faculty members (community) encouraged some motivated university faculty participants to seek out external partners to bring environmental education content into university courses. For example, both Lily and Kim described having success with external partners. These partners lifted the onus from the university faculty member who might have had little expertise in the area. In Kim's case, the program led by the external partners had ended, although Kim continued to use the resources (artifacts) from the project in subsequent years of her pre-service teacher preparation program. The project also helped to develop Kim's confidence in teaching environmental education. Similarly, Lily shared that her partnership with environmental education providers was a valuable resource for her students' future classrooms. She wanted her students to be aware of the benefits external partners could bring to the classroom through resources, professional development, and field experiences. Lily saw the value in the skills pre-service teachers received from environmental education, such as interdisciplinary connections; this was true even if they were not teaching environmental science. In these examples, motivated university faculty allowed for greater implementation of environmental education in the university classroom.

University Field Experiences. A third contradiction that could serve as a source of innovation were the challenges university faculty (community) faced in implementing field experiences (artifacts). Although this contradiction did not lead to an observed innovation, it had potential to do so. Gretchen spoke of the challenges she faced taking her students outside for environmental education, including

> The…limitation I've got [is] the structure of the course in particular. I mean, it just replicates the problems with formal classroom education in general, because I have them once a week for 2 and a half hours, either in the classroom or online.

Although this was a challenge, realizing that the challenges were the same as the ones classroom teachers faced was an opportunity for innovation rather than a roadblock. Recall from earlier in Chapter 4 that a goal of teacher preparation is to prepare future classroom teachers for all they could encounter in the K-12 classroom (Darling-Hammond, 2006). Preparing teachers for the challenges of implementing environmental education is one example of this. Innovative design and discussion with novice teachers on how university faculty developed ways to overcome these challenges could provide examples to K-12 teachers of how to do the same. Additionally, this innovative example highlights opportunities to bridge university systems with K-12 systems through shared challenges. Previous research suggests that if university faculty can introduce the challenges (and potential solutions) that early career teachers will face in the classroom, teachers will be more likely to succeed in including environmental education (Curry et al., 2016).

K-12 System Contradictions

Recall from Chapter 1, commonly cited challenges for the inclusion of environmental education within K-12 schools included lack of training, resources, and commitment to teach this topic (J. T. McDonald & Dominguez, 2010). Among the participants in this study, teachers discussed challenges with teaching students outside (both the rules associated with that, and the physical resources or artifacts needed to conduct field investigations). Additionally, a lack of training opportunities (artifacts) focused on specific environmental science content or science content in general was a challenge for teachers who were motivated to include environmental education.

One of the common challenges in the literature on environmental education is its multidisciplinary nature, and therefore the lack of responsibility for teachers of any discipline to teach it (Ham & Sewing, 1988). Some researchers have suggested that environmental education aligns most closely with science because it includes natural phenomena that can be observed and studied through scientific processes (Ashley, 2000; Ko & Lee, 2003; Marcinkowski et al., 2013). No study participants considered the role of teachers within other subjects (i.e., math, social studies) in teaching this topic, or shared opportunities for the inclusion of environmental education in English class, for example. Previous research corroborates that environmental education is most often seen only in science (Ham & Sewing, 1998).

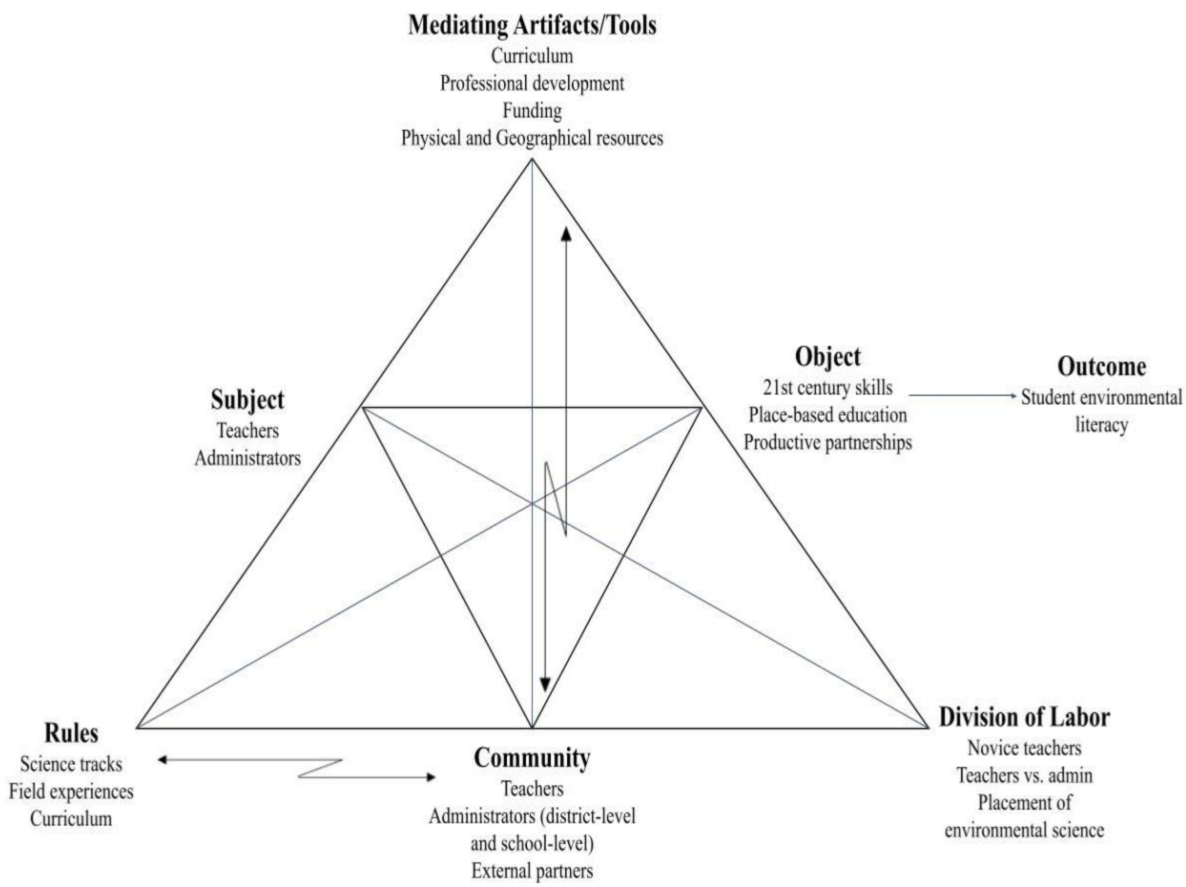
Despite this, the science teachers who I spoke with still felt a lack of responsibility for teaching environmental education due to their specific science content. One reason for this cited in previous research is the way secondary schools silo teachers in specific content areas, making them unsure of their responsibility to teach something multidisciplinary like environmental education (Kim & Fortner, 2006; Ko & Lee, 2003). For example, science teachers focus solely on their science courses and might not be able to work across disciplines to introduce a topic like environmental education outside of their specific discipline. Participants characterized this as less of a multidisciplinary issue and more a result of a specific placement of environmental education in the courses of environmental science and ecology. Study participants did not see how environmental education was appropriate across multiple science disciplines (i.e., chemistry, physics); rather, they assumed environmental education would only be taught in environmental science courses.

One of the unexpected findings related to the K-12 system was the lack of professional development offered to science teachers on content-specific topics. Although I considered this a challenge and not necessarily a contradiction, it did represent conflict within the K-12 system, mostly between the teachers and the administrators. Most teachers I interviewed felt they did not have the capacity to search for or attend external professional development opportunities like those suggested by their administrators because those trainings took place outside of school hours. The exception to this was Josh, who had opted into a plethora of professional development over the last few years. The professional development that was offered through schools and districts focused mainly on school policies or topics like classroom management that were applicable to all teachers. Even the district-level administrators, whose roles included professional development for teachers, seemed at a loss for why there were not more opportunities for content-specific training. I will discuss this challenge in Chapter 5 as a potential opportunity for environmental education partners to work with K-12 schools.

Two contradictions identified in the K-12 system led to innovation as it related to the inclusion of environmental education in early career teachers' classrooms—external partners and place-based education. Figure 10 illustrates these contradictions. First, external partners (community) solved some of the challenges with professional development and resources (artifacts) that a school could offer for environmental education. Second, challenges with taking students off campus (rules and artifacts) were alleviated with teacher-led (community) place-based education.

Figure 10

Contradictions Within Represented K-12 Activity Systems



Note. The cultural historical activity theory (CHAT) model for the K-12 system, as reported by study participants, included contradictions between artifacts and community (role of partners, place-based education) and between rules and community (place-based education).

K-12 External Partners. Several of the participating teachers (Lindsey, Melinda, Kayla) with comparatively higher quantities of environmental education were achieving this with help from an external partner (community). Despite challenges in partnering with external providers, such as the partner's limited capacity, several school districts successfully implemented environmental education through these partnerships (e.g., Welch County Schools, Carlson County Schools). Previous research suggests that external partners help to solve the lack of time and confidence that early career teachers face by providing administrative assistance (e.g., grant writing, permission forms, transportation) and training (Wanzare, 2007). Additionally, external partners leading field experiences took on the responsibility for classroom management outdoors, a leading challenge for teachers attempting to include environmental education (Ernst, 2007).

Within the study, external partners allowed the teachers to participate without needing expertise in outdoor classroom management or field experiences. External partners determined appropriate field locations, had existing resources and training on safety and classroom management outdoors, and had the expertise on environmental topics discussed on field experiences. Teachers reported that students enjoyed these experiences. External partners in the cases of Lindsey and Melinda also provided professional development as part of their grant-funded partnership with the school district. External partners in these examples provided a solution to the lack of professional development, a challenge previously noted by all teachers related to science and environmental education content. Finally, external partners provided ownership for who would teach environmental education instead of the unknown responsibility teachers felt depending on their content specialty. For example, teachers like Kayla who were not teaching environmental science or ecology courses placed the responsibility of teaching environmental education on other teachers because they felt it was not connected to their content.

But external partners, like those Melinda worked with, found connections between environmental education and the biology content. By partnering with external organizations, the capacity of the school to offer systemic implementation increased, especially as the diversity of partnerships increased. In addition, teachers who were motivated to include environmental education, but were daunted with the challenges they faced, found a solution through external help. Of course, the challenges accompanying partnerships was the time to build and create partnerships, funding to pay for experiences with outside providers, and the capacity limits of the providers, all which must be considered.

K-12 Field Experiences. A second contradiction that led to innovation for the K-12 system's inclusion of environmental education was the difficulty in providing off-campus field-based experiences for students due mainly to logistical barriers (e.g., permission forms, availability of partners). The innovation derived from this contradiction was a focus on place-based education, or environmental education activities on the school grounds. Place-based education engages students as they connect to their local environment and is especially important in developing a student's environmental literacy and civic engagement (Ardoin, 2006). I discussed the challenges of taking students off-site for field experiences earlier in the chapter (e.g., funding, permission slips, time to plan). By focusing on the school's adjacent natural areas, environmental education was included for all students without the challenges of taking students off-site (rules). Several motivated teacher participants provided examples of on-site physical locations that provided environmental education opportunities. For example, Chris, Ray, and Phoebe (community) all used properties within walking distance of their school, such as forests, fields, parks, ponds, and lakes, as locations for field investigations (artifacts). Ray had completed multiple outdoor labs using these spaces at the time of our first interview, which was only 2 months into the school year. Melinda added that field trips took "months of planning, whereas I can take kids out to the woods…any day of the week."

All schools have a sense of place or the relationship between a person and a place (Lim & Barton, 2006). Some are in rural neighborhoods and access to a pollinator garden. In contrast, others are located in urban environments and could study the effects of stormwater runoff. Melinda agreed that "every school has something outside that could be useful." In my study, if the school grounds were not conducive to field investigations, some of the participants' schools set up place-based resources on the schoolyard to eliminate the need to travel off-site. As previously mentioned, Robert, a district-level administrator, built miniature ecosystems on each site, and

> the idea is that they now have this one-stop shop that eliminates any excuses of, we can't take our students out in the field, or we can't get a bus or any of this. You can do this right outside…it's never more than 400 yards from their building.

Place-based education was a source of innovation, solving the challenges of taking students off-site (rules, artifacts), allowing for greater quantity of experiences, and allowing more students the possibility of participating by alleviating the challenge of permission slips (rules) and limits from external partners (artifacts). By focusing on the resources and natural areas on or near the school grounds, teachers were better equipped to implement environmental education and take students outside without the constraints of field trip fees, planning logistics, and transportation. In Chapter 5, I discuss the implications of this for environmental educators who partner with K-12 schools.

State System Contradictions

Recall from earlier in Chapter 4 that the state system was not one of the original systems considered for analysis. Throughout the interviews with study participants, the challenges and opportunities provided by the state for the inclusion of environmental education became too large to dismiss in considering influences on the early career teacher. Several participants cited challenges for environmental education including the plethora of regulations on schools and universities, the limited inclusion of environmental education within those regulations, and the influence of standardized tests on teachers' use of environmental education in the classroom.

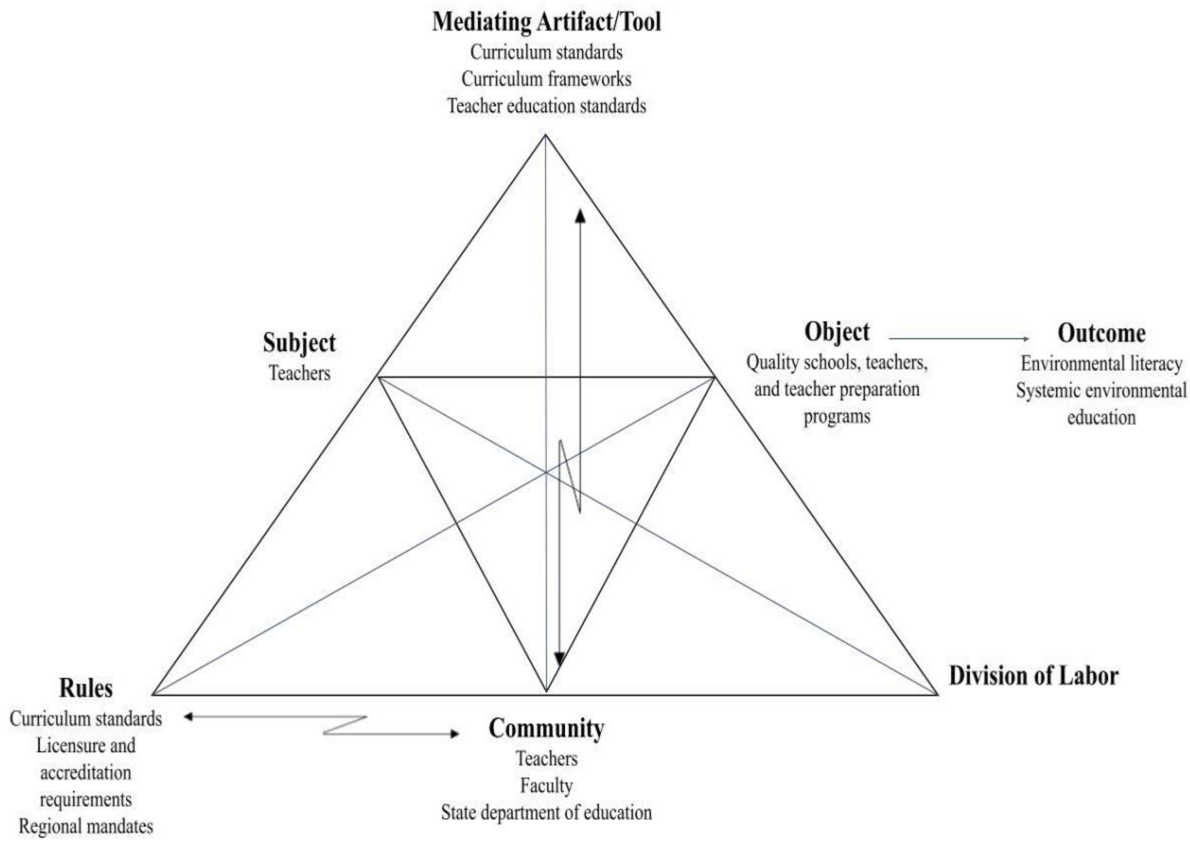
Despite what many would call challenges for environmental education to compete with the priorities of the state's curriculum standards for teachers and universities, there were examples in the study where environmental education was taking place successfully. At the K-12 level, Josh was including environmental education in biology, a course that some teachers felt had limited opportunities for environmental education due to the state's curriculum standards. He was also motivated to attend professional development that increased his knowledge of environmental practices that tied to his curriculum standards, helping him include even more environmental education in the future despite course requirements from the state.

At the university level, Kim addressed the requirement from the state department of education to include field investigations in her science methods course. Kim shared her program matrix datasheet submitted to the state department of education. This listed the exact requirement that Drew mentioned on his syllabus to conduct field investigations for all students on the school grounds and using community resources. Kim demonstrated that this requirement from the state was addressed in her secondary science methods course, despite several university faculty participants not mentioning this curriculum requirement as influencing their decision to include or exclude environmental education.

In examining the state system, two contradictions were identified that led to innovation or evolution of the system as it pertains to environmental education in early career teachers' classrooms. Figure 11 illustrates the two contradictions. First, the new environmental science course (artifacts) posed challenges and opportunities for teachers (community), while regional mandates (rules) assisted community members with justifying environmental education efforts.

Figure 11

Contradictions Within Represented State Activity System



Note. The cultural historical activity theory (CHAT) model for the state system, as reported by study participants, included contradictions between artifacts and community (new environmental science course) and between rules and community (regional mandates for environmental education).

Environmental Science Course. At the state level, one of the most frequently perceived influences teacher participants shared was the focus on the newly adopted environmental science course. Within the last few years, the introduction of environmental science as a replacement science for graduation (students must take three science courses to graduate in the state), had disrupted the typical science curriculum in some schools, while providing potential avenues for increased environmental education. For example, Heidi discussed her concerns with the lack of requirement for students to take a physical science class at her school now that environmental science was in place. In contrast, teachers like Melina, Kathy, and Phoebe saw great benefit to this new course in allowing them the freedom and flexibility to include environmental education within the science departments of their schools. Additionally, having a course (artifacts) dedicated to environmental science gave ownership to particular teachers teaching the course as the place where environmental education was to take place, and those teachers felt a responsibility to do so because it was explicitly listed in their state's curriculum standards. Kathy shared that she included environmental education in her environmental science class "all the time" because it was the focus of that class. Recall from earlier in Chapter 4 that the responsibility for teaching environmental education is often lacking in schools (Kim & Fortner, 2006; Ko & Lee, 2003). Courses dedicated to environmental learning, such as the state's new environmental science course, provide responsibility and time for teachers to include environmental education in K-12 schools.

Regional Mandates. A second potential source of innovation were regional mandates. In the study, one regional mandate was infrequently mentioned, but it had strong implications for the schools and districts in the state. Teachers (community) were aware of the regulations (rules) that the mandate presented, which was to include field experiences in elementary, middle, and high school grades. The regional mandate was a source of innovation because it provided justification for teachers and administrators to include environmental education in K-12 classrooms. Although a positive and potential source for innovation, challenges with the mandate included the lack of funding provided to support implementation of the mandate (e.g., transportation, substitute teachers, field supplies) and the lack of training offered to teachers on how to meet the mandate. This mandate also affected the university system, providing university faculty with the justification for inclusion of environmental education in their courses, because they were supporting pre-service teachers in understanding a rule that would affect them in the future as classroom teachers.

Across all of the examples from individual systems, motivation to include environmental education versus implementation of it was apparent. Whether teachers or administrators relied on external partners or found alternate ways to include place-based education without taking students off-site, there were opportunities to include environmental education despite challenges and contradictions. Similarly, challenges and contradictions existed across and among systems, illustrating more examples of innovation.

Challenges Transitioning Across Systems

Early career teachers experienced the contradictions related to the interaction of the three systems. Participants only discussed the systems individually, rather than focusing on how they related to each other, except for discussing how they wanted to use more of what they learned in pre-service in their classroom, and in discussing when to introduce teachers to environmental education. Nearly all participants shared a desire to include more from pre-service preparation into the classroom but stated that due to challenges related to the K-12 system, they had not done so yet. Despite a lack of direct statements about systems’ perceived influences on each other, there were explicit examples derived from participants’ perspectives of how the systems interacted and influenced each other, which I describe in the section that follows. I have focused the findings to three themes across the systems: bridging university learning to in-service teaching, professional learning about environmental education, and the placement of environmental education within pre-service teacher preparation.

Bridging University Learning to In-Service Teaching

One of the first findings related specifically to motivation versus implementation is the need to bridge university learning to in-service teaching. Nearly all of the teacher participants made statements about how they wished they could use more of what they had learned in their pre-service programs related to environmental education in their current classroom. This is not an uncommon challenge for early career teachers, and it has been well documented in the literature (Korthagen, 2010; Paniagua & Sánchez-Martí, 2018; E. R. Smith & Avetisian, 2011). This suggests a positive endorsement of the university system's teaching of environmental education within pre-service teacher preparation. The participants saw the value in their professional learning and wanted to include it into their classroom.

The difficulty was that early career teachers often fell into the "two-worlds pitfall" (Feiman-Nemser & Buchmann, 1985, p. 54) described in Chapter 2. Participating teachers struggled with the inclusion of their university learning once assimilated into their K-12 school. This suggests that the systems were too disparate, and more focus on assisting teachers with this transition might be needed. Lily, for example, spoke directly of this struggle to transition:

> the theory-to-practice divide…is very challenging. I'm already struggling with best practices for teaching science, getting students to make sense of science, getting students to do investigations, building them up to be able to create their own investigations and ask their own questions. That's the highest level that we're hoping for. But those methods very much take time. That isn't a reality right now in the schools. So, when they're doing their student teaching, it can be frustrating for…pre-service teachers, because they're

like, "We're learning all these things here that we can't use there."

Lily was not the only university faculty member who struggled with the divide between university learning and in-service teaching. Recall that Gretchen struggled with her personal teaching ideology (experiential education) and determining what teachers would actually need to know in today's science classroom. She felt that standards and regulations overpowered any chance the novice teacher had of including environmental education, and therefore she did not include it.

The challenges that novice teachers faced during in-service teaching, such as the rules of both the school (e.g., cultural norms, field trip regulations) and the state (e.g., standards, curriculum frameworks, standardized tests), heavily influenced teachers and their inclusion of environmental education. Even those teachers who were highly motivated to include environmental education were challenged as they transitioned from pre-service to in-service. Kathy, for example, a novice teacher who expressed a lifelong passion for the environment, struggled with implementation of environmental education. She strove to include meaningful field experiences for her students but had not been able to accomplish one at the time of the study due to the challenges described previously.

Lily did share some hope for resolving these challenges, stating that the state's move toward performance-based assessments would be "very helpful to moving the bar with environmental education," allowing teachers more flexibility with the standardized testing that was hindering them. Future work to bring the university and K-12 systems closer together, and within changing regulations from the state, could also allow for greater success for the inclusion of environmental education as novice teachers begin teaching.

Professional Learning About Environmental Education

Recall that one of the research questions guiding this study related to the professional learning that teachers received both in pre-service teacher preparation and within in-service teaching at their K-12 school. The second theme affecting early career teachers as they moved among systems was the reliance on pre-service teacher preparation for nearly all of the professional learning related to environmental education. Little to no professional learning related to environmental education occurred once teachers were teaching full-time.

The professional learning that pre-service teachers received during their teacher preparation program appeared to be somewhat haphazard depending on the university faculty member's comfort and interest in environmental education, their placement within either the science or education department, and their access to external partners, as described earlier. Table 5 lists the frequency of teachers' responses on the types of experiences they received during teacher preparation.

Table 5

Methods of Exposure to Environmental Education During Teacher Preparation

Exposure	No. of Teachers
Woven throughout methods or foundation course	5
Field experience	4
Required readings	4
Self-directed focus for course assignment	4
Guest speaker	3
Professional development workshop	3
Series of workshops	2
Field placements	2

Note. Teacher participants were asked about types of exposure opportunities in their teacher preparation for environmental education. Teachers were able to select more than one response.

University faculty participants shared examples of how environmental education was included in required coursework in teacher preparation courses. For example, Drew shared that

> the topic this week is environmental education, but kind of indirectly, or obliquely, by some of the papers that we read. And of course, they're welcome to bring things in, environmental education things, if they're interested in it [for] their projects.

Kim also shared that she takes her pre-service teachers outdoors to collect water quality data and discuss how pre-service teachers can incorporate similar experiences with their K-12 students in the future. She stated that these experiences "resonated with a lot of [pre-service teachers]."

Surprisingly, nearly half of teacher participants took part in an environmental education-related field experience during their preservice program, but most of the exposure methods included coursework and extraneous workshops, potentially through external partners. The only opportunities for professional learning in environmental education after teachers were in the classroom came from external partner resources, such as teacher professional development workshops that were shared by district administrators. Very few teacher participants reported participating in external professional development unless it was a requirement of a grant-funded project they were participating in. Therefore, the exposure to environmental education in the pre-service preparation programs was key to their professional learning.

Inclusion of Environmental Education in Teacher Preparation

If early career teachers experienced a pitfall (Feiman-Nemser & Buchmann, 1985) between their university preparation and teaching in the K-12 system, I was interested in learning whether the teacher participants would then suggest that environmental education should not be introduced in teacher preparation. Recall that J. T. McDonald and Dominguez (2010) stated that pre-service teacher training in environmental education was recommended as an effective approach for the inclusion of environmental education in K-12 schools. As I spoke with teachers, administrators, and university faculty participants, I questioned this approach.

Nearly all of the teacher participants (9 out of 10) stated that environmental education should, at minimum, be introduced during pre-service teacher preparation. Despite all of the challenges they shared and the lack of implementation they experienced with environmental education, teachers felt that the topic should still be introduced. For example, Phoebe shared,

> I think it's important to tell people before they get [to] the classroom so that they can go into it with more of a plan. And obviously things change when you're in your actual classroom, but being able to feel like you have the knowledge and the skills to do this thing is important.

Similarly, Lindsey shared,

> I'm glad we learned it in pre-service. Because I just think if you hadn't gotten that, people might not even know it's a thing. I did already because I was interested in it. But maybe, take the physics people, I don't think they would ever think—"I could take my kids outside" or connect that to it, which is harder for them. But it's still possible.

The only participant who, at first, stated that she felt learning about environmental education was more beneficial to them now as an in-service teacher was Kayla, but she also agreed that an introduction was helpful as a pre-service teacher. She felt that she would have benefitted from a more in-depth professional development after a few years of teaching experience. Hearing these perspectives suggested that pre-service teacher preparation on environmental education was influential to the early career teachers, and continued inclusion of environmental education in university programs is warranted. These perspectives also suggest that professional learning on environmental education should continue within K-12 school districts.

Champions

One final theme that emerged across all participants' perspectives was the role of champions. A. Ryan and Tilbury (2013) define environmental education champions as "educators with experience…and the drive to support it" (p. 285). For environmental education to be included in any system in this study, champions were needed to drive this implementation. Although many teachers and university faculty were interested and motivated to include environmental education in their classrooms, there was a lack of implementation compared to what teachers and university faculty reported that they would like to do. For example, Maddie, who taught courses where environmental education was not explicitly specified, stated that "no, not a whole lot is getting done with environmental science because of where it is unless a teacher chooses to take it in that direction." Maddie's statement supported teacher interest as a driving force for environmental education implementation.

Similarly, within the university system, university faculty encountered rules and challenges to incorporating environmental education in the university classroom, but if they wanted to champion this effort, they had the flexibility to do so. Some university faculty included field experiences for their students, brought in experts to speak to the class, allowed their students to do self-directed projects, and some chose readings related to environmental education to discuss in class. In contrast to a previous study that suggested that stringent program requirements and lack of mandates limit the inclusion of environmental education in university courses (Franzen, 2017), several university faculty participants in this study still included environmental education in some capacity.

Several researchers have focused on the role of champions within university programs, both in teacher preparation and in other university courses (e.g., Ashmann & Franzen, 2015;

Creighton, 1998; Wood et al., 2016). These studies suggest that successful integration of environmental education occurs where there are strong supporters or champions behind that effort. One group of researchers categorized champions into three groups—the savior, the nurturer, and the sustainability struggler (Wood et al., 2016). The savior strives to save the planet from the impending environmental impacts, the nurturer builds relationships across campus in an effort to make environmental education more interdisciplinary, and the struggler feels that their courses are under threat or that they have faced considerable challenges with environmental efforts on the university campus. Many of Gretchen's (university faculty) statements were reminiscent of what was described as *"struggler"* statements. Despite her background in sustainability education, she had had to relinquish some of her efforts for sustainability on campus, such as saving natural spaces on or adjacent to campus, taking students outside for environmental education due to lack of interest and support, and overwhelming pre-service teacher preparation program requirements. In summary, champions serve a key role in integrating environmental education on university campuses.

Rieckenburg (2014) identified a similar focus on champions in the K-12 system when she analyzed the characteristics of successful integration of environmental education. She stated, "it was quite apparent that…the environmental education program…would not be as strong or even possible without these champion teachers" (p. 40). Several districts in my study had success with systemic environmental education. One of the most common responses was having a champion within the district who was pushing the agenda of environmental education forward. A few of the districts described strategies that they were implementing to build their capacity for environmental education rather than relying on the role of external partners. For example, Tim shared that his district was building an environmental education center for teachers to bring their students for free field trips. This effort had been supported by their district's superintendent, who was passionate about environmental literacy for all students and had even received some funding to start the project. This effort would eliminate the need for grants to fund partnerships with external environmental education organizations because the district would have the natural space and possibly even internal staff to lead field experiences.

Another example of a district building capacity through a champion's support came from Maddie, who shared that a district-level administrator was working to purchase a fleet of kayaks, again so that the district did not have to rely on external partners to conduct field experiences. Maddie and another teacher were being trained as kayak instructors to lead these trips, eliminating the challenge of limited capacity from external providers. Robert, Tim, and Maddie discussed how their districts planned and implemented systemic environmental education across multiple grade levels to ensure that students had experiences in elementary, middle, and high. These efforts would not be possible without the support of a champion from within the district.

Champions for environmental education were found to be especially important for novice teachers. A previous study suggested that early career teachers had significant motivation to introduce innovative environmental and sustainability topics, materials, and strategies for teaching to the K-12 classroom (Merritt et al., 2018). To see that motivation through to implementation, teachers encountered multiple challenges as previously discussed in this chapter. It is possible that if these early career teachers were paired with a champion of environmental education, challenges could be more easily overcome with support and guidance from someone more experienced in this field. Through the support of champions within the schools, universities, and even the state department of education, early career teachers' inclusion of environmental education occurred.

Early Career Teachers' Integration of Environmental Education

The phenomenon of early career teachers' integration of environmental education in their classrooms is one that required in-depth study and analysis, including a focus on three influential systems—universities, K-12 schools, and the state department of education. These systems were complex, but the CHAT framework provided a lens to examine each system, as well as the interactions among the systems. Challenges exist for the implementation of environmental education within all systems, but champions can encourage novice teachers to move from motivated to successful in the inclusion of environmental education.

In Chapter 5, I will further discuss the challenges that participating early career teachers faced in implementing environmental education when transitioning between the university and K-12 systems. I will also share the implications of these findings for environmental educators, who have been discussed generally thus far as external partners, including specific suggestions for successful partnerships with university faculty and K-12 schools. Additionally, I will provide successful example projects for the inclusion of environmental education within teacher preparation and K-12 schools that address the challenges and contradictions highlighted in the findings reported in this chapter. Lastly, I will share ideas for future researchers to consider when including environmental education in K-12 schools and university systems.

CHAPTER 5

IMPLICATIONS

The purpose of this study was to understand the lived experiences of early career teachers as it related to their inclusion of environmental education in classrooms. Through interviews and artifacts, I gathered perspectives not only from early career teachers, but also from other members of university and K-12 school communities, such as university faculty and school- and district-level administrators. I considered the experiences within and among three systems: university, K-12 schools, and the state department of education. In Chapter 4, I analyzed these perspectives using cultural historical activity theory (CHAT) to frame and assist my analysis to determine the study's results. The findings, as reported in Chapter 4, were situated within extant literature when available. These findings suggested contradictions within and among the systems, such as motivation versus implementation of environmental education. The suggested contradictions led to, or could lead to, sources of innovation related to increased inclusion of environmental education within early career teachers' classrooms.

In Chapter 5, I will further discuss the challenges participating early career teachers faced in implementing environmental education when transitioning between the university and K-12 systems. I will also consider the implications of these findings for environmental educators, who have been discussed only generally thus far as external partners of the university, K-12, and state systems. In my experience, professional environmental educators could be connected to each of the systems through their service and advisory support—directly offering educational programs and professional development to students and teachers, providing reviews of existing state science standards, developing partnerships to better serve teachers and students within environmental education, and creating national environmental education standards for both K-12 education and teacher preparation accreditation. The potential roles of environmental educators within and among the systems of this study will be described in a later section.

Before I discuss the implications of the study's results, it is important to recall that CHAT (Engeström, 2015) underpinned all data generation and analysis. The complexity of the three interconnected activity systems was demonstrated in Chapter 4, and CHAT was used to understand the intricacies of the systems themselves and their influences on each other. CHAT was also used to examine how systems influenced the inclusion of environmental education from the participants' perspectives. My research questions focused on whether and how the systems' (K-12, university, and state) interactions with each other influenced the perspectives of early career teachers, administrators, and university faculty in their inclusion of environmental education in their courses or classrooms. CHAT allowed me to identify contradictions and understand how systems operated from participants' perspectives, as novice teachers transitioned from one system to the next, and as they continued to work within the K-12 school system.

It should be noted, however, that the influences from the third system in the study, the state department of education, were expressed indirectly in the data and data analysis. The state system's influences on the K-12 and university systems emerged in data generation and analysis. For example, the science standards were developed by the state system, yet were reinforced through the K-12 school system. State science standards also influenced how university faculty planned and taught their courses. Therefore, given that I focused on early career teachers' inclusion of environmental education, the third system was examined only relative to the other two. Therefore, recommendations for changes to the state system with reference to environmental education are not presented in this chapter. Future researchers could explore the influences of the state system further related to the inclusion of environmental education in K-12 schools and university systems.

In the subsequent sections of Chapter 5, I first discuss a continual issue in education, not just within environmental education, which is the misalignment between what the novice teacher learns in the university classroom and what they are able to implement in the K-12 system (Korthagen, 2010; Paniagua & Sánchez-Martí, 2018; E. R. Smith & Avetisian, 2011). I describe this misalignment within the context of environmental education. Next, I discuss the considerations for environmental educators within these systems, as previously mentioned. Finally, I provide implications for the field of environmental education, including specific suggestions for teacher preparation and professional environmental educators, and suggestions for future research in the field of environmental education.

Transitioning From University Learning to Full-Time Teaching

An overarching central idea from the study's findings discussed in Chapter 4 suggested a need to bridge university learning with in-service teaching. Phoebe shared that, "everything we're talking about [in our teacher preparation program] is really awesome in theory, but…it's so different when you're trying to apply it in the classroom." Recall that university faculty (Lily) also directly mentioned the continual struggle to connect teacher preparation with the realities of K-12 schools.

Several teachers specifically shared their challenges with transitioning the knowledge and skills gained through their teacher preparation to implementation of those strategies during in-service teaching. Kathy was very motivated to include a meaningful watershed educational experience with her students after learning about it in her teacher preparation program, but she had not implemented one due to the challenges she encountered in her K-12 school. For example, common planning required Kathy to teach topics at the same pace as her colleagues. Similarly, Lindsey and Phoebe both shared that, although teaching an elective course gave them more freedom to include environmental education, in required courses like biology, they had a lack of control due to prescribed curriculum and content standards. As novice teachers in the department, they were not able to challenge the status quo and implement ideas formed during teacher preparation. Additionally, Lindsey and Phoebe noted challenges related to their need for district-level support and supplemental resources to help them implement environmental education in the classroom. In summary, novice teachers were leaving teacher preparation motivated to include new environmental education ideas but had not implemented them at the time of the study due to challenges they experienced in the K-12 system.

These challenges experienced by teachers and university faculty participants suggest that the two systems of universities and K-12 schools were more disparate than most would think or prefer to believe. In fact, early career teachers whom I spoke with rarely mentioned the systems working in tandem, and instead focused on the challenges they experienced as they transitioned from university learning to in-service teaching. This lack of continuity between systems was highlighted in participants' motivations for the inclusion of environmental education versus implementation of it. This gap between the two systems has been coined the "two-worlds pitfall" (Feiman-Nemser & Buchmann, 1985, p. 54) as discussed in Chapter 2, and refers to the differing perspectives, rules, and social norms experienced between university-based learning and those inherent in full-time teaching in K-12 schools. Unfortunately, this pitfall was still affecting the novice teachers of this study nearly 40 years after the term was first identified. Previous research suggests that this gap should be expected due to the differences in policy and structure of K-12 schools and universities (Stevenson, 2007).

It stands to reason, then, that efforts to increase inclusion of environmental education must not be solely focused within one system; rather, the complexity of both systems and the interactions between them should be considered. Additionally, instead of simply suggesting that the systems change, the challenges of the systems should be accepted, and a focus put on the contradictions as sources of potential evolution (Foot, 2014). Decision makers should consider that systems are driven by a need to resolve these contradictions (DeVane & Squire, 2012), and that is where they can realistically expect change to be possible.

Inclusion of Environmental Education in Pre-Service Teacher Preparation

One example of a contradiction within and among systems is deciding when to introduce novice teachers to environmental education—during pre-service teacher preparation or within their K-12 school. For this study, the inclusion of environmental education in pre-service teacher preparation was of specific interest due to the identified challenges as teachers transitioned from teacher preparation to in-service teaching (Hammerness et al., 2020; Steele, 2001; Zimmerman, 2017). Is teacher preparation the best time to focus on professional development in environmental education? Or do teachers need to be fully situated within the K-12 school system to better understand how environmental education can be included in their classroom?

In recent years, there has been a focus on educating pre-service teachers on environmental education. J. T. McDonald and Dominguez (2010), for example, suggested that a focus on pre-service teachers is the best path toward successful integration of environmental education in K-12 schools. The authors suggested a focus on pre-service teachers because they recognized that to successfully include environmental education in K-12 classrooms, teachers must be prepared to challenge the status quo and address the social change-focused objectives of environmental education. This can be more easily done with teachers early in their career before the challenges of the K-12 system overwhelm them. Additionally, pre-service teachers have a high perceived readiness to integrate environmental education into their teaching. Therefore, teacher education programs should include courses that focus on addressing novice teachers' knowledge gaps related to environmental education (Batchar & Abad, 2023). Other researchers have also encouraged environmental educators and university faculty to consider ways to expand the inclusion of environmental education into pre-service teacher preparation (e.g., Álvarez-García et al., 2015; Hoeg, 2010; Wakefield et al., 2022).

Teacher participants in my study also supported the approach of working directly with pre-service teachers. All but one teacher recognized the need for inclusion of environmental education in pre-service teacher preparation. For example, Anne shared that since environmental education is "in our [standards], there's no reason why we shouldn't be having some type of environmental education in our pre-service [training]. I think it definitely needs to be pre-service." Over half of the participants suggested a repeated strategy for professional development on environmental education, with a focus both in pre-service teacher programs and during in-service teaching. Ray stated the importance of this because novice teachers "forget a lot from pre-service." Additionally, Shelley shared the importance of continual professional development:

> I think both [pre-service and in-service are important], but the reason I think it's important to tell people before they get the classroom is so that they can go into it with more of a plan. And obviously things change when you're in your actual classroom, but being able to feel like you have the knowledge and the skills to do this thing is important. But then…it's important to continue your education, as you're an educator, because new stuff is happening all the time. And sometimes…you need a reminder that…you are capable of doing this.

The perspectives of the teacher participants suggest an interest in continuing pre-service teacher professional development about environmental education, but also an acknowledgement of the inherent challenges teachers face as they transition to in-service teaching. Therefore, a different approach might be warranted to create stronger relationships across systems to ensure that motivation results in implementation. Lauren (university faculty) shared one such approach, stating that some of the teacher preparation courses at her university were now taught by current practitioners who are in-service teachers in the area:

> I feel like by having someone who has been a high school teacher come in and teach those courses, they know what their students came to their classes with. They know what their students are missing. They know the misconceptions.

Lauren shared that this "realistic perspective" helps teachers in the science methods course understand the challenges they will face in the K-12 classroom. University faculty and educational leaders within K-12 schools might need to consider increased alignment across systems such as Lauren's example. From the teacher participants' perspectives, two examples highlight this increased alignment. First, several teacher participants (Kayla, Melinda, Lindsey, Ray) shared the positive influence of their teaching practicum demonstrating successful environmental education in the K-12 classroom. Second, Anne shared how a university undergraduate course on urban environments was especially applicable to her understanding of environmental issues in the urban area where she taught, and provided a better understanding of place-based issues that would be relatable to her students.

Overall, university learning can build novice teachers' conceptual and pedagogical knowledge of how to include environmental education in K-12 classrooms (Batchar & Abad, 2023). Both systems are integral to developing and maintaining early career teachers' motivation to implement environmental education in K-12 schools.

External Partners and Pre-Service Teacher Preparation

Although university and K-12 school systems must better align themselves to resolve some of the inherent challenges with the inclusion of environmental education, several participants (Lindsey, Melinda, Kim, Lily, Kayla, Tim) identified a third CHAT community member (external partners) in both systems as a contradiction or source of innovation. Specifically in the university system, external partners were critical to the success of both Lily and Kim's inclusion of environmental education. Both recognized the lack of professional training they personally had participated in related to environmental education and relied on external partners for expertise and resources in environmental education. Both Lily and Kim partnered with environmental educators to provide content and field experiences related to environmental education for their pre-service teachers, as well as to provide resources and support for them to continue these efforts after the grant-funded partnership that brought the external partners to them had ended. Additionally, teacher participants from the universities that other faculty (Drew, Lauren, Gretchen) represented noted that their university faculty supported their inclusion of environmental education through funding their attendance at state-level science education conferences where novice teachers were exposed to environmental educators presenting content and ideas.

Environmental educators are professionals in their field and can provide the expertise and resources to support university faculty, administrators, and classroom teachers for the inclusion of environmental education in their schools and classrooms. As most international and national efforts to improve environmental education have largely been championed through policymakers and academics and not those directly involved in the dissemination of environmental education

(Stevenson, 2007), there might be a need to bring practitioners of environmental education into the discussion within and among all systems. Environmental educators could assist with efforts within and among the systems of this study since they served a key role with some study participants and had influence on whether environmental education was included in the K-12 classroom.

Additionally, based on my personal observations, there has been an increase in interest from environmental education organizations to partner with teacher preparation programs in the last 5 years. Although the reasons for this increase have not been documented, I speculate this could be caused by frustrations and challenges in reaching in-service teachers, feeling that efforts to reach in-service teachers have been exhausted, or seeking new and enthusiastic audiences to increase the inclusion of environmental education in K-12 schools. For example, the Sea Change program discussed in Chapter 3 began in part due to studies such as the one from J. T. McDonald and Dominguez (2010) and an interest in determining alternative pathways (to in-service professional development) to increase inclusion of environmental education in K-12 schools. My experiences with Sea Change and working with pre-service teachers have led environmental education organizations to request advice in how to create these partnerships with university faculty and teacher preparation programs. Unfortunately, I have found that many of these organizations do not understand the inherent challenges of the complex university system explored in this study and believe that simply offering programs for pre-service teachers will lead to successful implementation in K-12 classrooms. With increased understanding of the complex systems of both teacher preparation and K-12 schools, external partners could better assist with the inclusion of environmental education in both systems.

In my opinion, another benefit to partnering with environmental educators is that these professionals are typically not constrained by the rules, division of labor, and artifacts as other members of the systems' communities might be, and therefore might have the flexibility to support champions, as discussed in Chapter 4, who already exist within each system. I suggest that this is an opportunity for environmental educators to improve their understanding and partnership with both the university and K-12 school systems, serving as a bridge between and among systems.

Considerations for Environmental Educators

Although environmental educators were not the subject of this study, they served key roles in the inclusion of environmental education in participating early career teachers' classrooms and could be uniquely positioned to support both university and K-12 systems. For example, Kim and Lily both invited environmental educators to their university classrooms, while Lindsey and Melinda partnered with environmental educators to conduct field experiences with their students. School- and district-level administrators, such as Tim and Maddie, also sought environmental educators to enhance instruction and professional development within their schools through systemic implementation of environmental programs. Despite the participation of environmental educators within both systems, the specific roles of these educators within university and K-12 systems have yet to be discussed in environmental education research.

Research from the field of environmental education focuses mainly on the need for environmental literacy (e.g., Ardoin et al., 2020; Bartosh, 2003; Hollweg et al., 2011) and the results of particular environmental education programs on their intended audiences (e.g., James & Williams, 2017; Ko & Lee, 2003; Volk & Cheak, 2003). Yet, the qualifications and experiences of the environmental educators who offer these programs is not understood (Robertson, 2016). One reason for this is the difficulty in classifying who identifies as an environmental educator because this group is vast and could include formal teachers, university faculty, volunteers, community members, and professional non-formal educators. One reason for this variety is the lack of required credentials to engage in the practice of environmental education (Gupta et al., 2019). Despite attempts to provide certification programs within environmental education, credentialing is often seen as unnecessary to participate in the field (NAAEE, n.d.-b). Prior to Gupta et al.'s (2019) study, there was no empirical evidence describing the number of environmental educators and the diversity of roles of those working within the profession. Unfortunately, that study confirmed the difficulty in determining who identifies as a professional environmental educator, and there was an abundance of overlap between formal and non-formal educators.

Recall from Chapter 1 the differences between formal and non-formal education. Formal educators include classroom teachers and university faculty who teach within structured education institutions, often with standardized curricula and specific learning objectives (M. K. Smith, 2002). Non-formal educators include those teaching outside of the formal K-12 school day, often with participants self-selecting into the programs (e.g., camps, clubs, and public outreach programs). In my experience, non-formal environmental educators often work for organizations such as state and federal government; non-profit organizations; museums and aquariums; and local, state, or federal parks. Therefore, these environmental educators work outside of the specific systems of universities or K-12 schools. To further complicate the overlap between formal and non-formal educators, non-formal educators often partner with formal systems (schools and universities) to provide environmental education, as seen in Chapter 4.

But how can environmental educators best support the inclusion of environmental education, considering the complex systems and challenges identified earlier? In the following sections, I describe how the findings from Chapter 4 suggest specific situations for environmental educators to consider focusing their support and how these suggestions have implications for policy, planning, and leadership within K-12 and university systems. Policy refers to the decisions and rules made by those with power and their impacts on stakeholders (Fowler, 2013). Planning is the consideration of the series of objectives and actions needed to complete a task and can range from short-term events to strategic planning (Hinton, 2012). And leadership is a complex set of skills and characteristics that individuals have that help them inspire others to accomplish activities (Northouse, 2019).

Specifically, the suggestions I provide for environmental educators include professional development for both pre-service and in-service teachers, with a focus on in-service teachers due to the lack of training available within the K-12 system, sharing place-based education strategies to support teachers in better using their schoolyard for field experiences, and supporting teachers as they transition between systems.

Professional Development

In both the university and K-12 systems, professional development was identified as lacking. Within the K-12 systems, teachers and administrators (Kayla, Melinda, Tim) stated that professional development for environmental education was not occurring at all and that teachers were encouraged to seek training outside of the school district. Within the university systems, only two of the five university faculty participants (Kim and Lauren) had attended any professional development specific to environmental education. The other three university faculty were self-taught, using resources found online, and relied on their scientific training from undergraduate and graduate programs to facilitate environmental education in their classrooms. These findings suggest that additional opportunities for professional development might be needed in both systems.

Successful implementation of environmental education “requires the quality professional training of educators and school leaders, as well as opportunities for continuous professional development” (Mulvik et al., 2022, p. 9). This suggests that professional learning should be ongoing, following the novice teacher from university to K-12 school. Many of my study’s teacher participants (Shelley, Kathy, Josh, Ray, Melinda, Phoebe, and Lindsey) agreed with this sentiment, sharing that professional learning should take place in both pre-service teacher education and in-service teaching.

Environmental educators can provide support and leadership to interested university faculty as well as teachers and school leaders who are motivated to include environmental education but might need additional strategies and support to do so or to those who might not be receiving opportunities through their university or district to learn about it. In fact, most examples of professional development for environmental education teacher and administrator participants in this study discussed were offered by external partners, specifically environmental educators. For example, Kayla, Melinda, and Lindsey’s partnerships with environmental education organizations allowed them to participate in professional learning alongside their students’ participation in field experiences. Additionally, several of the professional learning opportunities at the university level, such as in Kim and Lily’s university courses, developed from partnerships with external environmental educators. Because of this, I suggest that environmental educators could play key roles within both the university and K-12 school systems. These roles could include championing and supporting teachers through professional development and partnerships to ensure environmental education occurs (Chawla & Cushing, 2007; Stevenson, 2007).

Pre-Service. In pre-service teacher education, there is a need for professional development directly for novice teachers and for university faculty (Álvarez-García, 2015; Rebar & Enochs, 2010). Before providing that professional learning, environmental educators and university faculty can first plan together and create partnerships. As shared in Chapter 4, university faculty (Lily, Kim, Lauren) already understood the value in environmental educators' expertise, resources, and supports for their students, but connecting with university faculty can be a challenge for environmental educators who are not associated with a university. For university faculty seeking external partners in environmental education, I suggest becoming familiar with local environmental education providers. Based on my experience, there might even be partners within the university who work in community engagement and environmental education. I also encourage environmental educators to contact university faculty from both the science and education departments to explore possibilities for potential partnerships, since this study highlighted that university faculty working with pre-service teachers can be located in both departments. When exploring partnerships, environmental educators should share relevant training resources and supports for novice teachers related to environmental education that can be provided to university faculty and pre-service teachers to demonstrate the benefits of the partnership to university faculty.

As stated earlier in this chapter, the university system is complex and includes several inherent challenges for the implementation of environmental education in university courses. University faculty participants in this study noted a lack of instructional time to devote to environmental education projects, non-traditional class times (such as evenings) limiting opportunities for outdoor learning, and a variety of disciplines represented in science methods courses as challenges for environmental education. For example, recall from Chapter 4 that university faculty noted the variety of disciplines (e.g., physics, chemistry, biology) represented by their students' majors in their pre-service methods courses. Environmental educators partnering with university faculty should consider these policy limitations and challenges when attempting to establish successful partnerships. Environmental educators might want to consider the following suggestions when partnering with university faculty to offer environmental education to pre-service teachers:

1. Due to university faculty participants' reported lack of time for environmental education, environmental educators should partner with university faculty to create focused pre-service professional learning programs that serve as introductions to environmental education. At this level, an introduction could build interest in environmental education but would not consume the entirety of instructional time that university faculty have with pre-service teachers, an important consideration since environmental education was not the primary focus of any of the university programs included in the study.
2. Environmental educators should remain flexible and understand that field experiences might not be possible or might need to be altered to fit into the pre-service teacher preparation program. Additionally, environmental education programs might need to be tailored to the course and audience within the program. For example, some university faculty (Gretchen, Drew, Lauren) noted that their teacher preparation programs included undergraduates who had yet to complete their teaching practicums, and therefore had limited understanding of the K-12 classroom; others (Lily and Kim) had graduate-level students with extensive field placement experience. Environmental educators should understand this difference and alter

content depending on the specific course the professional learning opportunity is offered within, the audience (i.e., undergraduate or graduate level), and the amount of teaching experience students have had at that point in their program.

3. Environmental educators should determine ways to connect pre-service teachers' professional learning opportunities with all science disciplines, including those that might have less direct connection within the K-12 curriculum standards, since science methods courses include pre-service teachers from a variety of disciplines within one course. Environmental educators who can demonstrate the relevancy of environmental education across all science disciplines might be more successful in developing partnerships with university faculty who see the benefit of environmental education professional learning for all students, rather than only the students who are interested in teaching environmental science.

Additionally, contradictions within the university system in my study highlighted the need for participating university faculty to discuss the challenges that novice teachers might experience when including environmental education in K-12 schools. Recall from Chapter 4 that Gretchen and Drew noted the challenges they experienced in planning and conducting field experiences for their pre-service students. These challenges mirror those experienced by K-12 teachers when attempting to include environmental education in K-12 classrooms. If university faculty can identify possible solutions to these challenges that novice teachers can use, the teachers can be better prepared for the transition to in-service teaching and the inclusion of environmental education in the K-12 classroom.

In-Service. Environmental education research related to professional development published during the past several decades has focused on in-service teacher professional development (e.g., Bell et al., 2003; Disinger & Howe, 1990; Ernst & Erickson, 2018). There are many examples of nationally available training opportunities for teachers in environmental education such as Project Wet (https://www.projectwet.org), Project WILD (https://www.fishwildlife.org/projectwild), and the Teacher at Sea program (https://www.fisheries.noaa.gov/topic/teacher-at-sea-program). These opportunities allow in-service teachers to develop knowledge, skills, and resources to include environmental education in their classrooms. In addition to these national programs, many local professional development opportunities are offered by community-based organizations and local and regional environmental educators to both teachers and administrators (Li & Krasny, 2019).

Despite what appears to be a plethora of professional learning opportunities nationally, study participants (teachers and administrators) suggested that there was a lack of training or lack of awareness of such trainings for environmental education in their area. Tim, a district-level administrator stated that "we don't have a lot of professional learning right now." Kathy (teacher) and Kate (school-level administrator) agreed that they had not experienced any environmental education professional learning through their school or district despite being interested in professional learning opportunities about environmental education. Many districts relied on external professional development opportunities like those offered by external partners. Chris (teacher) simply stated that he had no time or energy capacity for outside training. Similarly, Kayla (teacher) shared that she would have to use leave to attend such trainings during the workday, which also was not feasible.

These environmental education trainings are important for in-service teachers and school- and district-level administrators to consider in the science disciplines with end-of-course assessments, such as biology. Recall from Chapter 4 that most teacher participants shared their concerns about preparing students for the end-of course assessments, and that their school accreditation status could be impacted by these test results. Also recall that many teacher participants reported the lack of focus on environmental topics specifically within biology classes, and a focus on microbiology topics instead, due to the students' perceived needs to review these concepts in preparation for the end-of-course assessment. In reviewing the state level policy for end-of-course assessments for biology, there is a misalignment with this focus solely on microbiology topics. The assessment includes 38% of questions targeting ecology-related curriculum standards, suggesting to school and district leadership that additional inclusion of environmental topics should be included in the biology course. Additionally, to prepare teachers to successfully teach these topics, school and district leadership may consider increased professional development and instruction on environmental topics to ensure that students are adequately prepared for this assessment.

Similar to findings from the university system, the findings shared in Chapter 4 highlight challenges that environmental educators must consider within the K-12 system, such as limited time and energy teachers have for off-site training. Additionally, the findings highlighted a strong influence from the state system's science standards, which bound teachers' instruction to specific concepts, potentially limiting the inclusion of environmental education. Recall from Chapter 4, for example, that the science standards and end-of-grade testing in required courses influenced participating teachers' perspectives related to the inclusion of environmental education and provided challenges for many in their implementation of environmental education. One final challenge identified in Chapter 4 was the lack of responsibility teachers felt to include environmental education unless they were specifically teaching a course like environmental science or ecology.

Due to these challenges, environmental educators might want to consider the following suggestions when developing professional development programs for in-service teachers:

1. Environmental educators could offer training opportunities on preestablished professional learning days within the district, if possible. This allows teachers to avoid attending external training outside of required school hours. Environmental educators should also consider partnering with educational leaders who are responsible for planning these trainings. Tim and Robert were each responsible for district-wide science professional development opportunities; environmental educators should consider the role and support of educational leaders in implementation of professional development.
2. Environmental educators should be familiar with the applicable curriculum standards provided by their state department of education, and programming should be aligned to these standards to ensure it can be used in the classroom.
3. Environmental educators could focus efforts on teachers who have the greatest ability to include environmental education in the classroom as it relates to their discipline and curriculum standards. Although environmental educators can be creative in considering how environmental education could address any standard, it might be important to consider the limitations that K-12 teachers will face in implementation, and focus engagement on those with the highest likelihood and responsibility to teach these concepts. As described in Chapter 4, this could include teachers of environmental science, ecology, and other associated environmentally focused courses, rather than required courses like biology.

In addition to these suggestions, there were contradictions within the study's K-12 system that highlighted additional potential solutions for environmental educators to consider. One example of success identified in the study's findings was a focus on schoolyard investigations and place-based education by several teachers (Chris, Ray, Phoebe) which will be discussed in the next section. Recall from Chapter 4 that place-based education is an environmental education strategy where activities are conducted locally, such as directly on the school grounds, to better connect students to their local environment, build environmental literacy, and increase civic engagement (Ardoin, 2006). Based on the successful implementation of place-based education several teachers described, environmental educators should consider offering professional development focused on the accessible natural areas teachers have to increase inclusion of environmental education in schools. I explore this topic more fully in the next section.

Place-Based Education

Recall from Chapter 4 that participating teachers faced challenges with implementing off-site field experiences due to logistical barriers (e.g., permission forms, scheduling issues). Place-based education arose as a potential source of innovation within my study's K-12 school systems. Several teacher participants (Chris, Ray, Phoebe) found success through place-based education, and used adjacent properties within walking distance from their schools—such as forests, fields, parks, ponds, and lakes—for science instruction. A recent publication named place-based education as a successful strategy for environmental education that could lead to measurable environmental change (Ardoin et al., 2020). The authors stated,

> Programs leveraged participants' immediate home environment—occurring at a scale such as a watershed, park, nature reserve, urban green space, or schoolyard—to connect participants with broader environmental issues and engage them in environmental learning and action. Situating the issue and action locally facilitates measurement of more

> direct outcomes and helps mitigate issues of scale. The local environment is readily accessible: based in common sense, these programmatic foci suggest it is easier to measure water quality changes in a local creek than attempt to measure, and attribute, resulting changes in polar ice cap melt. (p. 7)

One example of a successful place-based environmental education program is the Using the Outdoors to Teach Experiential Science training (https://naturalsciences.org/learn/workshops-at-your-school) offered by the North Carolina Museum of Natural History. This program partners museum educators with local schools. Over several sessions, the museum educators share meaningful activities related specifically to the school's site and natural habitats. The program is tailored to the individual school. External educators work with the school's teachers and administrators to identify opportunities on the school's grounds and determine specific options for the installation of a wildlife habitat appropriate for the site. Museum educators also provide several training workshops to build teachers' confidence including environmental education within instruction. I suggest that environmental educators consider these successes and include place-based education strategies (similar to those conducted by the North Carolina Museum of Natural History) when partnering with teachers and administrators. Place-based education could also be introduced to pre-service teachers who can extrapolate these strategies in their future classrooms. For example, Kathy understood the benefits of place-based education and spoke directly about her goal to include as much place-based education in her science instruction as possible, focusing on local environmental issues relatable to her students whenever applicable.

I further recommend that the professional development offered to in-service teachers to learn about place-based education should also be offered to educational leaders. Educational leaders, such as school and district-level administrators, are key members of the K-12 community who could also benefit from environmental education training. Including educational leaders in professional development on place-based education could also remove some of the barriers teacher participants experienced when interested in taking students outside for instruction (e.g., rules from administrators, lack of opportunity, accessible spaces). For example, Shelley and Melinda both shared that their educational leaders were uncertain about taking students outside and required extensive permissions to do so. Training for educational leaders on the benefits and safety precautions that can be taken when outside could increase teachers' likelihood of using place-based education strategies.

Environmental educators who assist with place-based education should visit partnering schools to assess accessible and appropriate natural areas and develop field investigations tailored to those areas. I recognize the challenges that place-based education presents to environmental educators, specifically the greater preparation and planning time (Yemini et al., 2023) compared to bringing students to their own sites (e.g., museum, park) where their comfort and understanding are greater. However, if environmental educators provide options for field investigations on the school grounds, it could greatly influence early career teachers' inclusion of environmental education in their science instruction and reduce some of the challenges teachers face across and between systems (as explained in Chapter 4).

Across Systems

A final consideration for environmental educators is how they can support novice teachers as they transition from the university system to the K-12 system. Novice teachers in my study were interested in learning about environmental education during their teacher preparation, but despite this professional learning, they experienced a lack of connection to their in-service teaching experiences. For example, several teachers (Kathy, Chris, Anne, Phoebe, Shelley) did not observe these practices being implemented within their field placement, which left them without examples of successful integration of environmental education in the K-12 system. Given this aspect of the results, systems should better align their missions and goals to prioritize environmental education to avoid this pitfall. But, as demonstrated in Chapter 4, the complexities of these systems and their competing objectives, rules, artifacts, and division of labor make that difficult to accomplish. Additionally, policy implications at the state level such as the regional mandate for environmental education had limited impact on teacher participants' inclusion of these topics in the K-12 classroom due to a lack of funding and a lack of understanding of the mandate itself. Only one of the participating district-level administrators was aware of the mandate. This might suggest that environmental educators partner with district leaders with a deeper understanding of the state mandates, but also the districts' specific needs for environmental education such as professional development for teachers, resources for field experiences, and/or external partners to assist teachers with the inclusion of environmental education in the classroom. I suggest that it might be more beneficial for environmental educators and district leaders to consider implementing district-level mandates and partnerships in which environmental educators could work more intensively with districts to create deeper relationships to better meet their environmental education needs.

Environmental educators can serve both university and K-12 school systems by providing professional development and sharing place-based education strategies. But these supports taken alone will not address the pitfalls novice teachers might experience as they transition from one system to the next (e.g., Beauchamp & Thomas, 2011; Wanzare, 2007). Environmental educators can serve as bridges between the systems because they are not beholden to the same constraints as teachers in the school system and university faculty in the university system.

One possible scenario for environmental educators to connect across systems is to provide professional development for pre-service students that continues with the novice teachers as they transition into K-12 schools. This could include direct extended mentorship and professional development by the environmental educators themselves as teachers begin in-service teaching. Additionally, environmental educators could serve as connection points between novice and experienced teachers, connecting early-career teachers with those who have already successfully included environmental education within their classrooms. Lastly, environmental educators who work with pre-service teachers could connect novice teachers with environmental educator networks in the location of their K-12 classroom. These networks could help novice teachers find potential environmental educator partners who can provide expertise and resources in their local area to increase the inclusion of environmental education in K-12 classrooms. These efforts would continue to support the novice teacher throughout the transition to a new system (K-12 schools) and give them examples and mentorship of environmental education inclusion within that new system.

This does not mean that the two systems and their communities should allow environmental educators to take the full responsibility for ensuring environmental education is implemented in early career teachers' classrooms. University faculty must be willing partners and offer instructional time to dedicate to environmental education. K-12 schools must be active partners in identifying champion teachers who could serve as mentors for novice teachers and identify solutions to common logistical barriers (such as funding). But throughout, environmental educators could endorse efforts in both systems, providing resources, expertise, and professional development.

One example of such an across-systems program is Ontario's Institute for Studies in Education's Deepening Environmental Education in Pre-Service Education Resource (DEEPER). DEEPER is a university program which "aims to support and inspire university faculty, staff, and students to broaden and deepen the implementation of environmental education in initial teacher education programs" (Inwood & Jagger, 2014, p. 6). DEEPER suggests a realistic approach to resolving the challenges early career teachers face as they transition from university to in-service teaching. Teacher candidates are partnered with a supportive cooperating teacher who is an advocate for environmental education for their field placement where the teacher candidate can observe environmental education taking place. Additionally, the university relies on educational leaders like principals to identify champions within the K-12 system to support novice teachers as they transition to full-time teaching. Some of the key tenets of the DEEPER program include support from university faculty, reliance on national environmental education standards, identification of partners and champions, funding, external partners, and training for university faculty (Inwood & Jagger, 2014). This program stands apart from other environmental education programs for pre-service teachers due to its recognized focus on connecting pre-service teachers, when possible, to the K-12 systems.

The DEEPER program is a strong example for bridging connections between the university and K-12 school systems (Inwood & Jagger, 2014). The program has institutional support from both the university and K-12 school systems, recognizes the need for partners, and strives to connect two disparate systems. I recommend that similar programs be created in the U.S., with strong partnerships across university faculty, K-12 teachers, educational leaders, and external partners. Within DEEPER, the importance of external partners in bringing "expertise in specific environmental issues or approaches to environmental education can be instrumental in supporting…learning and developing a supportive network” (p. 25). DEEPER recognizes that partners can also provide support and resources for K-12 teachers after they transition fully into K-12 school systems. I believe these well-defined roles for non-formal educators as leaders, as well as suggested planning opportunities across systems, can increase the successful inclusion of environmental education across systems, despite policy limitations. As stated previously, environmental educators can champion environmental education efforts within both university and K-12 systems while supporting novice teachers as they transition from one system to the next.

Future Research

Recall from Chapter 4 that the results of this study suggest that the complex systems of teacher preparation, in-service teaching, and the state department of education all influenced early career teacher participants’ inclusion of environmental education. Additionally, the roles of external partners, specifically environmental educators, arose within both the university and K-12 systems in the study as sources of innovation for increased inclusion of environmental education. These sources of innovation included professional development opportunities within both systems, encouraging place-based strategies for K-12 teachers, and supporting novice teachers as they transitioned across systems. However, qualitative results like this are not generalizable to all community members within the university, K-12 school, and state education systems; they only describe the influences and challenges perceived by selected teachers, university faculty, and administrators. Because the results of this study are not generalizable, I recommend suggestions for future research to contribute to this understanding, including foci related to the potential roles and influences of environmental educators, use of CHAT within the field of environmental education, and how science teacher competencies developed during teacher preparation reflect the need to develop an environmentally literate society.

Role and Influence of Environmental Educators

I found no extant literature that focused on the roles of environmental educators in the university or state system; therefore, my first suggestion for future research relates to the role and influence of environmental educators in these systems. In the previous section, I highlighted the roles of professional environmental educators as they participated within both university and K-12 systems. The limited research on the roles of environmental educators within these partnerships should be considered. I found only two studies that focused on the specific roles of environmental educators within the activity system of K-12 schools and on the larger field of education (e.g., Gupta et al., 2019; Robertson, 2016). Robertson (2016) stated that the roles of environmental educators are constructed by the larger system of education, especially the division of labor. Recall from Chapter 1 that secondary science teachers often feel a lack of responsibility to include environmental education in their classrooms (Kim & Fortner, 2006; Ko & Lee, 2003). My findings reinforced that most of the participating teachers felt a lack of responsibility to teach environmental education unless they were teaching environmental science, ecology, or Advanced Placement environmental science. The division of labor related to who should include environmental education affected its implementation.

Environmental educators could help with the responsibility to include environmental education within the K-12 system, assisting teachers in moving from being motivated to include environmental education into actual implementation. For example, some teachers (Melinda, Lindsey) implemented more environmental education in their classrooms when they had partnerships with external environmental educators. My findings suggest a need for future work investigating the varied systems that environmental educators work within, such as state and federal government; non-profit organizations; museums and aquariums; and local, state, or federal parks. Future research could examine contradictions between these systems and the ones highlighted in this study (teacher preparation, K-12 schools, and state education systems).

Using CHAT to Examine Environmental Education

A second area for potential future research that this study has highlighted is the utility of CHAT in systemically examining complex and contradictory systems within environmental education. My findings challenge prior solutions that suggest a focus solely on pre-service teacher education would increase environmental education in K-12 schools (Cheong, 2005; J. T. McDonald & Dominguez, 2010; Richardson et al., 2018). Through CHAT, a more holistic understanding of the integration of environmental education into K-12, university, and state educational systems—and associated challenges—could occur. Currently, most environmental education research focuses solely within one system, but use of CHAT could expand the field of environmental education research. Research that focuses on the complexity of systems in which environmental education takes place could also provide valuable information to assist with the field's focus on systemic implementation. Recall from Chapter 1 that systemic implementation is defined as environmental education programs where all students in a district, school, grade, or class can participate (Sprague et al., n.d.). Future environmental education research could be conducted using this systemic analysis to understand the complex and sometimes-conflicting systems of K-12 schools, teacher preparation, and the state departments of education, as well as the systems in which environmental educators work.

Teacher Preparation Competencies and Environmental Literacy

A final suggestion for future research is an audit of teacher preparation competencies to better align with the current need for environmental literacy. With increased anthropogenic influences on the world, all citizens need to develop environmental literacy (Bey et al., 2020; Hollweg et al., 2011). Recall from Chapter 4 that many teacher, administrator, and university faculty participants in my study supported the goal of environmental literacy. For example, Gretchen stated “I keep looking for ways to integrate environmental education and environmental literacy into my teaching because I think it’s important for the future of humanity.” Additionally, recall from Chapter 4 that the state system also demonstrated support of environmental literacy through its development of a specific environmental science course.

With limited inclusion in teacher preparation programs, though, university faculty members’ individual conceptual knowledge for environmental education, and their ability to teach their students about environmental education strategies, is lacking (Miña, 2021). Future research could explore teacher preparation competencies within each state. Recall from Chapter 2 that several states have mandated environmental education within their teacher preparation programs (Rosemartin, 2015). As identified in my study, without direct rules or regulations requiring the inclusion of environmental education in teacher preparation, it might continue to occur haphazardly, dependent on university faculty interest.

Conclusion

In conclusion, all study participants (teachers and university faculty) recognized the importance of developing environmental literacy in both students and themselves. But the systems that teachers learn and work within are complex, making professional learning about, and implementation of, environmental education disparate and limited (Franzen, 2017; Powers, 2004; Wals, 2009). CHAT provided a framework to examine the intricacies of each system and the challenges faced within and among systems. These challenges included motivation versus implementation of environmental education, transitioning from university learning to in-service teaching, professional learning about environmental education, inclusion of environmental education in pre-service teacher preparation, and the need for advocates to champion these efforts within and among all systems.

Due to the systems' complexities, although individuals within the systems strove for change, a multitude of factors and perspectives within and among systems might have influenced and stifled that change. Systems might be constantly strained by these challenges, and it is important to recognize that even when systemic challenges inspire innovation that leads to system change, they might not readily change or evolve (DeVane & Squire, 2012). Several sources of innovation (e.g., inclusion of environmental education in teacher preparation, place-based education, professional learning for environmental education) were highlighted within and among the systems I examined as avenues to success. Examples of successful inclusion of environmental education did occur within and among participants' systems using strategies like external partnerships, place-based education, specific environmental science courses, regional mandates for environmental education, and direct demonstrations throughout university teaching of challenges to including environmental education within K-12 schools.

Additionally, the need for champions within all three systems was identified. These champions allowed for evolution within and among systems. To continue this work, champions need to be celebrated and provided continual support. Examples of successful champions included district-level administrators who focused on building capacity within their districts through facilities and resource acquisition, passionate teachers who found ways to incorporate environmental education despite limitations from the standards, and a state department of education that supported environmental literacy through development of a new Environmental Science course. Environmental educators were also identified as potential champions.

The specific roles of environmental educators need to be further explored, but potential avenues for these educators to participate within and among the systems was discussed. Environmental educators have the opportunity to connect champions across and within systems through professional development in both the university and K-12 systems, sharing place-based education strategies, and connecting novice teachers with experienced teachers who have successfully included environmental education in their K-12 classrooms. These efforts could increase the likelihood of early career teachers' inclusion of environmental education in their classrooms. Overall, recognizing and understanding the complexity of the systems that all educators work within, and the potential solutions for overcoming challenges within and among the systems, can further support those educators in increasing environmental education in K-12 classrooms.

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APPENDIX A

RESEARCHER AS INSTRUMENT STATEMENT

I come to this research study with many personal and professional experiences related to environmental education, and these experiences can affect how I view the world. Growing up in eastern Pennsylvania, my interest in the natural world was born out of my father's love of the outdoors. I remember exploring tons of trails that he had cut through the woods behind our house, leading to my favorite spot, which was the creek at the bottom of the hills. I have also always had a deep connection to the ocean, stretching back to family vacations, summer camps, day trips, and eventually to my current job at the Virginia Institute of Marine Science (VIMS). Although ocean sciences do not encompass all types of environmental education, I think it is my love of the ocean that brought out the true environmentalist in me. Most marine educators have that defining moment of what drew them to marine science, and mine is lying on a dock in Wilmington, NC, at a summer camp observing all of the animals and plants that had attached themselves to the dock. I remember being fascinated by all of the flora and fauna I had never seen before, in such vivid and diverse colors, and from that moment on I knew I wanted to combine my interests of teaching and the ocean into a career.

I found my niche of environmental education during a college internship where I was first able to design programs and engage people in learning about the outdoors. After graduation, but before beginning a Master's in Environmental Studies at the College of Charleston, I worked for Mote Marine Laboratory as a summer camp counselor in their Florida Keys program. I expanded my work with students and teachers, leading them on scuba diving trips, kayaking, snorkeling, and other marine adventures. I remember that as one of the best summers of my life, and I use that experience as an example to the students that I work with now in terms of taking advantage of opportunities to build your career. I was developing my love of environmental education and at the same time seeing the positive benefits of these programs, especially to students who had never had these types of opportunities. Another internship opportunity I took advantage of placed me with educators in South Carolina focused on writing curriculum, which drew me toward my thesis topic “Facilitating the Integration of Marine Science into the Curriculum through Product Development for K-8 Classrooms.” This time, my work experience was in curriculum development, allowing me to understand what teachers must consider when using or writing curricula for their classroom.

My Role in Environmental Education

The two experiences that most influence my thoughts and opinions on this study topic are my professional roles as both an informal environmental educator and an adjunct instructor for science pre-service teachers. For the past 17 years, I have worked as the Education Coordinator for the Chesapeake Bay National Estuarine Research Reserve in Virginia (CBNERR), located at VIMS. At VIMS, I work with students, teachers, and the general public to teach them about their local environment. Our mission is to generate awareness, understanding, appreciation, and responsible use of our local environment, specifically the Chesapeake Bay. Students visit CBNERR for their field experiences, teachers attend for professional development, and the general public attends family-friendly learning events. A secondary goal of these programs is to get people outside, increasing their comfort with and appreciation of the outdoors. I train teachers to lead meaningful watershed educational experiences (MWEEs), a watershed-wide initiative to increase opportunities for students to learn outdoors in a meaningful, curriculum-based way. I am a state leader in MWEE training other environmental educators, serving on regional and state advisory boards, publishing about best practices and benefits of MWEEs, and (most recently) bringing in pre-service teachers at William & Mary for training.

Secondly, during the past 3 years I have worked with pre-service science teachers both as an adjunct instructor for William & Mary's School of Education and as the Principal Investigator for the Sea Change (pseudonym) project, aimed specifically at training pre-service teachers how to include environmental education within their future classrooms. These experiences have allowed me to more fully understand the components of pre-service teacher education, as well as the challenges that pre-service teachers might face in implementing environmental education when they are working as full-time teachers.

Values and Beliefs

My past and current experiences have shaped my values and beliefs about environmental education and specifically its inclusion in pre-service teacher preparation programs. Environmental education has been my life's work for at least the past 20 years and is something I feel passionate about helping teachers include within the classroom. Most of the people I surround myself with share these beliefs, and I hope to instill a love and deep respect for the environment within my own children through sustainable behaviors, action projects, and community involvement. I believe that pre-service teachers also deserve time to learn about the benefits of environmental education and practical ways to include it in the classroom.

Expectations/Findings

Using the interpretivist research paradigm, I am interested to see if teachers are implementing environmental education within the early years of their teaching career. I have seen the challenges that early career teachers face firsthand, and I expect to find some that have personal motivations to ensure environmental education is happening in their classroom while others will be too overwhelmed to consider it. I am interested to see where teachers get their motivation and specific resources for environmental education and if those come more from their pre-service teacher preparation or their in-service teaching environment. I am willing to discover that teachers might have additional challenges that impede their ability to implement environmental education. I hope to discover that teachers value environmental education programs, whether they incorporate them into their classroom or not.

Throughout the study, I must remain open to the different perspectives that participants have regarding environmental education. The experiences I have had related to environmental education might not be the same as others, and I must be aware of the real challenges that others have encountered. Each of the participants' perspectives need to be respected and examined to more fully understand their working contexts and their experiences.

APPENDIX B

REFLEXIVE JOURNAL SAMPLE ENTRIES

January 10, 2023 – Reflections from First Interview with Lindsey

Lindsey has had multiple experiences with field experiences and MWEES, but I question whether those were ones that she sought out herself or rather ones that she was told she had to participate. For example, the museum project partnership she discussed was an effort by her district. I'm glad to hear positive feedback about the museum partnership, as it seemed she had struggles with it the previous year. Additionally, the field trip she took her students on tied closely to relationships she had with the organization hosting it.

It was fascinating to hear that for the first two weeks of school they do not really teach any content, or it is very light to allow students to adjust to school. Lindsey also stated that they have a lot of students that start late or switch schools at the beginning of the year. For that reason, in their district they teach the ecology unit of biology first as an easy introduction to science. This is unlike the participants from other districts that I have talked to so far. Unlike other districts, Lindsey's actually spends time on ecology. I wonder if that impacted Lindsey's use of environmental education in the fall semester. It seems as if Lindsey has more flexibility in her marine biology class to do environmental education.

January 14, 2023 – Further Analysis of First Interview with Lindsey

Lindsey is in a particularly interesting position to study as a first-year teacher who experienced environmental education within practicum, and has a grant-funded mandated program for MWEEs this year. She already was highly motivated to include environmental education, and was prior to joining the classroom. Her district is very supportive of programs like this, and led the development of this grant funded project with a museum which provides the structure for MWEEs to happen. It also showcases a truly systemic project where all 9th graders participate - and highlights the challenges with that in terms of how it relates to the curriculum of both environmental science and biology. Lindsey has also had a lot of specific environmental education training (more so than any of the other teachers as far as I can tell), but still lists tensions such as time, class size, and curriculum connections.

After reviewing Lindsey's first interview, I've come up with several questions to ask her in the second interview:

- Can you tell me a little more about what you remember from MWEE training?
    - Was that the first time you had heard of MWEEs?
    - How specifically has that been incorporated into your classroom?
    - How has your view of the BWET program changed over time, if at all?
- Tell me more about why the principal may not know you're doing the project with museum?
- What topics are covered in the ecology unit of bio?
- How, if at all, did environmental science help prepare your biology students for that class?

- How in lockstep, if at all, do you have to stay with your colleagues?
- How much time is involved in planning/scheduling on your part for the museum project?
- What different classroom management issues do you encounter, if any, when you take students outside?

January 23, 2023 – Generation of Codes and Possible Tensions from Second Interview with Lindsey

- Connection of undergraduate degree must be lumped with pre-service teaching - <u>maybe group those together for discussion of results?</u>
- Personal motivation for environmental education
- Feels that students need to be outside to apply it
- Remembers MWEE components from pre-service teacher preparation
- Has a different perspective with a grant-funded project that requires environmental education and professional development
    - Not all positive - <u>some tensions with lack of application with students, time required, and curriculum connection</u>
- Tension - principal without science understanding - doesn't know/understand grant-funded project and lack of interaction with teacher
- **Challenge for environmental education integration is that each school's context is so different and will need to be tailored to individual (place-based education)**
- Listed the ecology components of biology class and THERE WERE A TON TO CONNECT WITH ENVIRONMENT (why isn't it included???)
- Tension – lack of focus on science which continues the feeling of exclusion in underserved population
- <u>Environmental science is not preparing students to biology as intended to do</u>
- Personal feeling is to stay on track with the other teachers - as a new teacher, likes the support even if it's not the most exciting curriculum
- Tension - fears of classroom behavior if you take them outside
- Professional Development needs includes how to use the schoolyard, civic engagement, and interdisciplinary nature of environmental education
- Environmental education should be placed in teacher preparation
    - *"I think it should be something you continuously learn about because it's going to change, like how you do need to do it, it's going to change"*
    - Teachers will not change after a certain amount of time in the classroom, so environmental education needs to be integrated early on – *"Because I feel like people get set in their ways"*

February 25, 2023 Artifact Analysis – Lindsey

Lindsey shared her pacing guide for biology which states clearly that the ecology unit should last 9 blocks (third longest in the curriculum)**.** This course is a required end-of-grade test, and is required for school accreditation**.** There are many opportunities for environmental education such as interactions in ecosystems, photosynthesis, solutions for reducing negative effects of human activity on a watershed or ecosystem**.** Lindsey also shared some of her external resources from optional professional development. <u>Champion for environmental education?</u>

August 8, 2023 – Relationships Between Themes/Contradictions

One initial theme is the need for champions within each system. New teachers can be thought of as champions as they have the motivation to include environmental education in the classroom, but yet they face limitations for implementation. These limits are related to the navigating the switch from student (pre-service teacher preparation) to teacher (K-12 schools). There are systemic influences that impact implementation despite motivation.

Possible contradictions include:

- Disconnect between understanding of environmental education from a district-level person and an early-career teacher. The teachers seemed to lack the broader understanding of the district's initiatives to ensure environmental education is occurring. The district-level administrators appeared to have a far more optimistic view of what was occurring than what the teachers were actually implementing. Disconnect between champions at a higher level (district administrators) and teachers' implementation.
- Teachers and administrators want to be champions, but there are systemic influences that limit that both in university system and K-12 system.
- Pre-service teacher preparation requires "field investigations" yet faculty placement in education or science department may limit that. Most assume that the fieldwork is completed in undergraduate program.
- Pre-service should introduce environmental education even if there are challenges. In-service teachers still need the reinforcement of continual training.
- Environmental science is a large focus within the state, yet not licensure program for it specifically, and no official standards of education

Current question for organization of themes and results – Could I organize the chapter as CHAT contradictions with interesting stories to highlight each one?

APPENDIX C

STUDY ANNOUNCEMENT MESSAGE TO UNIVERSITY FACULTY

Subject Line: Study on Environmental Education within Pre-service and In-service Education

Dear Colleagues,

I am a Ph.D. candidate at William & Mary's School of Education, conducting my dissertation study. **I am researching early career teachers' perspectives on incorporating environmental education in the classroom.** I am specifically interested in their experiences in pre-service teacher preparation and in-service teaching related to environmental education. Specifically, I am seeking teachers who:

- are currently within the first 5-6 years of full-time teaching
- were exposed to environmental education within their pre-service teacher preparation program; and
- who are currently teaching secondary science.

If you know of teachers who meet the above criteria, please consider sharing their names and contact information with me, if that is allowable at your university.

Thank you!

Sarah Nuss
mcguire@vims.edu
757-784-7322

APPENDIX D

PARTICIPANT RECRUITMENT MESSAGE TO SECONDARY SCIENCE TEACHERS

Subject Line: Study on Environmental Education within Pre-service and In-service Education

Dear [Participant Name],

I am a Ph.D. candidate at William & Mary's School of Education, conducting my dissertation study. I am researching early career teachers' perspectives on incorporating environmental education in the classroom. I am specifically interested in their experiences in pre-service teacher preparation and subsequent in-service teaching related to environmental education.

You have been identified by [INSERT FACULTY NAME] as an early career secondary science teacher who might be a helpful source for my work. I am contacting you to see if you may be interested in participating in my study.

Participation in this study will include the following:

- I will ask you to provide a written response to this question: How did you learn about environmental education, if at all, during your pre-service teacher preparation program? I understand that you are busy, and this written response can be in the form of a bulleted list to save you some time.
- I will ask you to participate in two audio-recorded interviews, in person (if geographically possible) or via Zoom or other telecommunication, according to your preference. Each of the interviews will last approximately one to 1.5 hours.
- I will ask you to share any programmatic information related to environmental education such as state standards, district-wide resources, or lesson plans that you have encountered in your work as a full-time teacher.
- Following each interview, I will ask you to review and correct a written summary of the information that you shared as I understood it, making corrections as needed.

Participation in this study will take approximately 2-5 hours over the course of 2-3 months during the 2022-2023 school year. Participants will be asked to provide consent via a signed consent form and are responsible for abiding by their school's and/or district's policies for participating in this research study. Participants will not be required to answer every question posed during the interviews and may terminate their participation in this study at any time by email or by phone to the researcher. All data will be kept confidential, and the identities of the participants will not be released.

I know that as an early-career teacher, your time is limited, but I hope that you will consider participating in this research. Please let me know if you would like to participate by completing a brief online survey [INSERT LINK TO SURVEY]. Your responses will be used to help me to select participants from a range of backgrounds and experiences. I will contact you if you have been selected to invite you to participate in the study.

Thank you for your time.

Sincerely,
[Researcher's Email Signature]

APPENDIX E

INITIAL RECRUITMENT SURVEY

Environmental Education in the Classroom: Selected Early-Career Teachers' Experiences Navigating Pre-service and In-service Activity Systems

Thank you for your interest in participating in this study. Please complete the following survey questions, the answers to which will allow me to learn a bit more about you and both your pre-service and in-service education experiences. Your responses will be used to select 10-12 teacher-participants from a broad range of backgrounds and experiences.

If you are selected as a participant, your identity will remain strictly confidential and any personally identifying information will not appear in any publications or presentations of the study's results. Due to the nature of this study, I am searching for triads of participants (teacher, pre-service program professor, and school administrator), and participation from all three people in the triad is required. (Please note that professors and administrators will not be asked to comment on your work or professional preparation).

You may skip any questions that you do not wish to answer.

Contact Information

Name:

Email:

Phone:

Educational and Professional Background

Years of past teaching experience, not including this year:

Where did you receive your pre-service teacher preparation?

Were you exposed to environmental education (*a process which helps people develop understanding and skills to address both local and global environmental issues*) during your pre-service teacher preparation?

- Yes
- No

If yes, what best describes what you participated in? (Please select all that apply.)

- Guest speaker
- Professional development workshop
- Series of workshops
- Entire class dedicated to environmental education

- Environmental education was woven throughout methods or other foundational class
- Field experience(s)
- Required readings
- Self-selected project focus for course assignment(s)
- Field placement environmental education teaching

Name of professor primarily responsible for providing environmental education in your pre-service preparation:

Professor’s Email address:

Your Place of Employment

School Name:

Location (City, State):

School Type:

- Rural
- Suburban
- Urban
- Other (please specify)

Current Grade(s) Taught:

Science Discipline(s) Taught:

Name of current administrator at your school who knows the most about environmental education programs and efforts (principal, assistant principal, department head)

Administrator’s Job Title:

Administrator's Email Address:

APPENDIX F

CONSENT FORM FOR SELECTED TEACHER PARTICIPANTS

Title of Study: Environmental Education in the Classroom: Selected Early-Career Teachers' Experiences Navigating Pre-service and In-service Activity Systems

Principal Investigator: Sarah Nuss, Ph.D. Candidate

Purpose of the Study: This qualitative study will explore early career teachers' experiences with environmental education, including their pre-service teacher preparation program's influence, if any, and their current school's influence, if any, on their work in environmental education. This is a dissertation research study; the final portion of a Ph.D. program of studies. Results of the study may also be presented at professional conferences and/or published in an academic journal, but participant information will be kept strictly confidential.

Participant Selection Process: You have been identified by a faculty member from your teacher preparation program as an early-career secondary science teacher who may have encountered environmental education in your pre-service teacher preparation program. You are one of approximately 10-12 teachers invited to participate in this study. Each teacher participant will also recommend a faculty member and a current administrator to the study; therefore, there will be 10-12 triads, or 30 – 36 people participating in total.

Duration of Participation: Participation in this study will take approximately 2-5 hours over the course of 2-3 months during the 2022-2023 academic year, on days and times that are convenient for you.

Study Procedures: As a participant in this study, you will be asked to do the following tasks.

    - **Acquire school district permission:** I will ask you to check with your school district to receive any permissions needed to participate in the research study, which I will ask you to do outside of school hours and off of school property.
    - **Generate written memories**: I will ask you to provide a written response (bulleted items, if you prefer) to the following prompt: How did you learn about environmental education, if at all, during your pre-service teacher preparation program?
- **Participate in interviews:** I will ask you to participate in two audio recorded interviews, in person (if geographically possible) or via Zoom or other telecommunication, according to your preference. Each of the interviews will last approximately one to 1.5 hours.
- **Share existing documents:** I will ask you to share any programmatic information related to environmental education that you know about from your school or district, such as state standards, district-wide resources, and/or lesson plans.
- **Review the researcher's interpretations:** Following each interview, I will provide you with a draft of my understanding of the information that you shared. I will request that you confirm, append, and/or change any/all of the summary's contents so that it accurately reflects your thoughts, opinions, perceptions, and experiences. I will also ask

that you similarly review and correct portions of the study's results, which could take place months after completing the second interview.

Additional Information

Please know that:

- The confidentiality of your personally identifying information will be protected to the maximum extent allowable by law.

- Your name and other identifying information will be known only to the researcher through the information that you provide. Neither your name nor any other personally identifying information will be used in any research presentation or publication. Participant, place, school, and program pseudonyms will be used in both the data generated and the reporting of study findings.

- The audio recordings of the interviews described above will be erased after the study is complete.

- You may refuse to answer any questions during the interviews if you so choose. You may also terminate your participation in the study at any time. (To do so, simply inform me, the researcher, of your intention.) Neither of these actions will incur a penalty of any type.

- Your participation in this study is completely voluntary. If you decline to participate, this decision will not endanger your current or future relationship with William & Mary, the Virginia Institute of Marine Science, or your school district.

- A summary of the results of the study will be sent to you electronically once it is complete.

- There is no compensation for participating in the study.

- There are no foreseeable risks in study participation.

Questions or Concerns?

If you have any questions or concerns about this study, please contact the researcher, Sarah Nuss (mcguire@vims.edu or 757-784-7322) and/or her dissertation chairperson, Dr. Judi Harris (jbharr@wm.edu or 757-345-2477). If you have additional questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact, anonymously if you wish, Dr. Tom Ward at 757-221-2358 (EDIRC-L@wm.edu) or Jennifer Stevens at 757-221-3862 (jastev@wm.edu), chairs of the two William & Mary committees that supervise the treatment of study participants.

By checking the "I agree to participate" response below, then signing and dating this form, you will indicate your voluntary agreement to participate in this study and confirm that you are at least 18 years of age. Signed copies that cannot be returned in person should either be scanned and submitted to the researcher via email at mcguire@vims.edu, or you may send an email stating your consent to participate with the consent form attached.

___ I agree to participate.

___ I do not agree to participate.

Please keep a copy of this consent form for your records.

Participant Signature: ________________________________Date: ___________

Researcher Signature: ________________________________Date: ___________

THIS PROJECT WAS FOUND TO COMPLY WITH APPROPRIATE ETHICAL STANDARDS AND WAS EXEMPTED FROM THE NEED FOR FORMAL REVIEW BY THE WILLIAM AND MARY PROTECTION OF HUMAN SUBJECTS COMMITTEE (PHONE) ON [DATE] AND EXPIRES ON [DATE].

APPENDIX G

PARTICIPANT RECRUITMENT MESSAGE TO SCHOOL ADMINISTRATORS

Subject Line: Study on Environmental Education within Pre-service and In-service Education

Dear [Participant Name],

I am a Ph.D. candidate at William & Mary's School of Education, conducting my dissertation study. I am researching early career teachers' perspectives on incorporating environmental education in the classroom. I am specifically interested in their experiences in pre-service teacher preparation and subsequent in-service teaching related to environmental education.

The nature of this study requires teacher participants to identify school administrators who can speak to the environmental education efforts within their school districts. You have been identified by [INSERT TEACHER NAME] as an administrator at their school who might be a helpful source for this information. I am contacting you to see if you may be interested in participating in my study.

Participation in this study will include the following:

- I will ask you to participate in one audio-recorded interview, in person (if geographically possible) or via Zoom or other telecommunication, according to your preference. The interview will last approximately one hour.
- I will ask you to share any programmatic information related to environmental education such as state standards, district-wide resources, or school-specific programs.
- Following the interview, I will ask you to review and correct a written summary of the information that you shared as I understood it, making corrections as needed.

Participation in this study will take approximately 1-2 hours over the course of 2-3 months during the 2022-2023 school year. Participants will be asked to provide consent via a signed consent form and are responsible for abiding by their school's and/or district's policies for participating in this research study. Participants will not be required to answer every question posed during the interview and may terminate their participation in this study at any time by email or by phone to the researcher. All data will be kept confidential, and the identities of the participants will not be released.

I know that as a school administrator, your time is limited, but I hope that you will consider participating in this research. If you are interested and willing to participate, please complete the consent form [INSERT LINK FOR ADMINISTRATOR CONSENT FORM].

Thank you for your time, and please feel free to contact me if you have questions about participating.

Sincerely,
[Researcher's Email Signature]

APPENDIX H

PARTICIPANT RECRUITMENT MESSAGE TO UNIVERSITY FACULTY

Subject Line: Study on Environmental Education within Pre-service and In-service Education

Dear [Participant Name],

I am a Ph.D. candidate at William & Mary's School of Education, conducting my dissertation study. I am researching early career teachers' perspectives on incorporating environmental education in the classroom. I am specifically interested in their experiences in pre-service teacher preparation and subsequent in-service teaching related to environmental education.

The nature of this study requires teacher participants to identify a university faculty who can speak to the environmental education efforts within their pre-service teacher preparation program. You have been identified by [INSERT TEACHER NAME] as a university faculty member who might be a helpful source for my work. I am contacting you to see if you may be interested in participating in my study.

Participation in this study will include the following:

- I will ask you to participate in one audio-recorded interview, in person (if geographically possible) or via Zoom or other telecommunication, according to your preference. The interview will last approximately one hour.
- I will ask you to share any programmatic information related to environmental education such as state standards, university initiatives, and specific lesson plans.
- Following the interview, I will ask you to review a written summary of the information that you shared as I understood it, making corrections as needed.

Participation in this study will take approximately 1-2 hours over the course of 2-3 months during the 2022-2023 school year. Participants will be asked to provide consent via a signed consent form. Participants will not be required to answer every question posed during the interview and may terminate their participation in this study at any time by email or by phone to the researcher. All data will be kept confidential, and the identities of the participants will not be released.

I know that as a university faculty, your time is limited, but I hope that you will consider participating in this research. If you are interested and willing to participate, please complete the consent form [INSERT LINK FOR FACULTY CONSENT FORM].

Thank you for your time, and feel free to contact me with any questions.

Sincerely,
[Researcher's Email Signature]

APPENDIX I

CONSENT FORM FOR SELECTED ADMINISTRATOR PARTICIPANTS

Title of Study: Environmental Education in the Classroom: Selected Early-Career Teachers' Experiences Navigating Pre-service and In-service Activity Systems

Principal Investigator: Sarah Nuss, Ph.D. Candidate

Purpose of the Study: This qualitative study will explore early career teachers' experiences with environmental education, including their pre-service teacher preparation program's influence, if any, and their current school's influence, if any, on their work in environmental education. This is a dissertation research study; the final portion of a Ph.D. program of studies. Results of the study may also be presented at professional conferences and/or published in an academic journal, but participant information will be kept strictly confidential.

Participant Selection Process: You have been identified by a teacher at your school who is interested in participating in this study. Teachers were asked to share the name and contact information of a current administrator. The nature of this study requires perspectives from triads (teacher, faculty, and administrator), and you are one of 10-12 administrators invited to participate in this study. There will be 10-12 triads participating in total.

Duration of Participation: Participation in this study will take approximately 1-2 hours over the course of 2-3 months during the 2022-2023 academic year, on days and times that are convenient for you.

Study Procedures: As a participant in this study, you will be asked to do the following tasks.

- **Acquire school district permission:** I will ask you to check with your school district to receive any permissions needed to participate in the research study, which I will ask you to do outside of school hours and off of school property.
- **Participate in interviews:** I will ask you to participate in one audio recorded interview, in person (if geographically possible) or via Zoom or other telecommunication, according to your preference. The interview will last approximately one hour.
- **Share existing documents:** I will ask you to share any programmatic information related to environmental education that you know about from your school or district, such as state standards, district-wide resources, or school-specific programs.
- **Review the researcher's interpretations:** I will provide you with a draft of my understanding of the information that you shared. I will request that you confirm, append, and/or change any/all of the summary's contents so that it accurately reflects your thoughts, opinions, perceptions, and experiences. I will also ask that you similarly review and correct portions of the study's results, which could take place months after completing the second interview.

Additional Information

Please know that:

- The confidentiality of your personally identifying information will be protected to the maximum extent allowable by law.

- Your name and other identifying information will be known only to the researcher through the information that you provide. Neither your name nor any other personally identifying information will be used in any research presentation or publication. Participant, place, school, and program pseudonyms will be used in both the data generated and the reporting of study findings.

- The audio recordings of the interviews described above will be erased after the study is complete.

- You may refuse to answer any questions during the interviews if you so choose. You may also terminate your participation in the study at any time. (To do so, simply inform me, the researcher, of your intention.) Neither of these actions will incur a penalty of any type.

- Your participation in this study is completely voluntary. If you decline to participate, this decision will not endanger your current or future relationship with William & Mary, or your school district.

- A summary of the results of the study will be sent to you electronically once it is complete.

- There is no compensation for participating in the study.

- There are no foreseeable risks in study participation.

Questions or Concerns?

If you have any questions or concerns about this study, please contact the researcher, Sarah Nuss (mcguire@vims.edu or 757-784-7322) and/or her dissertation chairperson, Dr. Judi Harris (jbharr@wm.edu or 757-345-2477). If you have additional questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact, anonymously if you wish, Dr. Tom Ward at 757-221-2358 (EDIRC-L@wm.edu) or Jennifer Stevens at 757-221-3862 (jastev@wm.edu), chairs of the two William & Mary committees that supervise the treatment of study participants.

By checking the “I agree to participate” response below, then signing and dating this form, you will indicate your voluntary agreement to participate in this study and confirm that you are at least 18 years of age. Signed copies that cannot be returned in person should be scanned and submitted to the researcher via email at mcguire@vims.edu, or you may send an email stating your consent to participate with the consent form attached.

___ I agree to participate.

___ I do not agree to participate.

Please keep a copy of this consent form for your records.

Participant Signature: ________________________________Date: ___________

Researcher Signature: ________________________________Date: ___________

THIS PROJECT WAS FOUND TO COMPLY WITH APPROPRIATE ETHICAL STANDARDS AND WAS EXEMPTED FROM THE NEED FOR FORMAL REVIEW BY THE WILLIAM AND MARY PROTECTION OF HUMAN SUBJECTS COMMITTEE (PHONE) ON [DATE] AND EXPIRES ON [DATE].

APPENDIX J

CONSENT FORM FOR SELECTED FACULTY PARTICIPANTS

Title of Study: Environmental Education in the Classroom: Selected Early-Career Teachers' Experiences Navigating Pre-service and In-service Activity Systems

Principal Investigator: Sarah Nuss, Ph.D. Candidate

Purpose of the Study: This qualitative study will explore early career teachers' experiences with environmental education, including their pre-service teacher preparation program's influence, if any, and their current school's influence, if any, on their work in environmental education. This is a dissertation research study; the final portion of a Ph.D. program of studies. Results of the study may also be presented at professional conferences and/or published in an academic journal, but participant information will be kept strictly confidential.

Participant Selection Process: You have been identified by a secondary science teacher as a faculty member from their teacher preparation program who may have introduced teachers to environmental education. This study aims to find 10-12 triads of participants (teacher, faculty, administrator), and you are one of approximately 10-12 faculty members invited to participate in this study.

Duration of Participation: Participation in this study will take approximately 1-2 hours over the course of 2-3 months during the 2022-2023 academic year, on days and times that are convenient for you.

Study Procedures: As a participant in this study, you will be asked to do the following tasks.

- **Participate in interview:** I will ask you to participate in one audio recorded interview, in person (if geographically possible) or via Zoom or other telecommunication, according to your preference. The interview will last approximately one hour.
- **Share existing documents:** I will ask you to share any programmatic information related to environmental education that you know about from your state or university such as state standards, university initiatives, and/or specific lesson plans.
- **Review the researcher's interpretations:** Following the interview, I will provide you with a draft of my understanding of the information that you shared. I will request that you confirm, append, and/or change any/all of the summary's contents so that it accurately reflects your thoughts, opinions, perceptions, and experiences. I will also ask that you similarly review and correct portions of the study's results, which could take place months after completing the second interview.

Additional Information

Please know that:

- The confidentiality of your personally identifying information will be protected to the maximum extent allowable by law.

- Your name and other identifying information will be known only to the researcher through the information that you provide. Neither your name nor any other personally identifying information will be used in any research presentation or publication. Participant, place, school, and program pseudonyms will be used in both the data generated and in the reporting of study findings.

- The audio recordings of the interviews described above will be erased after the study is complete.

- You may refuse to answer any questions during the interviews if you so choose. You may also terminate your participation in the study at any time. (To do so, simply inform me, the researcher, of your intention.) Neither of these actions will incur a penalty of any type.

- Your participation in this study is completely voluntary. If you decline to participate, this decision will not endanger your current or future relationship with William & Mary.

- A summary of the results of the study will be sent to you electronically once it is complete.

- There is no compensation for participating in the study.

- There are no foreseeable risks in study participation.

Questions or Concerns?

If you have any questions or concerns about this study, please contact the researcher, Sarah Nuss (mcguire@vims.edu or 757-784-7322) and/or her dissertation chairperson, Dr. Judi Harris (jbharr@wm.edu or 757-345-2477). If you have additional questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact, anonymously if you wish, Dr. Tom Ward at 757-221-2358 (EDIRC-L@wm.edu) or Jennifer Stevens at 757-221-3862 (jastev@wm.edu), chairs of the two William & Mary committees that supervise the treatment of study participants.

By checking the "I agree to participate" response below, then signing and dating this form, you will indicate your voluntary agreement to participate in this study and confirm that you are at least 18 years of age. Signed copies that cannot be returned in person should be scanned and submitted to the researcher via email at mcguire@vims.edu, or you may send an email stating your consent to participate with the consent form attached.

___ I agree to participate.

___ I do not agree to participate.

Please keep a copy of this consent form for your records.

Participant Signature: ________________________________Date: ___________

Researcher Signature: _______________________________Date: ___________

THIS PROJECT WAS FOUND TO COMPLY WITH APPROPRIATE ETHICAL STANDARDS AND WAS EXEMPTED FROM THE NEED FOR FORMAL REVIEW BY THE WILLIAM AND MARY PROTECTION OF HUMAN SUBJECTS COMMITTEE (PHONE) ON [DATE] AND EXPIRES ON [DATE].

VITA

Sarah McGuire Nuss

b. July 1982 in Pennsylvania

Education

[2024]	Doctor of Philosophy Curriculum and Learning Design William & Mary, Williamsburg, VA
[2005]	Master of Science Environmental Studies College of Charleston, Charleston, SC
[2003]	Bachelor of Science Biology East Carolina University, Greenville, NC

Professional Experience

[2006-2024]	Education Coordinator Chesapeake Bay National Estuarine Research Reserve, Gloucester Point, VA
[2020-2024]	Adjunct Instructor William & Mary, Williamsburg, VA
[2005-2006]	Education Specialist Chesapeake Bay National Estuarine Research Reserve, Gloucester Point, VA
[2004-2005]	Program Manager COASTeam, Charleston, SC