ENVIRONMENTAL KNOWLEDGE AND
PERSONAL ENVIRONMENTAL EDUCATION TEACHING EFFICACY
OF PRE-SERVICE TEACHERS IN WISCONSIN

By

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ABSTRACT

If we are to create a population of environmentally literate citizens in our future K-12 classrooms, it seems that an emphasis should be placed on pre-service teachers. Environmental knowledge (EK) has been identified as a key component of environmental literacy. Yet the relationship between pre-service teachers’ EK and their confidence teaching EE material, also known as personal environmental education teaching efficacy (PEETE), has yet to be examined. Through criterion sampling and a non-experimental design, pre-service teachers in science methods courses across Wisconsin were studied. A one-time online Qualtrics link was administered to pre-service teachers, by their science methods instructors, during class time within the first eight weeks of the Fall 2018 semester. The Student Survey comprised of 36 total questions. The mean EK score for the pre-service teachers was 8.29 out of 12 ($n = 241$, $SD = 2.30$). In fact, only 49.0% of participants passed the basic EK exam (9 or more correct). At the surface, it appears that pre-service teachers have relatively low levels of EK. This may hinder the incorporation of EE material into their future classrooms due to avoidance behavior with information they are uncomfortable with as laid out by Bandura, 1977. Furthermore, results indicated a moderate, positive correlation between EK and PEETE, $r(238) = .311$, $p < .001$. In other words, high levels of EK were associated with higher levels of PEETE. Additional analyses included measuring differences in EK and PEETE between pre-service teachers seeking to teach different age levels, childhood environments, and the number of positive childhood environmental activities that influenced their outlook on the environment as a child. Ultimately, the study suggests the need for further EE principles, methods, and objectives in Wisconsin Teacher Preparation Programs (TPPs) to better prepare pre-service teachers to instruct their future students about environmental issues we are currently facing on a local and global level.
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CHAPTER 1:  
INTRODUCTION

The environmental problems of the world today are largely a consequence of the lifestyle and development of modern human society that endanger human health and wellbeing, degrade environmental stability, and threaten to destroy the environment on which modern society's existence depends. A main challenge for our society is to find a balanced relationship between human and natural environments. Education is a crucial agent for finding this balance and moving towards an environmentally literate society—a society motivated and equipped to influence decision making regarding the environment. The overarching goal of environmental education (EE) is to develop an environmentally literate population, full of environmentally literate citizens. An environmentally literate citizen is “someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life” (Hollweg et al., 2011, p. 2-3). Through the years, this goal has led to an increased emphasis on the inclusion of EE in formal education systems and, consequently, an increased need for teachers who can effectively incorporate EE into their classrooms.

One strategy to increase opportunities for more effective EE instruction, and to move toward an environmentally literate population, is to include EE curriculum in teacher preparation programs (TPPs). TPPs are educational programs at colleges or universities, that are state approved, for teachers before they enter into service as a teacher. TPPs are where pre-service teachers, students participating in a professional TPP, have the opportunity to become prepared on how to communicate and facilitate conversations about environmental topics with classroom aged students, who happen to be future citizens (Figure 1). These discussions can then be incorporated
into their future classrooms. If K-12 students are educated about environmental topics, then they may be more likely to make informed decisions about the environment, which may move the population one step closer to an environmentally literate citizenry.

Figure 1

_Avenue to Achieve Environmentally Literate Population_

Wisconsin is one of four states in the U.S. to have standards or licensure requirements related to EE in TPPs (Simmons, 2014). Wisconsin’s Department of Public Instruction (WDPI), the agency that advances public education in the state, requires that all pre-service teachers in TPPs must “demonstrate knowledge and understanding of environmental education including the conservation of natural resources for licenses in early childhood regular education, elementary and middle school regular education, science, and social studies” before entering the workforce (WDPI, 34.022(2), 2018). This requirement is a part of WDPI’s Administrative Code for educator licenses and program support. In short, it is known as WDPI 34.

Both in Wisconsin, and across the globe, the overarching goal of EE is an environmentally literate citizenry. An individual’s literacy represents a continuum rather than a simple classification scheme. In the course of a lifetime, an individual will learn about the environment from a combination of sources including school, books, newspapers or magazines, jobs, friends or family members, and the media (Coyle, 2005; Lane, Wilke, Champeau, & Sivek, 1995). However, educational systems are considered one of the best learning places for promoting environmental
literacy. What students learn in their formative years, such as in elementary school, can shape the citizens they will become later on. Schools provide a foundation where young people acquire the critical thinking and problem-solving skills they will need to be successful in this changing world. Classroom teachers play an important role in the development of students. One of the most essential roles that teachers play in the classroom is to inform their students. This may include concepts such as math, English, science or even knowledge about the environment, further known as EK.

EK is a key component within environmental literacy. EK is the knowledge that must be drawn on to respond competently to an environmental situation or issue (Hollweg et al., 2011). Although EK may not be solely sufficient for an individual to be environmentally literate, strong EK is a critical stepping stone in promoting environmentally responsible behavior in an individual or population, including K-12 students. Environmentally responsible behavior is when an individual or group aims to do what is right to help protect the environment in general daily practice (Mobley, Vagias, & DeWard, 2010). In regard to teachers, Tuncer et al. (2009) argued that teachers will produce students who are environmentally literate when they themselves are environmentally knowledgeable. In order for classroom teachers to be knowledgeable about environmental topics, they must first be educated about these topics. However, confidence in their abilities may also play a role, in addition to increasing their EK.

In order for classroom teachers to instruct their students about EE concepts they must have confidence in their abilities to complete such a task, also known as personal environmental education teaching efficacy (PEETE). PEETE is generally defined as a teacher’s belief in his or her ability to positively influence student achievement regarding EE practices. In other words, if we are to educate pre-service teachers about environmental topics, then an emphasis may also need
to be placed on increasing their PEETE. One such avenue for increasing pre-service teachers’ EK and PEETE may be through coursework at TPPs before they enter the workforce.

**Purpose of Study**

The purpose of this study was to better understand pre-service teachers’ EK, a component of environmental literacy, and their confidence teaching EE materials, PEETE. The study explored the state of EE in TPPs, seeking to determine the relationship between EK and PEETE, and the goals and effects of EE. Specifically, the study sought to better understand potential avenues to increase the number of pre-service teachers who are motivated and equipped to influence opportunities for making informed decisions about the environment in their future classrooms.

**Problem Statement**

The current research was inspired by a national survey that reported, “only one-third of American adults [passed] a simple test of EK with a grade equivalent to A, B, or C” (Coyle, 2005, p. 3). Furthermore, another study revealed that pre-service teachers in the College of Education at Michigan State University had particularly low levels of EK (Kaplowitz & Levine, 2005). In other words, not only does our U.S. adult population lack basic EK, but also potentially our future teachers. This is troubling because if our pre-service teachers are unfamiliar with or lack confidence in teaching environmental content knowledge, then they may be unlikely to teach this information in a future classroom setting (Lane, Wilke, Champeau, & Sivek, 1994). Consequently, the next generation of K-12 students may also have a limited outlook on the environment in the future. Thus, if we are to create a population of environmentally literate citizens in our future Wisconsin K-12 classrooms, then an emphasis should be placed on pre-service teachers’ in Wisconsin TPPs to better understand the direction of environmental literacy in the state.
Theoretical Framework

Although the relationship between knowledge and its ability to change one’s behavior is complex and not necessarily linear, researchers have shown that increasing an individual’s EK results in more positive attitudes toward the environment (Bradley, Waliczek, & Zajicek, 1999; McMillan, Wright, & Beazley, 2004) and, ultimately, more responsible environmental behavior (Hsu, 2004). This relates to Bandura’s (1977, 1997) self-efficacy theory, a theory of behavior change. There are two critical components of self-efficacy. First, the belief in one’s ability to successfully perform a specific behavior, known as efficacy expectation. Secondly, the belief that the performance of the specific behavior will have a desirable outcome, known as outcome expectancy. The self-efficacy theory of behavior change can be related to teachers as well.

Teaching efficacy, an extension of self-efficacy, is the extent to which teachers believe they can control or at least strongly influence student achievement and motivation (Armor et al., 1976). It consists of two independent constructs: Personal Teaching Efficacy (PTE) and Outcome Expectancy (OE). PTE provides insight into whether or not teachers believe they have the ability, and therefore confidence, to perform the required task at the desired level of competency. Whereas, OE provides insight into whether or not teachers believe they have accomplished a task at a desired level (Tschannen-Moran, Hoy, & Hoy, 1998). In other words, although a teacher may expect a certain activity to lead to a particular outcome, they may lack the motivation or confidence to modify their behavior to perform the action. Furthermore, PTE and OE were found to be independent constructs and content specific (Tschannen-Moran et al., 1998). Moseley, Utley, Angle and Mwavita (2016) modified PTE and OE to personal environmental education teaching efficacy (PEETE) and environmental education outcome expectancy (EEOE) in order to incorporate EE principles. The current study focused on PEETE since it specifically relates to pre-
service teacher behavior in regard to their ability and confidence to incorporate EE materials into their future classrooms (Figure 2).

Figure 2

*Diagrammatic Representation of the Difference Between PEETE and EEOE*

![Diagram](image)


In addition to addressing PTE, as well as OE, “the concept of self-efficacy is assigned a central role for analyzing changes achieved in fearful and avoidant behavior” (Bandura, 1977, p. 193). In the realm of EE, if a pre-service teacher can draw on their knowledge to respond competently to an environmental situation (high levels of EK) and feel confident in their ability to teach EE topics (high levels of PEETE), then they may be more likely to include EE in their future classroom. The inclusion of EE into K-12 curriculum is key because it will hopefully increase students’ EK, competencies, dispositions and behaviors further moving the population towards an environmentally literate citizenry that seeks to create a balanced relationship between human and natural environments. However, the opposite may be true. If a pre-service teacher has a low level of EK and a low level of PEETE, then this could result in a fearful or avoidant behavior in which EE topics are not included in their future classrooms. Ultimately, this would decrease our chances of moving towards an environmentally literate population. The foundation of this study assumes that EK and PEETE are internally consistent. This assumption is described further in Chapter 2.
and is presented in Figure 3. Of course, there is a chance for varying levels of EK and PEETE in pre-service teachers (e.g. low EK and high PEETE). Additionally, there may be other factors that influence a teacher’s willingness to include EE into their classrooms. However, both of these ideas extend beyond the scope of this study.

Figure 3

**Foundation of Current Study**

![Diagram showing high and low levels of EK and PEETE](image)

**Research Design and Data Analysis**

This study used a quantitative, non-experimental design to assess pre-service teachers’ individual EK and its relationship to their PEETE. Specifically, it was designed as an exploratory study purposed for initial findings on this topic and as a foundation for future research. Within this context, criterion sampling was employed to obtain participants based on their enrollment in a class. This impacted the ability for broad generalizations from the results of data collection and analysis.
Data were collected using two research instruments: a Student Survey, measuring pre-service teachers’ EK and PEETE, and an Instructor Survey, which provided additional information about how EE was incorporated into pre-service teacher coursework at their TPP. Both surveys were administered using a one-time online survey through the survey platform Qualtrics. The online Student Survey was administered by science methods instructors to pre-service teachers enrolled in their science methods course within the first eight weeks of the semester. The data were analyzed using Pearson product-moment correlation coefficient, one-way ANOVA, binary logistic regression, and independent samples t-tests statistical testing in SPSS. As for the Instructor Survey, instructor responses provided insight into their TPP, but no statistical testing was completed. For further discussion of methods used in this study, please see Chapter 3.

**Instrumentation**

This study implemented two survey instruments. The Student Survey provided 36 statements split into three parts: EK, PEETE and demographic questions (see Appendix A). The EK questions were developed by the National Environmental Education and Training Foundation (NEETF) in 1997 and included multiple choice options about basic environmental topics. These EK questions have been used in multiple state, national, and international studies (NEETF, 1997, 2001; Robelia & Murphy, 2012; Tuncer et al., 2009). Also, the researcher and her committee reviewed them to ensure they were current and relevant. Therefore, the EK questions were considered reliable and valid. EK scores were calculated for each pre-service teacher by compiling the total number of EK questions answered correctly (minimum 0, maximum 12). Additionally, pre-service teachers with nine or more points were considered to have passed the EK exam.

The 13 PEETE questions were developed by Moseley et al. (2016) in the EE Teaching Efficacy Belief Instrument (EETEBI). Moseley et al. (2016) found the PEETE questions to be reliable and valid. Each question included a six-point Likert scale response related to instructional
strategies used in teaching about the environment and environmental concepts. As for PEETE scores, a numerical value was given to each of the six-Likert scale responses for the 13 questions: Strongly Disagree (1), Disagree (2), Somewhat Disagree (3), Somewhat Agree (4), Agree (5), and Strongly Agree (6). Certain PEETE questions included reverse scoring because they were negatively worded. Then, the total PEETE score per pre-service teacher was calculated (minimum 13, maximum 78).

Lastly, the researcher drew from several previous surveys to develop the demographic questions found on the Student Survey (Moseley et al., 2016; O’Brien, 2007; WCEE, 1997). Additionally, a couple of demographic questions were created by the researcher and her graduate committee. Response types varied between demographic questions, but included options such as multiple choice, six-point Likert scale responses, and short answers.

As for the Instructor Survey, science methods course instructors were asked four questions to better understand how EE was incorporated at their TPP (see Appendix B). These questions were created by the researcher and her committee. Both the Student Survey and Instructor Survey were checked for validity and reliability during a pilot study (see Appendix C).

**Research Questions**

This study sought to respond to four primary research questions that form the basis of an assessment of the EK and PEETE of pre-service teachers across Wisconsin’s TPPs. The research questions focused on the relationships between pre-service teachers’ EK, PEETE, and the total number of positive childhood environmental activities. Additional emphasis was placed on differences in EK and PEETE between pre-service teachers seeking to teach different school-aged students such as early childhood, elementary, secondary, all ages (licensing level for music, art, and foreign languages) or both early childhood and elementary, further known as different age levels. The study further investigated the influence that certain childhood experiences had on pre-
service teachers’ EK and PEETE, including childhood environment (the environment in which pre-service teachers grew up as a child) and the number of positive childhood environmental activities (childhood activities that positively influenced a pre-service teacher’s outlook on the environment as a child). Lastly, of the six factors measured (different age levels, childhood environment, gender, institution type, PEETE scores, and the total number of positive childhood environmental activities), emphasis was placed on which were the most important in explaining whether pre-service teachers passed the EK exam. All of this information allowed for a better understanding of pre-service teachers EK and PEETE, while assessing the prevalence, and need, for EE in TPPs. The research questions of this study were:

1. What are the relationships between pre-service teachers' EK, PEETE, and number of positive childhood environmental activities?
2. Do pre-service teachers seeking to teach different age levels show significant differences in EK and PEETE? If so, then how?
3. Do pre-service teachers from different childhood environments show significant differences in EK and PEETE? If so, then how?
4. Of the factors that were measured, what factors are most important in explaining whether pre-service teachers passed the EK exam?

**Population**

Participants for this study were derived from the population of pre-service teachers enrolled in science methods courses across Wisconsin’s 33 TPPs. A science methods course is specifically designed for pre-service teachers and focuses on science pedagogy and science content. Science methods instructors served as the primary contact in which the online Student Survey was distributed to students; however, instructors were also asked to complete the
Instructor Survey. First, an initial contact gathering email was sent to science methods instructors across Wisconsin’s TPPs using a preliminary database (see Appendix D). Then, the final sample population of science methods instructors, and indirectly their science methods students, were acquired from three rounds of inquiry e-mails (see Appendix E).

Assumptions

The assumptions of this study provided the foundation for which to base observations and analysis. Throughout the research and analysis process, these assumptions were considered as influential to the design, assessment, results, and conclusion of this study. The following assumptions were considered:

1. Participants completed the Student Survey and Instructor Survey honestly and to the best of their ability.
2. Pre-service teachers were in a supervised setting when completing the Student Survey.
3. The varied timing of the Student Survey distribution by course instructors did not affect pre-service teacher responses.

Limitations

The following limitations were imposed upon this study due to external, and primarily uncontrollable, factors. The limitations were as follows:

1. Not all Wisconsin TPPs offered a science methods course during the Fall semester limiting participation by some institutions.
2. The possibility of inaccurate responses on both surveys due to self-reporting.
3. The possibility that students used outside sources, such as smart devices, to look up answers to the EK questions in a potentially unsupervised setting.
4. The possibility of variability in teaching experiences outside of TPP coursework among pre-service teachers.

5. A limited sample size that restricted the ability to generalize results.

**Delimitations**

The following delimitations were restrictions consciously placed on the study. These decisions were made to enhance the capacity of the study by intensifying the focus. The delimitations for this study were as follows:

1. The participants from the study were derived from a population consisting of pre-service teachers and course instructors from science methods courses across Wisconsin’s TPPs.

2. Although EE practices are often incorporated into science methods courses, changes in pre-service teachers’ EK and PEETE based on course content were not measured or analyzed.

3. Data were collected within the first eight weeks of a single semester to ensure access to pre-service teachers as some TPPs include off-campus field experiences during the second half of the semester.

**Definition of Terms and Abbreviations**

The following terms are significant within this study. They are defined below:

- **Different Age Levels**: Pre-service teachers in the study were able to select which school-age students they planned to work with once they graduated from their TPP.

- **Environmental Education (EE)**: The Tbilisi Declaration states that “EE is a learning process that increases people’s knowledge, awareness about the environment and associated challenges, develops the necessary skills and expertise to address challenges,
and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action” (UNESCO, 1978, p.2).

- **Environmental Education Outcome Expectancy (EEOE):** One of two independent constructs found within EE teaching efficacy (Moseley et al., 2016). It is a modified version of Bandura’s (1977, 1997) outcome expectancy (OE) to include EE. It is generally defined as a teacher’s belief that EE can work for all students, regardless of outside influences such as socio-economic status and parental influence.

- **Environmental Education Teaching Efficacy Belief Instrument (EETEBI):** The most current tool used to measure EE teaching efficacy (Moseley et al., 2016).

- **Environmental Knowledge (EK):** Is one of the four components of environmental literacy. It is the knowledge that must be drawn on to respond competently to an environmental situation or issue (Hollweg et al., 2011).

- **Environmental Literacy:** “Is knowledge of environmental concepts and issues; the attitudinal dispositions, motivation, cognitive abilities, and skills, and the confidence and appropriate behaviors to apply such knowledge in order to make effective decisions in a range of environmental contexts. Individuals demonstrating degrees of environmental literacy are willing to act on goals that improve the well-being of other individuals, societies, and the global environment, and are able to participate in civic life” (Hollweg et al., 2011, p. 5-15).

- **Personal Environmental Education Teaching Efficacy (PEETE):** One of two independent constructs found within EE teaching efficacy (Moseley et al., 2016). It is a modified version of Bandura’s (1977, 1997) efficacy expectation to include EE. It is generally defined as a teacher’s belief in his or her ability to positively influence student achievement regarding EE concepts.
• **Positive Childhood Environmental Activities:** Pre-service teachers in the study were able to select childhood activities that positively influenced their outlook on the environment as a child.

• **Self-Efficacy:** A theory of behavior change in which “the belief in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3). Bandura (1977, 1997) proposed that self-efficacy could result from four potential sources: mastery experiences, vicarious experiences, verbal persuasion, and physiological and emotional state.

  1. **Mastery Experiences:** Refers to actual performance, based on personally experienced successes and failures.

  2. **Vicarious experiences:** Refers to experiences in which observations of another person are made who happen to be modelling the specific task.

  3. **Verbal Persuasion:** Includes feedback that could encourage an individual to make a greater effort to succeed.

  4. **Physiological and Emotional State:** Includes the physiological and emotional state experienced by a person.

• **Self-Assessed Knowledge:** Pre-service teachers in the study were asked to assess their knowledge of environmental issues compared to their peers.

• **Student Status:** Pre-service teachers in the study were asked to identify their year in school.

• **Teaching Efficacy:** Teaching efficacy, an extension of self-efficacy, is the extent to which teachers believe they can control or at least strongly influence student achievement and motivation (Armor et al., 1976). It consists of two independent constructs: Personal Teaching Efficacy (PTE) and Outcome Expectancy (OE). PTE provides insight into
whether or not teachers believe they have the ability, and therefore confidence, to perform the required task at the desired level of competency. Whereas, OE provides insight into whether or not teachers believe they have accomplished a task at a desired level (Tschannen-Moran et al., 1998).

- **Teacher Preparation Programs (TPPs):** Educational programs at colleges or universities, that are state approved, for teachers before they enter into service as a teacher.

**Study Objectives**

Beyond the purpose of this study and the process to resolve the research questions posed, this study maintained several more far-reaching objectives. These objectives guided the development and process of this study. They have been considered in the presentation of research conclusions. The objectives of this study were:

1. Assess the EK and PEETE of upper level pre-service teachers.
2. Promote the importance of EE, and its research, in TPPs to increase the number of environmentally literate pre-service teachers, and indirectly their future students.
3. Analyze the possibilities of diversifying and expanding the scope and practice of EE in TPPs.

**Importance of Study**

This study carries a profound significance in both specific and broad manners. The initial importance of this study is to create a baseline EK and PEETE dataset of pre-service teachers across Wisconsin’s TPPs. This study represents one of the initial attempts at the exploration and assessment of pre-service teachers’ EK and PEETE. Past research has neglected to explore the potential connection between these two factors, particularly in the context of pre-service teachers. On a larger scale, the implications for linking pre-service teachers’ EK to their confidence teaching
EE in their future classrooms would be insurmountable in moving toward a world full of environmentally literate citizens.

**Summary**

This chapter has introduced the topic and purpose of this study. Through this outline, the research design and questions, objectives, and importance have manifested themselves with the significant context this study responds to. The next chapter will provide a review of relevant literature to further ground the theoretical and practical frameworks with which this study was founded. Chapter 3 presents the methods employed in the research design, before Chapter 4 offers the results of the study. Finally, Chapter 5 offers conclusions and implications about the information learned from this study, ultimately tying it back to the context presented in Chapters 1 and 2.
CHAPTER 2:
LITERATURE REVIEW

This chapter will explore the relevant literature associated with this study. A review of the literature helped to determine the context, framework, methods, and objectives for this research. Previous research aided in understanding and analyzing the outcomes of this study. This chapter will look at four main areas of literature: EE, EK as a component of environmental literacy, EE teaching efficacy, and the integration of EE into Wisconsin TPPs. Together these strands compose the interests and extensions of this study. Four main points serve as the primary arguments for this chapter:

1. EE has traditionally prioritized the development of environmental literacy, including EK as a component, and ultimately its expression as environmentally responsible behavior.

2. Pre-service teachers are vital in developing the next generation of environmentally literate citizens; however, they themselves may lack the skills and knowledge necessary to accomplish this.

3. For pre-service teachers to include EE content in their future classrooms they need to have a high level of EK and PEETE.

4. To increase pre-service teachers EK and PEETE, they need to be exposed to a greater number of opportunities in which they can learn how to incorporate EE practices into their future classrooms.
Environmental Education

Origins of environmental education.

EE in the United States has been defined and described in several distinct ways since its emergence in the 1960s. The modern origins of EE outline a philosophy focused on the transformation of learners for the sake of the environment. The catalysts (Stapp et al., 1969; UNESCO-UNEP, 1976; UNESCO, 1978) envisioned EE generating individual change in the learner. Individual change would then be expanded to a collective change in society and the environment. William Stapp, considered to be the founder of EE, and his graduate students at the University of Michigan provided one of the first and most noteworthy definitions of EE in the United States (Stapp et al., 1969). It called for action-oriented EE, particularly the ability of individuals to make environmental decisions and act in an environmentally responsible manner. This goal later became known as an environmentally literate citizen. Eventually, two other types of definitional statements emerged from the Belgrade Charter (1976) and the Tbilisi Declaration (1978).

The Belgrade Charter (1976) advanced Stapp et al.’s (1969) ideas of an action-oriented EE by setting goals and objectives. The objectives of the Belgrade Charter (knowledge, skills, attitudes, motivations, and commitments) provided not only an outstanding goal for EE, but also a map for how to get there. These parts were interconnected so that only when they naturally progressed from one to the next could the ultimate goal of environmental change be achieved.

The second definitional EE statement emerged during the world’s first intergovernmental conference on EE in Tbilisi, Georgia in 1977. The conference was organized by the United Nations Education, Scientific, and Cultural Organization (UNESCO) and endorsed new goals, objectives and guiding principles for EE at the national, regional, and global level. The Tbilisi Declaration states that “EE is a learning process that increases people’s knowledge, awareness about the
environment and associated challenges, develops the necessary skills and expertise to address challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action” (UNESCO, 1978, p.2). In addition, the Tbilisi Declaration’s goals, objectives, and guiding principles provided the fundamental principles for proposals and recommendations for subsequent international gatherings.

Similar to the Belgrade Charter, the goals from the Tbilisi Declaration (1978) progress from basic awareness and knowledge, to motivations and skills that ultimately result in a desired behavior for environmental change. Furthermore, it stated that EE should be a continuous lifelong process, beginning at the preschool level and continuing through all formal and non-formal education systems (UNESCO, 1978). Formal education refers to learning that happens in a classroom. Non-formal education includes learning that happens outside the classroom such as in after-school programs, community-based organizations, museums, libraries or at home.

The philosophy presented by these founding documents have remained vitally significant in the development of EE to the present day. These tenets are crucial in understanding where the research in EE has been and where it is now. The assumptions that were made by these early ideas have proved to be influential in forming ideas for the future. Together, the conceptual outlines provided by Stapp et al. (1969), the Belgrade Charter (1976), and the Tbilisi Declaration (1978) not only defined the goals of EE, but also the methods and processes to become an environmentally literate citizen.

Environmental literacy.

Stapp et al.’s (1969) initial descriptions of environmentally literate citizens, and the outline presented in both the Belgrade Charter (1976) and Tbilisi Declaration (1978), have had major ramifications for modern EE. Although the term environmental literacy has been used as a paramount goal of EE, there is little consensus among educators about the definition of the term.
Since 1990, a number of environmental literacy frameworks have been published, each of which has reflected the Tbilisi Declaration’s (1978) objectives by addressing knowledge (awareness and knowledge), cognitive skill (skills), affective disposition (attitudes), and behavior (participation) (e.g., Hungerford & Volk, 1990; Roth, 1992; Simmons, 1995; Wilke, 1995). The authors of these frameworks have attempted to provide coherent direction to environmental literacy by synthesizing and including definitional features, national and state program frameworks, and findings from reviews of research.

One of those frameworks challenged colleges and universities to increase their role in developing an environmentally literate citizenry through the creation of a general education requirement regarding environmental literacy (Wilke, 1995). Wilke acknowledged that the vast majority of students will not pursue environmental programs or majors but will gain their understanding of environmental issues and problems from their general education and elective courses at the university level (Wilke, 1995). Since Wilke’s call to action at the university level in 1995, multiple studies have been conducted to further study environmental literacy. For example, guided reviews of research (e.g., Volk & McBeth, 1998), development of assessment instruments (e.g., King & Franzen, 2017; Wilke, 1995), and several different national assessments of environmental literacy (e.g., Erdogan, 2009; McBeth, Marcinkowski, Volk, & Meyers, 2008; Negev, Sagy, Garb, Salzberg, & Tal, 2008; Shin et al., 2005) have been implemented. The most current environmental literacy framework is that of Hollweg et al. (2011), and therefore will be used for the current study.

Following previous studies, Hollweg et al. (2011) reported that an individual’s literacy represents a continuum of literacy over time. Individuals present degrees of literacy – they are not either environmentally literate or illiterate (Harvey, 1977; Roth, 1992). For the current study, environmental literacy is defined as:
The knowledge of environmental concepts and issues; the attitudinal dispositions, motivation, cognitive abilities, and skills, and the confidence and appropriate behaviors to apply such knowledge in order to make effective decisions in a range of environmental contexts. Individuals demonstrating degrees of environmental literacy are willing to act on goals that improve the well-being of other individuals, societies, and the global environment, and are able to participate in civic life. (Hollweg et al., 2011, p. 5-15)

Within this definition there are four key components of environmental literacy: knowledge, competencies, dispositions, and behavior. *Environmental knowledge* is the knowledge that must be drawn on to respond competently to an environmental situation or issue. *Environmental competencies* are clusters of skills and abilities that may be called upon and expressed in real-world, and assessment, settings to respond competently to an environmental situation or issue. *Environmental dispositions* are affective and cognitive inclinations to do or not to do something about an environmental situation or issue. Lastly, the ultimate goal of environmental literacy is behavior change. *Environmental behavior* is the expression of knowledge, dispositions, and competencies within a context.

**Role of classroom teachers in promoting environmental literacy.**

Environmental topics should be discussed at every level of formal education in order to help move our population towards an environmentally literate one. While research concerning environmental literacy has involved many different study subjects, one of the most frequently sampled groups includes teachers (e.g., Adey, 2006; Appleton & Kindt, 2002; Cutter & Smith, 2001). This is not surprising since teachers are one of the most influential components in educating children and teenagers to be leaders of tomorrow in protecting the environment.

As earlier mentioned, the goal of EE from the Belgrade Charter (1976) has led to an increased emphasis on the inclusion of EE in formal education and, consequently, an increased
need for effective EE teachers (McDonald & Dominguez, 2010; Moseley, Desjean-Perrotta, & Crim, 2014). It is of utmost importance that K-12 students benefit from the innovations and the learning outcomes advocated by their teachers through the inclusion of EE in the classroom. These learning outcomes must address basic environmental knowledge concepts.

Despite the research that shows that EE can provide positive student outcomes in academic achievement, critical thinking, motivation, and engagement (Culen & Volk, 2000; Lieberman & Hoody, 1998; Orr, 1992; Palmer, 1998; Volk & Cheak, 2003), pre-service teachers are rarely exposed to EE as part of their TPPs (Heimlich, Braus, Olivolo, McKeown-Ice, & Barringer-Smith, 2004; McKeown-Ice, 2000). This is problematic because an emphasis on the inclusion of EE curricula and teaching strategies in TPPs is essential (Cutter-Mackenzie & Smith, 2003; McKeown-Ice, 2000; Tuncer et al., 2009). This has led some states to create standards or licensure requirements related to EE in TPPs. Wisconsin is one of four states (others include Pennsylvania, Kentucky, and Washington) to have standards or licensure requirements related to EE in TPPs (Simmons, 2014). In fact, Wisconsin just recently revised its environmental literacy standards (WDPI, 2018).

Current limitations for environmental education’s integration into classrooms.

Many teachers believe EE should be integrated into K-12 formal curricula; however, several studies have reported that teachers do not feel competent in their knowledge or skills to teach EE effectively due to lack of training (Elder, 2003; Ernst, 2009; Plevyak, Bendixen-Noe, Henderson, Roth, & Wilke, 2001; Smith-Sebasto & Smith, 1997). Previous studies have identified factors (e.g., lack of time and lack of EE background) that may discourage teachers from teaching about the environment (Ham & Sewing, 1987; Lane et al., 1994; Pettus & Schwaab, 1979; Simmons, 1989; Towler, 1980). Effective EE instruction requires teachers to have the knowledge
and skill base to teach EE (Ernst, 2009). However, teachers may not be able to offer relatable teaching activities due to their unfamiliarity with environmental content knowledge.

**Environmental Knowledge: A Key Component of Environmental Literacy**

*Environmental knowledge.*

Although EK may not be solely sufficient for an individual to be environmentally literate, research suggests that EK is a key component of environmental literacy (Bamberg & Möser, 2007; Heimlich & Ardoin, 2008; Kollmus & Agyeman, 2002; UNESCO, 1978). It involves the knowledge and understanding of a wide range of environmental concepts, problems, and issues. Neither young people nor adults can be expected to have a full range of scientific knowledge in which they understand all of the complexities of the natural and built environment, along with its associated environmental problems and issues. However, fundamental knowledge and understanding of such problems and issues as population growth, use of natural resources, land use, loss of biodiversity, and ecosystem deterioration at local, regional, and global levels are needed to be environmentally literate (Hollweg et al., 2011).

While the relationship between knowledge, competencies, dispositions and behavior is complex and not necessarily linear, research has shown that increasing an individual’s EK results in more positive attitudes toward the environment (Bradley et al., 1999; McMillan et al., 2004) and more responsible environmental behavior (Hsu, 2004). It was found that a higher level of EK correlated significantly with a higher degree of reported pro-environmental behavior in American adults (NEETF, 2001). This is important because an essential part of environmental literacy is the ability of individuals and groups to apply knowledge and understanding in situations involving environmental issues. Then, to use this knowledge of the issue to generate the appropriate behavioral response.
In the course of a lifetime, an individual will accumulate EK from a combination of sources including school, books, newspapers or magazines, jobs, friends or family members, or television programs (Coyle, 2005; Lane et al., 1995). Additionally, childhood involvement with the natural environment may set an individual on the path toward adult environmentalism (Wells & Lekies, 2006). Earlier research by Goldman, Yavetz, and Peer (2006) suggested that childhood home environment, such as rural or urban areas, was significant in influencing Israeli pre-service teachers’ environmental behavior. For example, Israeli pre-service teachers who grew up in rural areas had significantly higher scores for citizen action, nature related leisure activities, and environmental activism than those that grew up in urban areas (Goldman et al., 2006).

However, there is a growing body of research suggesting that there is a disconnect between children and their environment (Charles & Louv, 2009). This disconnect stems from the fact that the U.S., and other countries, have lost much of its rural areas. In fact, humans are becoming increasingly more of an urban species (Charles & Louv, 2009). Opportunities for children to play outside, such as recess in school or just time for unstructured outdoor play, have been reduced or eliminated in certain school districts in an effort to provide more instructional time and increase student achievement (Fedewa & Ahn, 2011; Jarrett & Waite-Stupiansky, 2009). This is concerning because the knowledge children gain from being outside is foundational to literacy and science learning (Dewey, 1938/1963).

Additional research has indicated a connection between childhood play and adult environmental behaviors in urban settings. For example, a study conducted in Tokyo indicated that the frequency of childhood play in green spaces was correlated strongly with the frequency of nature-based activities among adult urban residents (Hosaka, Numata, & Sugimoto, 2018). However, the study focused on the relationship between childhood play and adult behavior, not their EK. Therefore, the relationship between pre-service teachers’ EK and childhood play in green
spaces, also known as positive childhood environmental activities, will be further studied to address this gap in literature. In order to study this relationship, an effective EK measuring instrument is need.

**Measuring environmental knowledge.**

In 1997, NEETF crafted 12 questions to measure the EK of American adults, ages 18 and older. The NEETF survey tool examined basic environmental issue questions – for example, how energy is produced, where trash ends up, and the chief source of water and air pollution. Question subjects were selected based on the likelihood of the public having heard about the information through the media, reflecting a basic EK profile. More than 50 questions were tested in focus groups to screen out confusion and bias before the 12 questions were finalized. The goal was to aim the questions at the average intelligent adult and to avoid using an insider's familiarity with the subject matter (Coyle, 2005). From 1997 to 2002, NEETF conducted national surveys in the U.S. to measure different components of environmental literacy resulting in annual National Environmental Report Cards. These annual report cards included a total number of correct responses for each American adult which then translated to a letter grade (A, B, C, D or F). Furthermore, EK scores greater than 70% (nine or more questions correct) were considered passing or acceptable levels of EK (Coyle, 2005).

The NEETF survey tool was not only utilized in both the 1997 and 2001 Environmental Report Cards, but also on the university, state, national and even international level. For example, Kaplowitz and Levine (2005) measured the level of EK of students at Michigan State University using the EK survey. Additionally, Robelia and Murphy (2012) compiled data from 15 publicized state and national environmental surveys, including data from Kentucky, Louisiana, Nebraska, Pennsylvania, and Minnesota, that all utilized the NEETF survey tool in some capacity. State surveys used NEETF questions, but sometimes changed the wording or added their own questions.
to reflect local topics. Of special note, NEETF did not coordinate the state surveys, nor did the state surveys coordinate with other states. Lastly, Tuncer et al. (2009) measured the level of EK of pre-service teachers in Turkey using the EK survey, but slightly modified it to better suit environmental issues in Turkey. Since the NEETF survey tool has been utilized at the university, state, national and international level, it was utilized in the current study to measure Wisconsin’s pre-service teachers’ EK.

**Environmental knowledge national survey results.**

The following sections highlight key results from the national survey that played a crucial role in the development of the current study’s sub-research questions: overall results, gender differences, self-assessed knowledge of environmental issues, age, and the role of media on environmental myths.

**Overall results.**

The overall results from the 1997 and 2001 Environmental Report Cards were nearly identical. Only one-third of American adults passed a simple test of EK (NEETF, 1997, 2001). Although this lack of detailed knowledge parallels other school-taught subjects, such as the physical or life sciences, it is particularly concerning because EE has such strong implications for action in the real world (Coyle, 2005).

**Gender.**

Furthermore, both national surveys indicated a gender gap in EK scores in which males scored higher than females (NEETF, 1997, 2001). Additionally, a larger percentage of males passed the EK exam than females (NEETF, 1997, 2001). This EK gender gap also aligns with the 15 other publicized state and national environmental surveys identified by Robelia & Murphy (2012). These results signal a special challenge for those working to increase environmental literacy nationwide.
**Self-assessed knowledge of environmental issues.**

Additionally, American adults were asked to self-assess their knowledge of environmental issues in order to get a general sense of what they knew about the environment. This allowed researchers to compare what Americans thought they knew to their actual EK levels. Results indicated that self-assessed knowledge was higher among males than females (NEETF, 1997, 2001). A study by Cooper, Krieg and Brownell (2018) explored the influence of student characteristics, such as gender, on student academic self-concept. Academic self-concept refers to one’s perception of their ability in an academic setting and is formed by comparing oneself to other students. Cooper et al. (2018) indicated that male students had higher levels of self-concept when comparing their self-assessed knowledge to female peers. This further supports the results of the national EK surveys (NEETF, 1997, 2001).

**Age.**

As for age, the 1997 and 2001 surveys indicated that Americans aged 35 – 54 were more environmentally knowledgeable than 18 – 34-year olds. It was expected that the younger adult age group (age 18-34) would have higher EK because they were exposed to formal EE in schools since the late 1970’s, whereas the older adults (age 35-54) had little to no EE in school. However, this was not the case. Results suggested that EK is acquired over a lifetime and through many sources such as jobs, friends, and television (Coyle, 2005).

Another hypothesis for the difference in EK scores between adult age groups could be due to intrinsic motivations for learning. For example, a previous study indicated that non-traditional students, those over the age of 27, had higher levels of intrinsic motivation for learning than traditional aged students, ages 18 to 21 (Bye, Pushkar, & Conway, 2007). In other words, in the case of EK, older adults may have higher levels of EK based on their motivations to learn about the environment, in addition to what they might acquire through jobs, friends, and television. In
regard to students, these varying motivation levels between different age groups may be related to Brophy and Good’s expectancy-value theory (1984). According to this theory, the degree to which a student (in this case an American adult) is motivated to engage in an academic task (learning about the environment) is jointly determined by his/her expectancy for success (being environmentally literate), in addition to the value that he/she has attached to a specific task (caring for the planet). In other words, this theory suggests that a student can be motivated to learn about the environment if they apply reasonable effort and appreciate the value of learning to care for the environment. In the case of this national study, older American adults (age 35-54) may have higher levels of EK because they have a higher level of expectancy when it comes to obtaining information about the environment, in addition to an increased value for taking care of the planet. This motivation-based theory may explain why older adults have higher levels of EK than their younger counterparts.

*The role of media on environmental myths.*

Instead of focusing just on EK, the 1998 National Report Card specifically examined the public’s belief in environmental “myths,” which were considered to be outdated or erroneous information about the environment (NEETF, 1998). Each question addressed an issue that had been visibly covered in the media throughout the previous year. The results indicated just how powerful some myths were. In fact, the 1998 results indicated that participants selected the myth answer choice more frequently for seven of the ten multiple-choice questions than the correct answer. For example, when asked to identify the most common source of water pollution, 47% of American adults selected the myth answer (factories and businesses), whereas only 22% selected the correct answer (surface water running off yards, city streets, paved lots, and farm fields).

The origins of these environmental myths are unknown, but data from ten years of NEETF surveys strongly imply that the media plays a large role creating these environmental
misconceptions (Coyle, 2005). However, it is not necessarily that the media is supplying incorrect information. Rather, individuals absorb bits of information in their own way and according to their own unique beliefs. Individuals then meld these bits of information with pre-existing ideas, in turn forming misconceptions about environmental topics. While environmental misconceptions played a large role in assessing adult literacy in 1998, results from the 1997 and 2001 survey indicated that the most significant single factor in the varying levels of adult EK appeared to be people's level of education (NEETF, 1997, 1998, 2001). Americans with a college degree were significantly more likely to give correct answers than those with a high school degree or less (NEETF, 1997, 2001). If education is the single most determining factor in adult EK, then EE must play an integral role throughout our educational system.

*Role of education in promoting environmental knowledge.*

Education is a key factor in developing public knowledge and awareness about issues that affect the future of a nation and, subsequently, the world. Schools are a likely venue for the development of the necessary knowledge, skills and attitudes to move towards an environmentally literate population (Ashmann & Franzen, 2015). For example, university students who completed at least one environmental science class in their undergraduate careers were found to have higher EK than those who did not (Robinson & Crowther, 2001).

In particular, research shows that classroom teachers are a strong influence on how children perceive their role in the environment (Rickinson, 2001; Shepardson, Wee, Priddy, & Harbor, 2005) and play a critical role in advancing environmental literacy in schools (Alvarez-Garcia, Sureda-Negre, & Comas-Forgas, 2015; Hestness, McGinnis, Riedinger, & Marbach-Ad, 2011; Karpudewan & Ismail, 2012). Elementary education is the first stage of compulsory education and considered the best learning phase to foster environmental awareness. Thus, many researchers are
concerned about EE implementation in elementary schools which warrants the need for environmentally literate teachers (Cutter & Smith, 2001; Cutter-Mackenzie & Smith, 2003).

However, earlier studies show that elementary school teachers do not have sufficient EK, and often hold misconceptions about environmental issues, such as acid rain, ozone layer depletion, greenhouse effect, and renewable energy sources (Khalid, 2003; Michail, Stamou, & Stamou, 2006). Furthermore, a national study indicated that most secondary science teachers in the U.S. include climate science in their courses, but do not have a sufficient grasp of the science (Plutzer et al., 2016). As for pre-service teachers, a study at Michigan State University compared 6,004 undergraduate, graduate and professional students’ EK to the results from the 2001 NEETF EK survey. The study brought to light the relatively low level of EK (mean EK 7.99) among pre-service teachers in the College of Education (Kaplowitz & Levine, 2005). Additionally, Tuncer et al. (2009) measured 684 pre-service teachers’ EK at a public university in Turkey. Results indicated that only 49% of pre-service teachers received a passing EK score (Tuncer et al., 2009).

In conclusion, previous studies indicate that not only do in-service teachers have limited EK, but also pre-service teachers.

**Implications for limited environmental knowledge in teachers.**

This is concerning since EK is reported to be a significant predictor of environmental concern, attitudes, and responsibility (Teksoz, Sahin, & Tekkaya-Oztekin, 2012). It is reported that teachers’ knowledge of and values regarding the environment and its associated problems may influence their teaching practices and their perceptions of students’ learning in EE (Ballantyne, 1995; Ernst, 2009; Robottom & Kyburz-Graber, 2000). Ernst (2007) concluded that the largest barrier for teachers to implement EE is a lack of professional training related to environmental topics. In fact, previous studies indicate that pre-service teachers are rarely exposed to EE as part of their TPPs (Heimlich et al., 2004; McKeown-Ice, 2000). As earlier mentioned, Tuncer et al.
(2009) argued that teachers will produce students who are environmentally literate when they themselves are environmentally knowledgeable.

As evidenced by the research literature, there is room for improving both the quantity and quality of professional development opportunities for pre-service and in-service teachers in regard to EE practices (Lane et al., 1994; Wade, 1996). This is especially important because if teachers are not adequately prepared to teach our youth about the environment, then our hopes of the next generation being able to solve these problems has incurred a serious setback (Ashmann & Franzen, 2015). In other words, if teachers are uncomfortable and/or unfamiliar with EE topics, they may avoid such topics in their classrooms, which may influence the next generation’s outlook on the environment. This avoidance behavior is further described through Bandura’s (1977) self-efficacy theory.

Environmental Education Teaching Efficacy

What is self-efficacy?

Bandura (1977) introduced the concept of self-efficacy to explain behavioral change. He further defined self-efficacy as “the belief in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3). He argued that a person’s self-efficacy was not a reflection of their actual skills but a perception of what they could accomplish with any skills they did possess (Bandura, 1986). These beliefs influence how much effort individuals put forth, how long they will persist in the face of obstacles, how resistant they are at dealing with failures, and how much stress they experience in coping with demanding situations (Bandura, 1977).

This lends to research suggesting that teachers’ instructional decisions are influenced by their beliefs, which are framed by their personal experiences (Gay, 2010). Bandura (1997) also
theorized that the level of efficacy people bring to specific tasks plays an important role in their success or failure to complete those tasks. A person with high self-efficacy will believe they are capable of learning a task well and judge they have the ability to perform that task, particularly if the task is considered a difficult one. It is often viewed interchangeably with self-confidence (Appleton & Kindt, 2002).

It was proposed by Bandura (1977, 1997) that self-efficacy could result from four potential sources: mastery experiences, vicarious experiences, verbal persuasion, and physiological and emotional states. Mastery experiences include actual performance, based on personally experienced successes and failures. The mastery of tasks was considered by Bandura (1977) to be the most valuable, authentic source for enhancing self-efficacy.

Vicarious experiences, or observation of modelling of a task by another, was classified by Bandura as the second most powerful source of self-efficacy. This was especially important if the observers perceived the person modelling the task as having similar ability to them. Nonetheless, Bandura (1997) considered that modelling was not as significant in building self-efficacy as actual experiences of success and failure.

Bandura’s third source of self-efficacy was verbal persuasion, described as feedback that could encourage an individual to make a greater effort to succeed. This could promote a positive perception of potential achievement. However, this advice was dependent upon the credibility of the person who was providing the verbal persuasion and the quality of the feedback (Bandura, 1997).

The fourth source of self-efficacy was the physiological and emotional state experienced by a person. A positive emotional state should potentially increase the perception of self-efficacy (Bandura, 1997). In comparison, stress could have a negative effect on the person’s perceived capability. Being stressed may act as a cue for people to doubt their ability to be successful.
Teaching efficacy.

Grounded in Bandura’s self-efficacy theory (1977), this research study is framed around the concept of teaching efficacy. Teaching efficacy, an extension of self-efficacy, is the extent to which teachers believe they can control or at least strongly influence student achievement and motivation (Armor et al., 1976). As previously mentioned, teaching efficacy consists of two independent measures: personal teaching efficacy (PTE) and outcome expectancy (OE). PTE provides insight into whether or not teachers believe they have the ability, and therefore confidence, to perform the required task at the desired level of competency. Whereas, OE provides insight into whether or not teachers believe they have accomplished a task at a desired level (Tschannen-Moran et al., 1998). Early research indicates that effective teachers tend to have a high sense of efficacy about their own teaching. They believe that they can help almost all of their students learn, including those who are the most difficult to teach (Berman & McLauglin, 1977). A high sense of efficacy has been identified as one of the teacher dispositions associated with effective practice, along with job satisfaction, professional engagement, and commitment to teaching (Moseley & Utley, 2006).

Opportunities to increase teaching efficacy in pre-service teachers.

Teacher efficacy has been shown to strengthen as a teacher acquires the personal belief that he/she has mastered the behaviors and skills necessary to achieve a desired outcome (Bandura, 1997). The development of teaching efficacy beliefs among pre-service teachers has generated a great deal of research interest because once efficacy beliefs are established they appear to be somewhat resistant to change (Malandrakis, 2017). There is a large body of research that reveals the complex interaction of variables that can improve the confidence of pre-service teachers (e.g. Adey, 2006; Howitt, 2007).
In particular, opportunities to increase pre-service teachers’ science teaching efficacy has been studied heavily. Earlier research has indicated contradictory results regarding avenues to increase pre-service teachers’ science teaching efficacy such as student teaching experiences, which are considered mastery experiences (Bandura, 1997). For example, Hoy and Spero (2005) assessed the efficacy of 53 prospective and novice teachers at the beginning of their preparation program, at the end of student teaching, and after their first year of employment as a teacher. Results indicated significant increases in efficacy during student teaching. However, a study conducted by Morrell and Carrol (2003) indicated contradictory results. This study examined the impact of science methods courses, student teaching, and science content courses on 172 elementary pre-service teachers’ science teaching efficacy enrolled in a small liberal arts private university. Pre-service teachers in the student teaching seminar showed no significant change in their personal science teaching efficacy during the time they were enrolled in the classes.

Another potential avenue for increasing science teaching efficacy is through traditional science content courses. This assumes that increased science knowledge will lead to improved attitudes towards science and increased confidence to teach it. However, research on science content courses and its influence on increasing teaching efficacy has led to conflicting results (e.g. Appleton, 1995; Menon & Sadler, 2016). For example, Appleton (1995) indicated that increasing science content knowledge does not necessarily lead to improved science teaching and confidence to teach it. Whereas, Menon & Sadler (2016) provided evidence that pre-service teachers enrolled in a specialized physics content course experienced positive changes in their science teaching efficacy beliefs. The course was designed for pre-service elementary and early childhood teachers and included inquiry-based hands-on investigations, collaboration, team work, and group discussions that could be applicable in their future classrooms (Menon & Sadler, 2016). Such
conflicting results highlight that other factors, as well as science content, are required to produce an effective primary science teacher.

Furthermore, service-learning opportunities associated with coursework have been found to increase teaching efficacy in pre-service teachers. Results from a previous study indicated that students who engaged in service-learning as part of a course requirement, as opposed to voluntarily choosing a service-learning opportunity, felt more positively toward their preparedness and ability to teach children (Bernadowski, Perry, & Del Greco, 2013). More specifically, these findings indicated course connected service learning had a greater impact on pre-service teachers’ perceptions of their ability to be effective future classroom teachers.

Additionally, science methods courses have been found to be a vehicle for change in pre-service elementary teachers’ attitude, confidence and efficacy. Science methods courses are often where pre-service teachers are exposed to teaching science for the first time. It can be one of the important courses directed at the improvement of teaching efficacy, especially in regard to teaching science (Oh, 2011). Research has found that improved teaching efficacy was related to the use of various instructional strategies such as inquiry-based science teaching (Avery & Meyer, 2012). An inquiry-based learning environment is one in which learning is viewed in terms of processes through which students act as scientists, creating, designing, and conducting their own scientific investigations and communicating their findings to their peers. In other words, if science methods instructors incorporated inquiry-based instructional strategies into their science methods courses then it may increase pre-service teachers’ science teaching efficacy.

Lastly, teaching efficacy increases throughout a pre-service teachers’ time in their TPP. For example, Beisenherz and Dantonio (1991) indicated that the more courses completed by pre-service teachers in their major and minor areas of certification, the more likely they will be able to relate ideas and concepts from one area to another and build their teaching efficacy. It has been
shown to strengthen as a teacher acquires the personal belief that he or she has mastered the behaviors and skills necessary to achieve a desired outcome. The higher pre-service teachers’ self-efficacy, the more confident they are in teaching the material (Bleicher, 2006). However, the opposite may be true. For example, lack of confidence in teaching abilities towards science is a major factor in the avoidance of classroom teachers teaching science to elementary school students (Howitt, 2007). This avoidance behavior, in regard to teaching science, can be related back to Bandura’s self-efficacy theory (Bandura, 1977). Thus, measuring teaching efficacy is crucial to better understanding the different components of teaching efficacy, including avoidance behavior, and further promoting avenues to increase teaching efficacy.

**Evolution of an environmental education teaching efficacy measurement tool.**

There has been extensive research over the last 30 years toward the development of valid and reliable instruments that measure teaching efficacy since it was found to be content specific (Tschannen-Moran et al., 1998). Gibson and Dembo (1984) created the Teacher Efficacy Scale with two constructs that measured PTE and general teaching efficacy. These authors suggested that general teaching efficacy corresponded to OE, a component of Bandura’s self-efficacy theory (Bandura, 1977).

Building on Gibson and Dembo’s study to be content specific, Riggs (1988) and Riggs and Enochs (1990) developed the Science Teaching Efficacy Belief Instrument (STEBI) to measure teachers’ science teaching efficacy. It also identified two uncorrelated factors within STEBI: personal science teaching efficacy and science teaching outcomes expectancy. Enochs and Riggs (1990) further developed the Science Teaching Efficacy Belief Instrument-B (STEBI-B), a modified STEBI, specifically designed for the measurement of pre-service teachers’ science teaching efficacy beliefs. Studies have shown the STEBI-B to have high validity and reliability (Bleicher & Lindgren, 2005; Settlage, 2000; Schoon & Boone, 1998).
Multiple teaching efficacy instruments have been further developed. For example, Rubeck and Enochs (1991) distinguished chemistry teaching efficacy from science teaching efficacy with the development of the STEBI-CHEM. Enochs, Smith, and Huinker (2000) developed a similar instrument to measure the efficacy of mathematics teaching (MTEBI). With the development of the STEBI and STEBI-B, Bandura's self-efficacy has now been widely used in teacher education research (Bleicher & Lindgren, 2005). Despite this, specific research relating to EE teaching efficacy is limited.

To date, only two researchers have studied EE teaching efficacy. In 1992, Sia modified STEBI-B to include the words EE instead of science. Sia shared this information at a conference proceeding, but it was not a peer reviewed publication. Secondly, Moseley et al. (2016) created the Environmental Education Teaching Efficacy Belief Instrument (EETEBI) which was based off of STEBI-B (Enochs & Riggs, 1990). Two major modifications occurred between STEBI-B and EETEBI. First, a six-point Likert scale was used in the modified EETEBI rather than a five-point Likert scale such as in STEBI-B to eliminate a neutral choice. The six-point Likert scale aligned with Hoy and Woolfolk's (1993) Teacher Efficacy Scale.

The second major change between STEBI-B and EETEBI included the incorporation of the phrase *environmental education* not the phrase *environmental science*. In previous studies, replacing the word science with mathematics or chemistry was adequate with the development of MTEBI or STEBI-CHEM (Enochs et al., 2000; Rubeck & Enochs, 1991). However, Moseley et al., (2016) determined that it was not equivalent to replace the word science with EE, as was done previously (Moseley, Reinke, & Bookout, 2002; Sia, 1992). Instead, the researchers focused on instructional strategies used in teaching about the environment and environmental concepts when developing the assessment instrument. More specifically, the phrase EE was used in the survey and not the phrase environmental science. The reason being that EE is not a separate subject taught
in the public schools, nor in most TPPs. Moseley et al. (2016) and many others have stated that environmental science and EE are different constructs. Environmental science tends to draw on concepts found within the traditional disciplines of biology, chemistry, and physics and applies those concepts in environmental contexts (Gough, 2002). EE, conversely, while recognizing the importance of scientific knowledge within these science disciplines, is characterized by the integration of subject areas, especially science and social studies; problem-based learning experiences; and constructivist approaches (NAAEE, 2019).

After these two major modifications, Moseley et al. (2016) ran a factor analysis to further test the validity and reliability of EETEBI. The factor analysis revealed that 20 out of the original 26 items found in STEBI-B were a good fit for a two-factor structure in EETEBI. Just as in previous studies, results indicated that EE teaching efficacy is made up of two independent constructs: PEETE and EEOE (Moseley et al., 2016). Moseley et al. (2016) found the reliability for the PEETE scale to be excellent (Cronbach’s alpha = .920) while the EEOE scale was acceptable (Cronbach’s alpha = .767). Therefore, since EETEBI was found to be both valid and reliable it is a key component of the current study.

As earlier indicated in Figure 2, a teacher might expect a behavior change to occur in their students if they incorporate EE concepts into their classroom (EEOE), but the teacher may lack the personal motivation or confidence to incorporate EE into their classroom to begin with (PEETE). The relationship between pre-service teachers’ confidence to incorporate EE materials (PEETE) and its connection to their EK is paramount to the current study. Therefore, the 13 PEETE questions from EETEBI will be utilized in the current study, not EEOE, to better understand avenues to increase pre-service teacher’s confidence teaching EE in their future classrooms. For a summary of the progression of EE teaching efficacy instruments see Figure 4.
Previous studies on environmental education teaching efficacy.

Research on EE teaching efficacy is limited both for in-service and pre-service teachers. This is problematic because Gardner (2009) found that teachers with high self-efficacy are more likely to use student centered, hands-on methods required for effective EE instruction than teachers with low self-efficacy. One study identified three major groups of elements that contributed to EE teaching efficacy needed by in-service teachers to implement EE in schools – teaching conditions, competencies used to achieve educational outcomes, and practices teachers use on a day-to-day basis (May, 2000). First, the study indicated that if teachers are to successfully incorporate EE into their classrooms, they must have the right teaching conditions. For example, *opportunity-to-learn standards* that describe the conditions and resources that must be present for students to be able to achieve performance standards. Secondly, they must have...
the competencies to achieve educational outcomes. For example, *educational content standards* that describe what school-age learners should know and be able to do. Lastly, in order for in-service teachers to implement EE, they must have a set of practices to use EE on a day-to-day basis. For example, *student performance standards* that define what levels of learning are considered satisfactory. An additional study on in-service teachers, sought to determine change in EE teaching efficacy beliefs of K–12 teachers who participated in a two-week intensive summer course that focused on earth systems science (Moseley, Huss, & Utley, 2010). Results indicated that teachers reported significant gains in both PEETE and EEOE immediately following the workshop.

As for pre-service teachers’ EE teaching efficacy, research is equally limited. One study (Moseley et al., 2002) evaluated the effect of participation in a 3-day outdoor EE program on pre-service teachers’ attitudes toward self-efficacy. The results suggested that pre-service teachers’ self-efficacy was high before the program and remained unchanged by their teaching experiences but dropped significantly approximately seven weeks after teaching. Another study evaluated EE teaching efficacy of elementary pre-service teachers after they participated in a semester long Earth systems science course that followed a specific curriculum known as Global Learning and Observations to Benefit the Environment (GLOBE) (Moseley & Utley, 2008). Results indicated that the Earth systems science course and, in specific, the GLOBE curriculum did not significantly influence either component of pre-service teachers’ EE teaching efficacy.

However, no research has been found in regard to the correlation between EK and pre-service teachers’ PEETE. In other studies, a moderate, positive relationship was found between mathematic content knowledge and personal teaching efficacy of pre-service elementary teachers enrolled in an elementary mathematics methods course (Newton, Leonard, Evans, & Eastburn, 2012). Additionally, Menon et al. (2016) indicated a moderate, positive relationship between gains
in science conceptual understandings (science knowledge) and gains in personal science teaching efficacy for pre-service elementary teachers enrolled in a semester long specialized science content course. In other words, increasing pre-service teachers’ EK may increase their confidence teaching EE materials (PEETE) and vice versa. Therefore, this will be a key focus of the current study to further investigate the relationship between these two factors.

Environmental Education in Wisconsin

History of environmental education in Wisconsin.

Wisconsin has long been a leader in EE across the United States, particularly in regard to their inclusion of EE in their educational systems. In the 1930s, Wisconsin citizens identified the need for conservation education for youth in the state. As for curriculum planning, Wisconsin requires that “environmental education objectives and activities shall be integrated into K-12 curriculum plans, with the greatest emphasis in art, health, science and social studies education” (WDPI, 8.01(2)(k) 6.b, 1985). A first set of EE standards were created in 1998. Additionally, Wisconsin’s Plan to Advance Education for Environmental Literacy and Sustainability in PK-12 Schools (WDPI, 2011) proposed strategies to ensure all students graduate environmentally literate and prepared to contribute to a sustainable future. This included goals to provide field experiences (field trips) as part of school curriculum to contribute to healthy lifestyles through outdoor recreation.

Additional support for EE in the state comes from multiple organizations. The Wisconsin Center for Environmental Education (WCEE) and Wisconsin Environmental Education Board (WEEB) were created by Wisconsin Act 299 (Wisconsin Legislature, 1989). Their installation was to further support implementation of EE in Wisconsin schools and communities. The WCEE provides programming and staff support across the state for primary and secondary schools. The
WEEB had a grants program that provided support to schools and other environmental educators, but no longer exists as of 2017.

Other EE support organizations include Wisconsin Association for Environmental Education (WAEE), Wisconsin Environmental Education Foundation (WEEF), and Teacher Educators Network for Environmental Education (TENFEE). WAEE, created in 1974, offers networking opportunities, for school teachers and other environmental educators, while being an advocate for EE in the state. WEEF was created in 2005 and provided an avenue to garner financial support for EE, but no longer exists as of 2017. However, this support for EE was transferred to the Natural Resources Foundation, which offers small grants to schools and provides additional support for EE. Lastly, TENFEE is a special interest group within WAEE that is over 20 years old. It serves as a communication hub for EE in TPPs, advocates for TPP inclusion of EE, and acts as an umbrella for EE research in higher education programs. In 2017, a collection of instructional materials was created by Wisconsin TPP faculty during a professional development TENFEE workshop to provide faculty with additional teaching resources to include EE curriculum in their TPP coursework (Franzen et al., 2017). All of these organizations and instructional materials, at one time or another, promoted and supported EE in the state.

**Integration of environmental education into Wisconsin TPPs.**

Although Wisconsin has a long history of EE, a comprehensive description of how Wisconsin’s TPPs are currently preparing teacher candidates in this realm is limited. Lane et al. (1994) and Wilke (1985) surveyed teachers about their teacher education experiences in learning to teach about the environment. Results from these two studies implied that lack of training in EE is a major reason teachers do not infuse these environmental concepts into their classrooms. Sanera (1997) examined the content of EE materials used in courses required for
teacher licensing at eight University of Wisconsin System campuses (no private colleges). However, all three of these studies are over fifteen years old.

Currently, PI 34 requires the 33 TPPs in the state to prepare teachers to address all state standards, including the EE standards. Ashmann and Franzen (2015) identified two main ways in which EE is integrated into Wisconsin TPPs: activity-based EE and course-based EE. Activity-based EE integration usually entails field trip participation combined with observing public school students in a natural area. The purpose of these field trips many times is to help pre-service teachers better understand the resources available to them as they teach primary and secondary students about the environment (Ashmann & Franzen, 2015).

Course-based EE integration includes two different options. First, EE may be integrated into a biological sciences course requirement, most with a lab component. However, teaching methods are rarely, if ever, included as a topic so students are left to make connections for themselves between the topics they are learning in the course. They must relate the science content material to information they use to teach their future students in a classroom setting (Ashmann & Franzen, 2015). Secondly, EE may also be integrated into TPP curriculum from a menu of science courses in combination with a science methods course. In this approach, students are required to select a course from a menu of possibilities chosen by TPP faculty in collaboration with faculty from the science disciplines. Then, methods instructors, particularly science methods instructors, are asked to integrate EE content into their coursework (Ashmann & Franzen, 2015).

Wisconsin is one of the few states that mandates that pre-service teachers be prepared to teach EE. With that being said, it does not appear that research has been conducted on pre-service teachers’ EK, nor its relationship to PEETE. Ultimately, this study hopes to merge these topics and research in EE, EK as a component of environmental literacy, pre-service teachers’ EE
teaching efficacy, and EE efforts in TPPs in order to promote the creation of environmentally literate pre-service teachers, and indirectly their future students.

Summary

This chapter has reviewed the relevant literature for this study. Specifically, this chapter focused on EE, EK as a component of environmental literacy, EE teaching efficacy, and EE in Wisconsin. The findings of this literature review have influenced the focus of this study and its methods, which will be explained in Chapter 3. Additionally, the information presented in this chapter will provide a context for which to reflect upon the results and implications discussed in Chapters 4 and 5.
CHAPTER 3:
METHODS

This chapter discusses the methods of this study. The chapter is structured to provide a description of the data collection and analysis strategies used to answer each research question and sub-research question. The findings of the study are presented in Chapter 4. Primary emphasis in this chapter has been given to the focus of the study, research design, instrumentation and its development, data analysis strategies, and the goals of the study. The methods employed in this study are derived from the research questions. They assist in the discovery of the conclusions and implications that this study suggests.

Research Design

This study was designed to assess pre-service teachers’ individual EK and its relationship to their PEETE. Specifically, it was designed as an exploratory study in which the guiding framework came from Bandura’s self-efficacy theory (1977). This study used a quantitative, non-experimental research design and gathered participants through criterion sampling (O’Leary, 2004). The participants were involved in the study based on their enrollment in a science methods course. A web survey was chosen as the delivery method based on previous studies that used web surveys through the incorporation of the Tailored Design approach (Dillman, Smyth, & Christian, 2014).

Data were collected in the form of a one-time online Instructor Survey and Student Survey. The Instructor Survey was a short survey in which science methods instructors could provide additional information about the incorporation of EE into pre-service teacher coursework. As for
the Student Survey, it was administered to pre-service teachers by their science methods instructors online in class.

Pre-service teachers in science methods courses were chosen as participants for three reasons. First, science methods courses are usually a required class for pre-service teachers seeking to teach early childhood, elementary and secondary school-aged children. In other words, there was a greater chance of reaching a variety of pre-service teachers. Secondly, science methods courses are typically taken by upper level pre-service teachers such as junior or seniors. This was key since teaching efficacy has been shown to increase with the amount of completed coursework in pre-service teachers’ major and minor areas of certification (Beisenherz & Dantonio, 1991). Lastly, pre-service teachers in science methods courses are still completing coursework on-campus in a classroom setting. It was important for the survey to be dispensed during class time to reduce the risk of pre-service teachers searching for the EK answers online in an unsupervised setting. Of special note is that some science methods courses meet only the first half of the semester. Oftentimes, the second half of the semester is when pre-service teachers leave campus to complete their related field experience requirements in local schools. Therefore, in order to maintain continuity between different TPPs, instructors were asked to administer the Student Survey within the first eight weeks of the semester.

This research design, along with the data analysis strategies explained later in this chapter, sought to provide answers to the following research questions:

1. What are the relationships between pre-service teachers' EK, PEETE, and number of positive childhood environmental activities?

2. Do pre-service teachers seeking to teach different age levels show significant differences in EK and PEETE? If so, then how?
3. Do pre-service teachers from different childhood environments show significant differences in EK and PEETE? If so, then how?

4. Of the factors that were measured, what factors are most important in explaining whether pre-service teachers passed the EK exam?

Instrumentation

Instrument one: Student survey.

An online Student Survey was used to measure pre-service teachers’ EK and their PEETE (Appendix A). The survey platform, Qualtrics, was used to dispense the Student Survey. It was distributed to pre-service teachers in science methods courses across Wisconsin’s TPPs by their course instructors. The link to the Student Survey was emailed to science methods instructors two-weeks before the start of the Fall 2018 semester with detailed instructions and a pre-made PowerPoint slide (Appendix F). The PowerPoint slide stated the study’s research topic, approximated the amount of time it would take to complete the survey, information about the compatibility of the survey with smart devices and personal computers, in addition to the physical link to the survey. It was then at the discretion of the instructor to set aside time in-class for students to complete the survey within the first eight weeks of the semester, or by November 1st at 11:59pm. In total, the Student Survey included thirty-six statements split into three parts: EK, PEETE, and demographic questions. The survey took roughly ten minutes to complete.

Part one of student survey: EK.

This section examined basic environmental issue questions such as “how is most of the electricity in the U.S. generated?” Twelve multiple choice questions were included in this section of the survey. These 12 EK questions were published by NEETF in 1997. Question subjects were selected based on the likelihood of the public having heard about the information through the
media, reflecting a basic EK profile. More than 50 questions were tested in focus groups to screen out confusion and bias before the 12 questions were finalized (Coyle, 2005). Each set of answer choices were designed to have one correct answer choice, one conceivable but incorrect choice, two implausible choices, and a don’t know choice (Coyle, 2005). EK scores were calculated for each pre-service teacher by compiling the total number of EK questions answered correctly to replicate the NEETF surveys (NEETF 1997, 2001). Each correct answer was given one point (minimum 0, maximum 12), whereas any answers that were incorrect, left blank or in which don’t know was selected, were given a score of 0.

**Part two of student survey: PEETE.**

This section examined pre-service teachers’ PEETE using positive or negative statements such as “I understand the strategies to effectively teach environmental concepts” or “Even if I try hard, I cannot teach about the environment as well as I can teach about other topics.” Thirteen questions were included in this section of the survey. These 13 questions were selected from Moseley et al.’s (2016) EETEBI, but date back to instruments used by Enochs and Riggs in 1990. Each question included a six-point Likert scale response in which a numerical value was given: Strongly Disagree (1), Disagree (2), Somewhat Disagree (3), Somewhat Agree (4), Agree (5), and Strongly Agree (6). Reverse scoring was accounted for in PEETE questions 2, 4, 5, 7, 10, 11, and 13 since these questions were negatively worded. Then, the PEETE score per pre-service teacher was calculated (minimum 13, maximum 78).

**Part three of student survey: demographics.**

This section examined demographic questions such as gender, student status, and major to help further answer the study’s research questions. Eleven questions were included in this section.
Response types varied between questions, but included options such as multiple choice, six-point Likert scale responses, or short answers. Demographic questions were gathered from a number of different resources. For a list of demographic question topics and their sources see Table 1.

Table 1

<table>
<thead>
<tr>
<th>Q#</th>
<th>Demographic Question Topic</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TPP Name</td>
<td>Researcher &amp; Committee</td>
</tr>
<tr>
<td>2</td>
<td>Major</td>
<td>Researcher &amp; Committee</td>
</tr>
<tr>
<td>3</td>
<td>Age Level Seeking to Teach (Different Age Levels)</td>
<td>Researcher &amp; Committee</td>
</tr>
<tr>
<td>4</td>
<td>Student Status</td>
<td>Researcher &amp; Committee</td>
</tr>
<tr>
<td>5</td>
<td>Gender</td>
<td>Researcher &amp; Committee</td>
</tr>
<tr>
<td>6</td>
<td>Assessment of EE in Coursework (Tbilisi EE Definition)</td>
<td>Inspired by Moseley et al. (2016)</td>
</tr>
<tr>
<td>7</td>
<td>Self-Assessed Knowledge of Environmental Issues Compared to Peers</td>
<td>WCEE (1997)</td>
</tr>
<tr>
<td>8</td>
<td>Positive Childhood Environmental Activities</td>
<td>O'Brien (2007)</td>
</tr>
<tr>
<td>9</td>
<td>Primary Sources of Environmental Information</td>
<td>O'Brien (2007)</td>
</tr>
<tr>
<td>10</td>
<td>Childhood Environment</td>
<td>O'Brien (2007)</td>
</tr>
<tr>
<td>11</td>
<td>State or Country Where Childhood was Spent</td>
<td>Researcher &amp; Committee</td>
</tr>
</tbody>
</table>

Of special note, answer choices from demographic questions eight and nine were slightly modified from their original format (O’Brien, 2007) to better fit the current researcher’s interest. For example, **demographic question eight** included the addition of attending summer camp and snowshoeing/skiing as answer choices, whereas planting a tree was removed. Additionally, some questions were combined based on expected similar audiences e.g. hunting and fishing became hunting/fishing. Similarly, in **demographic question nine**, books and library became books/library and magazines and newspapers became magazines/newspaper. **Social Media (Facebook, YouTube, Instagram, Twitter)** was added as an answer choice to include current social
media platforms. Lastly, the current study asked pre-service teachers to select up to three primary sources of environmental information, whereas, the original question allowed participants to select as many as possible.

**Instrument two: Instructor survey.**

The second research instrument was an online Instructor Survey (Appendix B). The Qualtrics-based survey was distributed, via email, to science methods instructors at the same time as the Student Survey. However, it was only to be completed by the instructor teaching the course. It was at the discretion of the instructor to complete the five-minute survey by November 1st at 11:59pm.

The Instructor Survey included four questions designed by the researcher. Three questions included short answer responses regarding institution name, course(s) in which the Student Survey was distributed, and a description of how EE was incorporated into their TPP. The final question was identical to the one asked on the Student Survey in regard to the degree to which they agreed or disagreed with how well EE was incorporated into TPP required coursework based on the Tbilisi Declaration’s EE definition.

**Preliminary Data Analysis**

In order to ensure for the validity of the Student and Instructor Surveys as assessment tools, preliminary data analysis was conducted using a Pilot Study. A science methods instructor from the University of Wisconsin-Stevens Point agreed to distribute the Pilot Study Student Survey to his science methods students in April 2018 (Appendix C). However, the instructor never agreed nor completed the Pilot Study Instructor Survey. Consequently, in August 2018, the researcher administered the Pilot Study Instructor Survey to an EE professor at the University of Wisconsin-Stevens Point who found the survey to be free of errors.
As for the Pilot Study Student Survey, it included an introductory email with instructions, in addition to the Qualtrics link to the Student Survey. Students were asked to voluntarily complete the survey and provide verbal feedback to the researcher about the format and wording of the survey instrument before its launch date in August. A small sub-set of students completed the survey. Unfortunately, no students provided verbal feedback. However, logistical aspects of the survey were observed such as time to complete the survey, in addition to the compatibility of Qualtrics as a survey platform. Furthermore, Cronbach’s alpha was used to test the reliability of the PEETE scale. Based on available information and feedback, no changes were made between the Pilot Study surveys and the surveys launched in August 2018.

Solicitation

Contact gathering.

A search for science methods instructors across Wisconsin’s 33 TPPs was completed in April 2018. A database, provided by the Wisconsin Society of Science Teachers, was initially referenced for information regarding potential instructor names, and their alleged email addresses. For those with emails listed in the database, a contact gathering email was sent to ask if they were indeed the correct contact for their TPP (Appendix D). If they were not the correct contact, they were politely asked to provide the correct contact information of their colleague. If no contact information was listed on the initial database, then the researcher searched individual TPP websites to find the supposed science methods instructor. If contact information could not be readily found on the website, then the researcher either called the Education Department’s main phone number or reached out to the dean of the education department via email asking for the instructor(s) contact information.
Inquiry emails.

Once the proper contact information was obtained from each TPP, the instructors were sent an inquiry email in early May (Appendix E). This email invited them, and their Fall 2018 science methods students, to partake in this research opportunity. Originally, the plan was to recruit instructors by sending two inquiry emails followed by a phone call. However, instructor’s phone numbers proved too difficult to gather. In its place, a final inquiry email was sent out two-weeks before the survey’s launch date in August. If at any point an instructor agreed to partake in the study, they were added to the study’s contact list. However, if an instructor declined to partake, stated their TPP did not offer a Fall science methods course or never responded to the three inquiry attempts, they were removed from the study’s contact list.

Pre-survey instructions, reminders, and conclusory thank you emails.

Those that agreed to partake in the research were included in the following forms of communication (Appendix F). First, instructors were sent a pre-survey instruction email in late August. This was emailed two-weeks before the anticipated start of the Fall 2018 semester. Second, throughout the semester, two reminder emails were sent prompting them to complete the Instructor Survey, in addition to distributing the Student Survey link to their science methods students. The reminder emails were sent two-weeks before the deadline, as well as the day before the November 1st deadline. Finally, a conclusory thank you email was sent in the middle of November to all science methods instructors that partook in the study.

RQ 1: Correlation Between Knowledge, Efficacy, and Positive Childhood Environmental Activities

The methods used to answer research question one focused on the correlations between pre-service teachers’ EK, PEETE, and the number of positive childhood environmental activities. The relationships between EK (as measured by mean EK scores), PEETE (as measured by mean
PEETE scores), and positive childhood environmental activities (as measured by mean number of positive childhood environmental activities) were investigated using Pearson product-moment correlation coefficient in SPSS v. 25.

EK scores were calculated for each pre-service teacher by compiling the total number of EK questions answered correctly (minimum 0, maximum 12). As for PEETE scores, a numerical value was given to each of the six-Likert scale responses per question. Then, the total PEETE score was calculated for each pre-service teacher (minimum 13, maximum 78). If a student left any of the PEETE questions blank, then they were excluded from any further analyses involving PEETE. Lastly, the total number of positive childhood environmental activities was calculated by awarding a point per environmental activity self-selected by pre-service teachers on the Student Survey (minimum 0, maximum 15).

**RQ 2: Different Age Levels**

The second research question focused on the influence of pre-service teachers seeking to teach different age levels as a factor in determining mean EK and PEETE scores. The different age level categories included early childhood, elementary, secondary, all ages (licensing level for music, art, and foreign languages), *both early childhood and elementary*, and *other*. However, descriptive statistics showed that only one student selected all ages, therefore, they were excluded from analysis. Additionally, 12 students selected *other* and listed their answer in short answer format. Based on the information they provided, 11 of the 12 students who selected *other* were switched by the researcher to either the *both early childhood and elementary* or the elementary category. The last of the 12 students to select *other* could not be placed into a category by the researcher; therefore, this individual was removed from analysis.
Based on the results of the descriptive statistics only four age level categories were used in the RQ 2 analysis: early childhood, elementary, secondary, and both early childhood and elementary. The question considered the dependent variables to be EK and PEETE scores. The researcher used ANOVA to determine whether the mean EK and PEETE scores were significantly different between each of the four age level categories. Then, they were measured for statistical significance using two, one-way between group analyses of variances, also known as one-way ANOVAs, in SPSS. These tests were used to measure the variance of EK and PEETE scores between pre-service teachers seeking to teach different age level students. If statistical significance was found between groups, then post hoc comparisons using the Tukey HSD test were completed. However, if the assumption of homogeneity of variance was violated, then Welch’s F-ratio was recorded, and the Games-Howell post hoc test was used. For this particular research question, a Games-Howell post hoc test was conducted for mean EK scores to find which age level was significantly different from the others. In addition, eta squared was calculated to measure effect size.

**RQ 3: Childhood Environment**

The third research question focused on the influence of different childhood environments as a factor in determining mean EK and PEETE scores. The question considered the dependent variables to be mean EK and PEETE scores. The researcher used ANOVA to determine whether the mean EK and PEETE scores were significantly different between each of the six categories: rural farm, rural non-farm, suburban, small town (less than 2,500 people), small city (between 2,500-50,000), and large city (greater than 50,000). Then, they were measured for statistical significance using two, one-way ANOVAs in SPSS. This test measured the variance in EK and PEETE scores between pre-service teachers from different childhood environments. In addition,
eta squared was calculated to measure effect size. Of special note, three students originally selected the other category, but were switched by the researcher into existing categories based on the short answer responses they provided.

**RQ 4: Factors Influencing Environmental Knowledge**

The fourth research question focused on six factors and how well they predicted whether pre-service teachers would pass the EK exam. Pre-service teachers passed the EK exam if they answered nine or more questions correctly (maximum 12). Conversely, students who answered eight or fewer questions correctly failed the EK exam. This research question considered the dependent variable to be EK (pass or fail), whereas the six factors were the independent variables. The independent variables included different age levels, childhood environment, gender, institution type, PEETE scores, and the total number of positive childhood environmental activities. Both PEETE scores and total number of positive childhood environmental activities were classified as continuous variables: PEETE (13 to 78) and total number of positive childhood environmental activities (0 to 15). Whereas, the other four factors were classified as categorical variables: childhood environment (rural farm, rural non-farm, small town vs. suburban, small city, large city); gender (female vs. male); institution type (public TPP vs. private TPP); and different age levels (early childhood, elementary, both early childhood and elementary vs. secondary). A binary logistic regression was run in SPSS to assess the overall model significance, as well as the significance, direction of effect, and effect size/values of each independent variable in the model. A set of six factors was used to predict whether students would pass the EK exam. For a summary of all data analysis strategies for the four main research questions please see Table 2.
### Additional Data Analysis

Data analysis was also conducted in SPSS for five additional sub-research questions, including descriptive statistics.

**SQ 1:** Do pre-service teachers with different student statuses show significant differences in EK and PEETE? If so, then how?

**SQ 2:** Do pre-service teachers with different self-assessed knowledge levels show significant differences in EK and PEETE? If so, then how?

**SQ 3:** Do pre-service teachers attending public versus private TPPs show significant differences in EK and PEETE? If so, then how?

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**Table 2**

*Research Question (RQ) Analysis Strategies*

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Focus</th>
<th>Dependent Variables</th>
<th>Independent Variables</th>
<th>Research Instrument</th>
<th>Data Analysis Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the relationships between pre-service teachers' EK, PEETE, and number of positive childhood environmental activities?</td>
<td>Correlation Between Knowledge, Efficacy, and Positive Childhood Environmental Activities</td>
<td>N/A</td>
<td>N/A</td>
<td>Student Survey</td>
<td>Pearson product-moment correlation coefficient</td>
</tr>
<tr>
<td>Do pre-service teachers seeking to teach different age levels show significant differences in EK and PEETE? If so, then how?</td>
<td>Different Age Levels</td>
<td>EK and PEETE scores</td>
<td>Age Levels: 4 categories</td>
<td>Student Survey</td>
<td>Two, one-way ANOVAs</td>
</tr>
<tr>
<td>Do pre-service teachers from different childhood environments show significant differences in EK and PEETE? If so, then how?</td>
<td>Childhood Environment</td>
<td>EK and PEETE scores</td>
<td>Childhood Environments: 6 categories</td>
<td>Student Survey</td>
<td>Two, one-way ANOVAs</td>
</tr>
<tr>
<td>Of the factors that were measured, what factors are most important in explaining whether pre-service teachers passed the EK exam?</td>
<td>Factors Influencing EK (pass or fail)</td>
<td>EK</td>
<td>6 Factors</td>
<td>Student Survey</td>
<td>Binary Logistic Regression</td>
</tr>
</tbody>
</table>

---

Data analysis was also conducted in SPSS for five additional sub-research questions, including descriptive statistics.

SQ 1: Do pre-service teachers with different student statuses show significant differences in EK and PEETE? If so, then how?

SQ 2: Do pre-service teachers with different self-assessed knowledge levels show significant differences in EK and PEETE? If so, then how?

SQ 3: Do pre-service teachers attending public versus private TPPs show significant differences in EK and PEETE? If so, then how?
SQ 4: Do male and female pre-service teachers show significant differences in EK and PEETE? If so, then how?

SQ 5: Do pre-service teachers with different majors show significant differences in EK and PEETE? If so, then how?

The methods used for SQ 1 and SQ 2 were identical. Both questions focused on an individual factor (student status or self-assessed knowledge). The questions considered the dependent variables to be EK and PEETE scores. The researcher used ANOVA to determine whether the mean EK and PEETE scores were significantly different between each of the categories within those factors, then measured for statistical significance using two, one-way ANOVAs in SPSS. Eta-squared was calculated to measure effect size for each analysis. SQ 1 focused on the influence of student status on mean EK and PEETE scores. Student status refers to pre-service teachers’ self-identified year in school. Student statuses were sorted into five categories: first year, sophomore, junior, senior, and I already have a bachelor’s degree and am currently seeking a teaching license, further known as I already have a bachelor’s degree. However, descriptive statistics showed that zero students selected first year, therefore it was excluded from the analysis. SQ 2 focused on pre-service teacher’s self-assessed knowledge of environmental issues compared to their peers, further known as self-assessed knowledge. Self-assessed knowledge responses were sorted into three categories: below average, average, or above average.

The methods used for SQ 3, SQ 4, and SQ 5 were identical. Each question focused on an individual factor (institution type, gender, or major) and measured its influence on mean EK and PEETE scores. Data analysis was conducted in SPSS. The researcher used two, independent samples t-tests for each sub-research question to determine whether the mean EK and PEETE
scores were significantly different for each grouping. Furthermore, eta-squared was calculated to measure effect size. SQ 3 looked at **institution type**. This information was gathered based on student responses to the college or university they listed on the Student Survey. Responses were assigned by the researcher to institution type categories: public TPP or private TPP. If a student did not indicate their college or university name, then they were excluded from this analysis. SQ 4 focused on **gender**: male, female, or *other*. However, descriptive statistics indicated that zero students selected *other*. Therefore, the category was excluded from the analysis and only male or female categories remained. If a student did not select their gender, then they were excluded from analysis.

Lastly, SQ 5 focused on student **major** such as education (early childhood or elementary), natural sciences, humanities, social sciences, mathematics or *other*. Descriptive statistics indicated that zero students selected humanities, social sciences, or mathematics. Therefore, these categories were excluded from the analysis. Of special note, 12 students selected *other* and indicated their major in short answer format. Ten of these 12 students were switched by the researcher to different major categories based on their short answer responses. However, the other two students were excluded from this research analysis because their responses did not correspond with any of the answer choices. For a summary of all data analysis strategies for the five sub-research questions please see Table 3.
Table 3

*Sub-Research Question (SQ) Analysis Strategies*

<table>
<thead>
<tr>
<th>Sub-Research Question</th>
<th>Focus</th>
<th>Dependent Variables</th>
<th>Independent Variables</th>
<th>Research Instrument</th>
<th>Data Analysis Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do pre-service teachers with different student statuses show significant differences in EK and PEETE? If so, then how?</td>
<td>Student Status</td>
<td>EK and PEETE scores</td>
<td>Student Status: 4 categories</td>
<td>Student Survey</td>
<td>Two, one-way ANOVAs</td>
</tr>
<tr>
<td>Do pre-service teachers with different self-assessed knowledge levels show significant differences in EK and PEETE? If so, then how?</td>
<td>Self-Assessed Knowledge</td>
<td>EK and PEETE scores</td>
<td>Self-Assessed Knowledge: 3 categories</td>
<td>Student Survey</td>
<td>Two, one-way ANOVAs</td>
</tr>
<tr>
<td>Do pre-service teachers attending public versus private TPPs show significant differences in EK and PEETE? If so, then how?</td>
<td>Institution Type</td>
<td>EK and PEETE scores</td>
<td>Institution Type: 2 categories</td>
<td>Student Survey</td>
<td>Two, independent samples t-tests</td>
</tr>
<tr>
<td>Do male and female pre-service teachers show significant differences in EK and PEETE? If so, then how?</td>
<td>Gender</td>
<td>EK and PEETE scores</td>
<td>Gender: 2 categories</td>
<td>Student Survey</td>
<td>Two, independent samples t-tests</td>
</tr>
<tr>
<td>Do pre-service teachers with different majors show significant differences in EK and PEETE? If so, then how?</td>
<td>Major</td>
<td>EK and PEETE scores</td>
<td>Major: 2 categories</td>
<td>Student Survey</td>
<td>Two, independent samples t-tests</td>
</tr>
</tbody>
</table>

**Summary**

These methods represent the research design and data analysis strategies for the study of pre-service teachers’ EK and PEETE in science methods courses across Wisconsin’s TPPs. In order to answer the four research questions of this study, the methods connected important strands including the correlation between knowledge, efficacy, and positive childhood environmental activities, in addition to different age levels, childhood environment, and factors influencing EK. These methods were employed to determine the results and conclusion of this study. The results of the study are discussed in Chapter 4, while the conclusions and implications are the subject of Chapter 5.
CHAPTER 4:
RESULTS

This chapter will present the results of this study. The chapter has been split into 10 sections of results: reliability of PEETE scale, descriptive statistics, knowledge items, PEETE scores, Instructor Survey results, four main research questions, and additional data analysis through sub-research questions. Each section will present the primary focus of its inquiry and data analysis strategy before summarizing results. These descriptions will be supplemented by tables and figures that more concisely present the data.

Reliability of PEETE Scale

To further test for reliability of the PEETE scale, Cronbach’s alpha was calculated for the Pilot Study dataset. A Cronbach alpha of .936 was reported. Of special note, the Pilot Study Cronbach alpha test indicated that the twelfth PEETE question had a negative value in the inter-item correlation matrix. However, the question was kept in the finalized Student Survey for two reasons. First, the value in the corrected item-total correlation section of the Item-Total Statistics was greater than .3, which was acceptable. Secondly, these 13 questions were previously used by Moseley et al. (2016) who reported the scale to have good internal consistency with a Cronbach alpha of .920. An additional Cronbach’s alpha was calculated for the study’s official dataset (Cronbach alpha = .902). Therefore, based on the results from the Pilot Study and Student Survey, the PEETE scale was found to be consistent with the results of Moseley et al. (2016).
Descriptive Statistics

Pre-service teacher response rate.

In total, 251 pre-service teachers submitted answers to the Student Survey. However, 10 students were removed from the dataset. Of those 10 students, six students did not complete any of the PEETE Likert scale responses while an additional two students did not complete any demographic questions. Lastly, two students were removed from the dataset due to suspicious looking answers. In conclusion, the dataset included 241 pre-service teachers from 17 different TPPs which were used for further analysis (see Figure 5 for listing of TPPs).

Figure 5

Wisconsin TPPs Present in Study

<table>
<thead>
<tr>
<th>Institution Type</th>
<th>TPP Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private (8)</td>
<td>Cardinal Stritch University</td>
</tr>
<tr>
<td></td>
<td>Carthage College</td>
</tr>
<tr>
<td></td>
<td>Concordia University</td>
</tr>
<tr>
<td></td>
<td>Edgewood College</td>
</tr>
<tr>
<td></td>
<td>Maranatha Baptist Bible College</td>
</tr>
<tr>
<td></td>
<td>Mariah University</td>
</tr>
<tr>
<td></td>
<td>Saint Norbert College</td>
</tr>
<tr>
<td></td>
<td>Silver Lake College</td>
</tr>
<tr>
<td>Public (9)</td>
<td>UW-Green Bay</td>
</tr>
<tr>
<td></td>
<td>UW-La Crosse</td>
</tr>
<tr>
<td></td>
<td>UW-Madison</td>
</tr>
<tr>
<td></td>
<td>UW-Milwaukee</td>
</tr>
<tr>
<td></td>
<td>UW-Oshkosh</td>
</tr>
<tr>
<td></td>
<td>UW-River Falls</td>
</tr>
<tr>
<td></td>
<td>UW-Stevens Point</td>
</tr>
<tr>
<td></td>
<td>UW-Superior</td>
</tr>
<tr>
<td></td>
<td>UW-Whitewater</td>
</tr>
</tbody>
</table>

Instructor response rate.

Originally, science methods instructors from 22 out of the 33 WI TPPs agreed to partake in the study. However, only 18 completed the survey from 17 different TPPs. One TPP had two
separate instructors complete the survey. As for the 16 TPPs not included in the final dataset, two professors declined to partake, four did not offer science methods courses during the Fall semester, five never responded to the three inquiry emails, and five originally agreed to partake in August but did not complete the Instructor Survey (nor did their students participate in the study).

**Demographics of pre-service teachers.**

Results from the 11 demographic questions were collected from Student Survey responses. Of the 241 pre-services teachers, 88% selected education (early childhood and elementary) as their major, 11% chose natural sciences, and 1% selected other. Zero students identified humanities, social sciences or mathematics as their major.

As for pre-service teachers seeking to teach **different age levels**, the most selected category was elementary \( (n = 154) \) followed by both early childhood and elementary \( (n = 47) \), secondary \( (n = 29) \), early childhood \( (n = 9) \), all ages \( (n = 1) \), and other \( (n = 1) \). Results indicated that more public TPP pre-service teachers completed the Student Survey \( (n = 158) \) than those attending private TPP \( (n = 60) \). Unfortunately, 23 students did not complete this question; therefore, they were not included in analyses that required information about **institution types**.

As per criterion sampling, a large percentage of the participants were upper level pre-service teachers when asked their **student status**. Over 95% of the students selected junior, senior, or I already have a bachelor’s degree. Ten students self-identified as sophomores, yet zero students designated themselves as first years. One student did not answer the student status question; therefore, they were not included in analyses requiring information about student status. Of the 241 pre-service teachers, 213 were female (88.4%), 27 were male (11.2%), and zero students selected other. However, one student did not identify their **gender**; therefore, they were not included in analyses requiring information about gender.
For the **Tbilisi EE definition question**, 72.0% agreed that EE was incorporated in their coursework with statements such as somewhat agree, agree, or strongly agree. However, 28.0% of participants disagreed with the statement by selecting answers such as somewhat disagree, disagree, or strongly disagree. Four students did not answer this question. In addition, 12 students elected to elaborate on why they agreed or disagreed with short answer responses. However, due to an error in the creation of the online Student Survey, they were only able to provide short answer responses. They were unable to additionally select an answer from the six-point Likert scale. Therefore, these 12 students were excluded from analysis regarding the Tbilisi EE definition. However, their short answer responses shed further light on the variability that can be found between TPPs when it comes to the incorporation of EE into pre-service teacher coursework. For example, answers ranged from “we touch on it very briefly” to “we take an entire course on it.”

In regard to **self-assessed knowledge** compared to their peers, 66.4% selected *average* (*n* = 160), 24.1% chose *above average* (*n* = 58), and 9.5% indicated *below average* (*n* = 23). Additionally, of the 58 students who selected *above average*, 75.9% of those students passed the EK exam (*n* = 44). Similarly, of the 23 students who selected *below average*, only 4.3% of those students passed the exam (*n* = 1). In other words, a large percentage of pre-service teachers whom indicated a high level of self-assessed knowledge, *above average*, did indeed pass the EK exam. Whereas, those that indicated low levels of self-assessed knowledge, *below average*, performed poorly on the EK exam.

Wisconsin was identified as the main **state where pre-service teachers grew up** as a child (72.6%). Interestingly enough, two students selected growing up outside of the U.S. in Venezuela and Bangladesh. For **childhood environment**, small city (between 2,500 – 50,000) and suburban were the two most selected answers with 48.5% of pre-service teachers selecting one or the other.
Two demographic questions allowed pre-service teachers to identify multiple environmental factors that influenced their lives (Table 4). In regard to positive childhood environmental activities, playing outside was the most selected answer \((n = 220)\). The least selected was bird watching \((n = 59)\). One student did not select any choices, whereas another student selected the maximum of 15. Of special note, four out of the 16 students who selected other indicated that they “grew up on a farm” when asked to elaborate with a short answer response. As for primary sources of environmental information, pre-service teachers indicated classes/courses \((n = 154)\), movies/documentaries \((n = 117)\), and social media \((n = 109)\) to be the top three avenues in which they learn about environmental information. The least selected was radio \((n = 8)\). All pre-service teachers selected at least one primary source of environmental information. None of the above was an option, but zero students selected it.
Table 4

*Environmental Factors Influencing Pre-Service Teachers*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Possible Answer Choices</th>
<th>( n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Environmental Childhood Activities(^a)</td>
<td>Playing outside</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>Visiting zoos/aquariums</td>
<td>182</td>
</tr>
<tr>
<td></td>
<td>Biking</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Hiking</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>Camping</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>Visiting nature centers</td>
<td>154</td>
</tr>
<tr>
<td></td>
<td>Fishing/hunting</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>Canoeing/kayaking</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>Gardening</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Watching &quot;Animal Planet&quot; or similar movies/shows</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>Attending summer camp</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Reading a nature-related book</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Snowshoeing/skiing</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Bird-watching</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary Sources of Environmental Information(^b)</th>
<th>Classes/courses</th>
<th>154</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Movies/documentaries</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Social Media (Facebook, YouTube, Instagram, Twitter)</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td>Friends/relatives</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>TV news programs</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Books/library</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Magazines/newspaper (print or online)</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Radio</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>None of the above</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^a\)Able to select as many as was applicable \(^b\)Able to select a maximum of three
Knowledge Items

The Student Survey asked 12 EK questions (see Appendix A for full listing of questions and answer choices). The mean EK score for the study was 8.29 ($n = 241$, SD = 2.30). This translated to letter grade of a D. In fact, only 49% ($n = 118$) of pre-service teachers passed the EK exam with a score of 9 or more (Table 5). In other words, less than half of the pre-service teachers passed the basic EK exam. The percentage of correct responses per EK question is reported in Table 6.

Table 5

*Pre-Service Teachers’ Environmental Knowledge Report Card*

<table>
<thead>
<tr>
<th>Grade</th>
<th>EK Exam</th>
<th>Total Sample Receiving Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (11 or 12 correct)</td>
<td>Pass</td>
<td>20%</td>
</tr>
<tr>
<td>B (10 correct)</td>
<td>Pass</td>
<td>16%</td>
</tr>
<tr>
<td>C (9 correct)</td>
<td>Pass</td>
<td>13%</td>
</tr>
<tr>
<td>D (8 correct)</td>
<td>Fail</td>
<td>14%</td>
</tr>
<tr>
<td>F (7 or fewer)</td>
<td>Fail</td>
<td>37%</td>
</tr>
<tr>
<td>Overall passing grade</td>
<td></td>
<td>49%</td>
</tr>
</tbody>
</table>

Results indicated that there were six EK questions where 15% or more of the students selected a singularly incorrect answer (Table 7). For example, 46% of the pre-service teachers incorrectly selected factories and businesses as the largest contributor of carbon monoxide to air pollution as opposed to the correct answer, which was motor vehicles (EK2). Furthermore, over 21% selected don’t know, which was considered to be an incorrect answer, when presented with questions about nuclear waste storage in the U.S. (EK11) and the primary role of wetlands (EK12).

Table 7

<table>
<thead>
<tr>
<th>Abbreviated EK Question</th>
<th>Incorrect Answer Selected</th>
<th>n</th>
<th>% Selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>EK2 Largest contributor of carbon monoxide to air pollution?</td>
<td>a. Factories and businesses</td>
<td>111</td>
<td>46</td>
</tr>
<tr>
<td>EK11 What happens with nuclear waste in U.S.?</td>
<td>e. Don't Know</td>
<td>67</td>
<td>28</td>
</tr>
<tr>
<td>EK12 Primary role of a wetland?</td>
<td>e. Don't Know</td>
<td>55</td>
<td>23</td>
</tr>
<tr>
<td>EK4 Most common cause of water pollution?</td>
<td>d. Waste dumped by factories</td>
<td>52</td>
<td>22</td>
</tr>
<tr>
<td>EK7 Most likely place for garbage to end up?</td>
<td>a. Oceans</td>
<td>48</td>
<td>20</td>
</tr>
<tr>
<td>EK9 Household hazardous waste?</td>
<td>a. Plastic packaging</td>
<td>37</td>
<td>15</td>
</tr>
</tbody>
</table>
Six demographic questions were looked at more in-depth. The mean EK scores and percentage of students who passed the EK exam were calculated for each of the levels within these six questions (Table 8). For example, 85% (n = 23) of the students who selected natural sciences as their major passed the EK exam, whereas only 44% (n = 94) of education (early childhood and elementary) majors passed. In other words, a higher percentage of natural science majors passed the EK exam than education majors. As for pre-service teachers seeking to teach different age levels, 83% (n = 24) of those seeking to teach secondary-aged students passed the EK exam. Whereas, less than half of the pre-service teachers seeking to teach younger-aged students passed (early childhood, elementary, or both early child and elementary). Another demographic question, student status, highlighted that 82% (n = 22) of students who selected I already have a bachelor’s degree passed the EK exam; however, only 25% (n = 2) of sophomores passed. In other words, a higher percentage of students with more academic preparation passed the EK exam than those just starting out in their academic careers. In regard to gender, 85% (n = 23) of male pre-service teachers passed the EK exam, whereas less than 50% (n = 95) of female pre-service teachers passed. As for institution type, 53% (n = 83) of pre-service teachers attending a public TPP passed, whereas only 35% (n = 21) of private TPP students passed. Lastly, regarding childhood environment, more than 50% of pre-service teachers from rural non-farm, suburban, or small city categories passed the EK exam. Meanwhile, less than 50% of the pre-service teachers that selected small town, rural farm, or large city passed the exam.
Table 8

*Mean EK and Passing Rate for Six Demographic Questions*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Level</th>
<th>n</th>
<th>Mean EK</th>
<th>Passed EK Exam n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>Natural Sciences</td>
<td>27</td>
<td>10.37</td>
<td>23 (85%)</td>
</tr>
<tr>
<td></td>
<td>Education (early childhood or elementary)</td>
<td>212</td>
<td>8.02</td>
<td>94 (44%)</td>
</tr>
<tr>
<td>Different Age Levels</td>
<td>All Ages (licensing level for music, art, and foreign languages)</td>
<td>1</td>
<td>11.00</td>
<td>1 (100%)</td>
</tr>
<tr>
<td></td>
<td>Secondary</td>
<td>29</td>
<td>10.21</td>
<td>24 (83%)</td>
</tr>
<tr>
<td></td>
<td>Elementary</td>
<td>154</td>
<td>8.12</td>
<td>72 (47%)</td>
</tr>
<tr>
<td></td>
<td><em>Both Early Childhood and Elementary</em></td>
<td>47</td>
<td>7.98</td>
<td>20 (43%)</td>
</tr>
<tr>
<td></td>
<td>Early Childhood</td>
<td>9</td>
<td>6.44</td>
<td>1 (11%)</td>
</tr>
<tr>
<td></td>
<td><em>Other</em></td>
<td>1</td>
<td>7.00</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Student Status</td>
<td><em>I already have a bachelor's degree</em></td>
<td>27</td>
<td>10.04</td>
<td>22 (82%)</td>
</tr>
<tr>
<td></td>
<td>Senior</td>
<td>163</td>
<td>8.34</td>
<td>83 (51%)</td>
</tr>
<tr>
<td></td>
<td>Junior</td>
<td>40</td>
<td>7.10</td>
<td>11 (28%)</td>
</tr>
<tr>
<td></td>
<td>Sophomore</td>
<td>10</td>
<td>7.80</td>
<td>2 (25%)</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>6.00</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>27</td>
<td>9.93</td>
<td>23 (85%)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>213</td>
<td>8.09</td>
<td>95 (45%)</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>6.00</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Institution Type</td>
<td>Public TPP</td>
<td>158</td>
<td>8.41</td>
<td>83 (53%)</td>
</tr>
<tr>
<td></td>
<td>Private TPP</td>
<td>60</td>
<td>7.75</td>
<td>21 (35%)</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>23</td>
<td>8.91</td>
<td>14 (61%)</td>
</tr>
<tr>
<td>Childhood Environment</td>
<td>Rural Non-Farm</td>
<td>29</td>
<td>9.07</td>
<td>16 (55%)</td>
</tr>
<tr>
<td></td>
<td>Suburban</td>
<td>49</td>
<td>8.43</td>
<td>27 (55%)</td>
</tr>
<tr>
<td></td>
<td>Small City (between 2,500 - 50,000 people)</td>
<td>68</td>
<td>8.38</td>
<td>36 (53%)</td>
</tr>
<tr>
<td></td>
<td>Small Town (less than 2,500 people)</td>
<td>33</td>
<td>7.97</td>
<td>15 (46%)</td>
</tr>
<tr>
<td></td>
<td>Rural Farm</td>
<td>38</td>
<td>7.87</td>
<td>15 (40%)</td>
</tr>
<tr>
<td></td>
<td>Large City (greater than 50,000)</td>
<td>24</td>
<td>7.92</td>
<td>9 (38%)</td>
</tr>
</tbody>
</table>
Personal Environmental Education Teaching Efficacy Scores

The Student Survey asked 13 PEETE questions with a potential range of PEETE scores from 13 to 78 (see Appendix A for full listing of questions and answer choices). The frequency of PEETE scores for the study are reported in Figure 6. One student did not select an answer for a PEETE question; therefore, they were excluded from all analyses involving PEETE. The mean PEETE score for the study was 56.54 ($n = 240$, $SD = 8.97$), while the median was 57. The maximum PEETE score was 78 ($n = 3$), while the minimum was 31 ($n = 1$).

Figure 6

*Frequency of PEETE Scores*

Instructor Survey Results

The information gathered from the Instructor Survey provided insight into the TPP and the related Student Survey responses. Instructors were asked to assess the incorporation of EE into
their pre-service teacher coursework at their TPP using a six-point Likert scale. Furthermore, instructors were asked to elaborate on where EE is included in their pre-service teacher coursework. Listed below are four out of 18 instructors’ responses regarding their assessment of the incorporation of EE (Tbilisi EE Definition) and their short answer responses in order to provide context for the range of instructor responses. Two moderate answers were recorded (disagree and somewhat agree), as well as two extreme responses (strongly agree and strongly disagree).

1. **Strongly Disagreed** with how EE is incorporated in pre-service teacher coursework at their TPP: In fact, so much so that the instructor just stated, “they don’t” when asked where pre-service teachers learn about EE in their coursework.

2. **Disagreed** with how EE is incorporated in pre-service teacher coursework at their TPP: “They’re supposed to learn about it in my courses [Science Teaching Methods (secondary) & Methods of Teaching Science (elementary)]. Honestly, we often run out of time, and it is not always addressed with sufficient detail…”

3. **Somewhat Agreed** with how EE is incorporated in pre-service teacher coursework at their TPP: “Most education students are required to complete a 2-credit Environmental Education course as a part of their pre-service teacher training.”

4. **Strongly agreed** with how EE is incorporated in pre-service teacher coursework at their TPP: “In this course [Integrated STEM Methods], the students learn about environmental education topics. They also take a Geology course that talks about it as well as an advanced course in Educational Studies.”

Five instructors were unable to record their response to the Likert scale because of an error in the survey.
RQ 1: Correlation Between Knowledge, Efficacy, and Positive Childhood Environmental Activities

The first research question this study sought to answer was:

What are the relationships between pre-service teachers' EK, PEETE, and number of positive childhood environmental activities?

The primary data analysis strategy employed to resolve this question was a Pearson product-moment correlation coefficient, or Pearson correlation coefficient. The analysis was used to discover the relationship between pre-service teachers' EK (as measured by mean EK scores), PEETE (as measured by mean PEETE scores) and positive childhood environmental activities (as measured by mean number of positive childhood environmental activities). Then, the Pearson correlation coefficient measured the strength of the relationship between each of the variables: EK to PEETE, PEETE to positive childhood environmental activities, and EK to positive childhood environmental activities.

Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity had occurred. The results from the Pearson correlation coefficient indicated that there was a moderate, positive correlation between EK and PEETE, $r(238) = .311, p < .001$ (meaning that there is less than a 1 in 1000 chance of the result being due to random chance). In other words, high levels of EK were associated with higher levels of PEETE. In addition, there was a small, positive correlation between PEETE and positive childhood environmental activities, $r(238) = .180, p = .005$, meaning a high level of PEETE was associated with a higher number of positive childhood environmental activities. However, the relationship between EK and positive childhood environmental activities was not significant, $r(239) = .061, p = .350$. 


RQ 2: Different Age Levels

The second research question asked by this study considered the following:

Do pre-service teachers seeking to teach different age levels show significant differences in EK and PEETE? If so, then how?

Two separate, one-way ANOVAs were conducted to determine whether EK (as measured by the mean EK scores) and PEETE (as measured by mean PEETE scores) of pre-service teachers seeking to teach different school-aged children were significantly different. Pre-service teachers were placed into different age level categories based on self-selected answers chosen on the Student Survey: early childhood, elementary, secondary, or both early childhood and elementary. Mean EK and PEETE were calculated for each of the different age level categories. The assumption of homogeneity of variance was violated for EK; therefore, the Welch $F$-ratio was reported.

Results indicated that there were significant differences between pre-service teachers seeking to teach different age levels in regards to EK, $F(3, 32.68) = 16.37, p < .001$. The effect size, calculated using eta squared, was .12. In other words, the actual difference in EK between groups was medium in size. Post hoc comparisons using the Games-Howell test indicated that EK for pre-service teachers seeking to teach secondary-aged students ($M = 10.21, SD = 1.57$) was significantly higher than the other three groups: elementary ($M = 8.12, SD = 2.19$), both early childhood and elementary ($M = 7.98, SD = 2.46$), and early childhood ($M = 6.44, SD = 1.94$). However, there was no statistically significant difference in EK between the other three groups.

As for PEETE, there was no statistically significant difference at the $p < .05$ level between any of the different age levels categories: $F(3, 234) = 1.14, p = .335$. The effect size, calculated using eta squared, was .01 and small in size.
RQ 3: Childhood Environment

The third research question emphasized by this study was:

Do pre-service teachers from different childhood environments show significant differences in EK and PEETE? If so, then how?

Two separate, one-way ANOVAs were conducted to determine whether EK (as measured by the mean EK scores) and PEETE (as measured by mean PEETE scores) of pre-service teachers from different childhood environments were significantly different. Pre-service teachers were placed into childhood environment categories based on self-selected answers chosen on the Student Survey: rural farm, rural non-farm, suburban, small town, small city, and large city. Mean EK and PEETE were calculated for each of the childhood environment categories. The assumption of homogeneity of variance was violated when calculating EK; therefore, the Welch $F$-ratio was reported for each.

Results indicated there was no statistically significant difference in EK between any of the different childhood environment categories, $F(5, 93.88) = 1.33, p = .258$. The effect size, calculated using eta squared, was .03 and small in size. In addition, there was no statistically significant difference in PEETE for any of the different childhood environment categories, $F(5, 234) = .97, p = .440$. The effect size, calculated using eta squared, was .02 and small in size. In other words, pre-service teachers from different childhood environments were not different in their EK and PEETE.

RQ 4: Factors Influencing Environmental Knowledge

The fourth research question this study sought to answer was:

Of the factors that were measured, what factors are most important in explaining whether pre-service teachers passed the EK exam?
Binary logistic regression was performed to assess the impacts of a number of factors on the likelihood that pre-service teachers would pass the EK exam. The model contained six independent variables (different age levels, childhood environment, gender, institution type, PEETE scores, and total number of positive childhood environmental activities). The full model containing all independent variables was statistically significant, $\chi^2 (6, N = 215) = 40.99, p < .001$, indicating that the model was able to distinguish between pre-service teachers that passed and did not pass the EK exam. The model as a whole explained between 17.4% (Cox and Snell R square) and 23.2% (Nagelkerke R squared) of the variance in pre-service teachers that passed the EK exam, and correctly classified 66.5% of cases.

Four of the six independent variables made a unique statistically significant ($p < .05$) contribution to the model: gender, different age levels, PEETE score, and institution type. The strongest predictor of reporting a passing EK exam score was gender, recording an odds ratio of 5.64. In other words, men were 5.64 times more likely to pass the EK exam than women, controlling for all other factors in the model. Additionally, pre-service teachers seeking to teach secondary age level students were 4.36 times more likely to pass the EK exam than pre-service teachers seeking to teach younger students (early childhood, elementary, and early childhood and elementary). As for PEETE score, pre-service teachers were 1.06 times more likely to pass the EK exam for every unit their PEETE score increased. A unit of PEETE score equaled one point. For example, five units of difference would be allotted for someone who indicated, strongly agree (6 points) on a given PEETE question versus strongly disagree (1 point). Therefore, for each PEETE question, a pre-service teacher who strongly agreed with the question was 5.30 times more likely to pass the EK test than a pre-service teacher who strongly disagreed with the statement. Lastly, in regard to institution type, pre-service teachers educated at public TPPs were 2.13
times more likely to pass the EK exam than those educated at private TPPs. See Table 9 for additional detail.

Table 9

**Logistic Regression Predicting Likelihood of Passing EK Exam**

<table>
<thead>
<tr>
<th>Factor</th>
<th>B</th>
<th>S.E</th>
<th>Wald</th>
<th>df</th>
<th>p</th>
<th>Odds Ratio</th>
<th>95% C.I. for Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1.73</td>
<td>.79</td>
<td>4.78</td>
<td>1</td>
<td>.03*</td>
<td>5.64</td>
<td>1.20 - 26.60</td>
</tr>
<tr>
<td>Different Age Levels</td>
<td>1.47</td>
<td>.55</td>
<td>7.06</td>
<td>1</td>
<td>.01*</td>
<td>4.36</td>
<td>1.47 - 12.92</td>
</tr>
<tr>
<td>Total PEETE Score</td>
<td>.06</td>
<td>.02</td>
<td>9.43</td>
<td>1</td>
<td>.00*</td>
<td>1.06</td>
<td>1.02 - 1.10</td>
</tr>
<tr>
<td>Institution Type</td>
<td>-.75</td>
<td>.35</td>
<td>4.53</td>
<td>1</td>
<td>.03*</td>
<td>.47</td>
<td>.24 - .94</td>
</tr>
<tr>
<td>Childhood Environment</td>
<td>.35</td>
<td>.31</td>
<td>1.28</td>
<td>1</td>
<td>.26</td>
<td>1.42</td>
<td>.77 - 2.63</td>
</tr>
<tr>
<td>Total # of Positive Childhood Environmental Activities</td>
<td>.03</td>
<td>.06</td>
<td>.21</td>
<td>1</td>
<td>.65</td>
<td>1.03</td>
<td>.92 - 1.15</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.74</td>
<td>1.11</td>
<td>11.34</td>
<td>1</td>
<td>.00</td>
<td>.02</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05

**Additional Data Analysis**

**SQ 1: Student status.**

Do pre-service teachers with different student statuses show significant differences in EK and PEETE? If so, then how?

Two separate, one-way ANOVAs were conducted to determine whether EK (as measured by the mean EK scores) and PEETE (as measured by mean PEETE scores) of pre-service teachers in different student status categories were significantly different. Pre-service teachers were placed into four student status categories based on self-selected answers chosen on the Student Survey: sophomores, juniors, seniors, and *I already have a bachelor’s degree*. Mean EK and PEETE were calculated for each student status category. The assumption of homogeneity of variance was violated when calculating EK and PEETE; therefore, the Welch $F$-ratio was reported.

Student status groups were significantly different in their EK, $F(3, 35.63) = 11.48, p < .001$. The effect size, calculated using eta squared, was .11. In other words, the actual difference
in EK between student status categories was medium in size. Post hoc comparisons using the Games-Howell test indicated that EK for I already have a bachelor’s degree students \((M = 10.04, SD = 1.81)\) was significantly higher than all other student status categories: senior \((M = 8.34, SD = 2.21)\), junior \((M = 7.10, SD = 2.39)\), and sophomore \((M = 7.80, SD = 1.48)\). Furthermore, EK for seniors was significantly higher than juniors, but not sophomores. However, there was no significant difference in EK between juniors and sophomores. As for PEETE, there was no statistically significant difference between the four student status categories: \(F(3, 32.82) = 2.45, p = .08\). The effect size, calculated using eta squared, was .04.

**SQ 2: Self-assessed knowledge.**

Do pre-service teachers with different self-assessed knowledge levels show significant differences in EK and PEETE? If so, then how?

Two separate, one-way ANOVAs were conducted to determine whether EK (as measured by the mean EK scores) and PEETE (as measured by mean PEETE scores) of pre-service teachers in different self-assessed knowledge categories were significantly different. Pre-service teachers were placed into three self-assessed knowledge categories based on their self-selected answers on the Student Survey: below average, average, and above average. Average EK and PEETE were calculated for each category. The assumption of homogeneity of variance was violated when calculating EK; therefore, the Welch \(F\)-ratio was reported.

As for EK, self-assessed knowledge responses were significantly different between groups on EK, \(F(2, 64.50) = 29.11, p < .001\). The effect size, calculated using eta squared, was very large in size 0.15. Post hoc comparisons using the Games-Howell test indicated that EK for above average students \((M = 9.66, SD = 2.00)\) was significantly higher than all other self-assessed knowledge categories: average \((M = 8.04, SD = 2.25)\), and below average \((M = 6.57, SD = 1.50)\). Furthermore, average students had significantly higher EK than below average students. In other words, students accurately self-selected their perceived EK in comparison to their actual EK.
As for PEETE, there was a statistically significant difference in PEETE for the three self-assessed knowledge categories: \( F(2, 237) = 57.81, p < .001 \). The effect size, calculated using eta squared, was .33 and very large in size. Post-hoc comparisons using the Tukey HSD test indicated that there were statistically significant differences in PEETE between all three categories. Post hoc results indicated that PEETE for *above average* students \((M = 63.54, SD = 7.41)\) was significantly higher than all other self-assessed knowledge categories: *average* \((M = 55.80, SD = 7.47)\), and *below average* \((M = 44.35, SD = 6.64)\). Furthermore, *average* students had significantly higher PEETE than *below average* students. In other words, students who selected that they were more knowledgeable (*above average*) about environmental information than their peers, also self-identified as being more confident teaching EE materials with higher PEETE scores.

**SQ 3: Institution type.**

Do pre-service teachers attending public versus private TPPs show significant differences in EK and PEETE? If so, then how?

Two separate, independent-samples \( t \)-tests were conducted to determine whether EK (as measured by the mean EK scores) and PEETE (as measured by mean PEETE scores) were significantly different for pre-service teachers at different institution types. Pre-service teachers were placed into *public* or *private* TPP categories based on self-selected answers chosen on the Student Survey. Average EK and PEETE were calculated for each of the categories. Results indicated there were no statistically significant differences in EK between students based on their institution type, \( t(216) = 1.88, p = .061, 95\% \text{ CI } [-.03, 1.34] \). The effect size, calculated using eta squared, was .02 and small in size. Additionally, there were no statistically significant differences in PEETE for students based on their institution type, \( t(215) = 1.25, p = .213, 95\% \text{ CI } [-1.00, 4.47] \). The effect size, calculated using eta squared, was .01 and small in size.
SQ 4: Gender.

Do male and female pre-service teachers show significant differences in EK and PEETE? If so, then how?

Two separate, independent-samples $t$-tests were conducted to determine whether EK (as measured by the mean EK scores) and PEETE (as measured by mean PEETE scores) were significantly different for male or female pre-service teachers. Pre-service teachers were placed into male or female categories based on self-selected answers chosen on the Student Survey. Average EK and PEETE were calculated for each of the categories. The assumption of homogeneity of variance was violated when calculating EK; therefore, Welch’s $t$ was reported. EK was higher for male pre-service teachers ($M = 9.93, SD = 1.75$) than for females ($M = 8.09, SD = 2.28$), $t(38.16) = -4.93, p < .001, 95\% CI [-2.58, -1.08]$. The effect size, calculated using eta squared, was .09 and moderate in size. In other words, 9% of the variance in EK scores was associated with student gender.

As for PEETE, there was a statistically significant difference in PEETE scores between males ($M = 61.04, SD = 9.04$) and females ($M = 56.03, SD = 8.80$), $t(237) = -2.78, p = .006, 95\% CI [-8.56, -1.46]$. The effect size, calculated using eta squared, was .03 and small in size. In other words, male pre-service teachers had significantly higher EK and self-identified as being more confident teaching EE materials than female pre-service teachers.

SQ 5: Major.

Do pre-service teachers with different majors show significant differences in EK and PEETE? If so, then how?

Two separate, independent-samples $t$-tests were conducted to determine whether EK (as measured by the mean EK scores) and PEETE (as measured by mean PEETE scores) were significantly different for pre-service teachers with different majors. Pre-service teachers were placed into education (early childhood and elementary) or natural sciences categories based on
self-selected answers chosen on the Student Survey. Average EK and PEETE scores were calculated for both categories. The assumption of homogeneity of variance was violated when calculating EK; therefore, Welch’s $t$ was reported.

Results indicated that there was a statistically significant difference in EK between majors. Natural sciences students ($M = 10.37, SD = 1.39$) scored higher than education students ($M = 8.02, SD = 2.26$), $t(45.79) = -7.60, p < .001, 95\% CI [-2.97, -1.73]$. The effect size, calculated using eta squared, was .20 and very large in size. In other words, 20\% of the variance in EK was associated with student major.

As for PEETE, there was no statistically significant difference at the $p < .05$ level in PEETE for education (early childhood and elementary) nor natural sciences students, $t(236) = -1.28, p = .202, 95\% CI [-5.96, 1.27]$. The effect size, calculated using eta squared, was .01 and small in size. In other words, a pre-service teacher’s major did not impact their confidence teaching EE materials.

**Summary**

This chapter has covered the results of the study, focusing on reliability of PEETE scale, descriptive statistics, knowledge items, PEETE scores, Instructor Survey results, four main research questions, and additional data analysis through sub-research questions. Through descriptive statistics, Pearson correlation coefficient, independent samples $t$-tests, logistic regression, and one-way ANOVAs, supplemented by both Tukey HSD and Games-Howell post hoc tests, the results from this study have been determined. The final chapter of this study will explain the implications of the results of this chapter. Chapter 5 will depict that the results of this study demonstrated significant conclusions with profound implications for the understanding and development of pre-service teachers’ EK and PEETE in science methods courses across Wisconsin’s TPPs.
CHAPTER 5: CONCLUSION

This chapter serves as the culmination of this study, presenting the conclusions and implications. The previous chapters have provided an introduction to the focus of this study (Chapter 1), a review of pertinent literature to offer a context for this study (Chapter 2), the methods used to resolve the study’s research questions (Chapter 3), and the results (Chapter 4).

This chapter will draw conclusions from the results to the four research questions in this study, as well as relevant sub-research questions, and discuss further recommendations for TPPs and non-formal EE centers.

The goals of this chapter echo the objectives of this study laid out in Chapter 1:

1. Assess the EK and PEETE of upper level pre-service teachers.
2. Promote the importance of EE, and its research, in TPPs to increase the number of environmentally literate pre-service teachers, and indirectly their future students.
3. Analyze the possibilities of diversifying and expanding the scope and practice of EE in TPPs.

These objectives suggest the relevance of this study for TPPs and EE professionals within these topics, as well as its significance for future research. By the end of this chapter, the meaning of the study will be clear regarding a better understanding of EK and PEETE of pre-service teachers in science methods courses across Wisconsin’s TPPs.

RQ 1: Correlation Between Knowledge, Efficacy, and Positive Childhood Environmental Activities

The first research question of the study was:

What are the relationships between pre-service teachers' EK, PEETE, and number of positive childhood environmental activities?
EK and PEETE.

The results from RQ 1 support the idea that there is a moderate, positive relationship between pre-service teachers’ EK and their confidence teaching EE materials, PEETE. This is supported by earlier research in which a moderate, positive relationship was found between mathematic content knowledge and personal teaching efficacy of pre-service elementary teachers enrolled in an elementary mathematics methods course (Newton et al., 2012). Additionally, Menon and Sadler (2016) indicated a moderate, positive relationship between gains in science conceptual understandings (science knowledge) and gains in personal science teaching efficacy for pre-service elementary teachers enrolled in a semester long specialized science content course. Although there is a positive correlation between EK and PEETE, it does not mean that increasing one will directly increase the other. However, there is strong evidence from both Newton et al. (2012) and Menon and Sadler’s (2016) research, as well as the current research, that increasing content knowledge, in a specific subject such as science, mathematics or EK, may be an avenue to increase pre-service teachers’ personal teaching efficacy in that subject. For example, it is possible that a pre-service teacher who becomes more knowledgeable about environmental concepts will feel more confident teaching about the environment in their future classroom. Similarly, if a pre-service teacher becomes more confident teaching environmental concepts (increases PEETE), then they will be more likely to invest time and energy to learn about environmental concepts (increases EK) in order to better communicate environmental concepts to their future students. Of course, there is a chance that other outside factors such as age, gender, motivation and others play a role in explaining this correlation, but that is outside the scope of the current study. Therefore, this relationship between EK and PEETE will lay the groundwork for the remainder of this chapter. In fact, the results from the current study fall in line with the theories as connected and presented in Chapter 1 (Figure 3).
Additionally, results from the current study indicate that Wisconsin pre-service teachers have low EK (M = 8.29 or a letter grade of D). This is worrisome because effective EE instruction requires teachers to have the knowledge and skill base to teach EE (Ernst, 2009). Low EK may hinder the incorporation of EE material into their future classrooms due to avoidance behavior as laid out by Bandura’s self-efficacy theory (1977). Furthermore, previous research has shown that increasing an individual’s EK results in more positive attitudes toward the environment (Bradley et al., 1999; McMillan et al., 2004) and more responsible environmental behavior (Hsu, 2004).

Therefore, one suggestion to increase pre-service teachers’ EK would be to require all pre-service teachers to take at least one environmental science class during their undergraduate careers. For example, Robinson and Crowther (2001) indicated that university students who completed at least one environmental science class had higher EK than those who did not. However, increasing pre-service teacher course load is not always possible. Therefore, if we are to further develop EK of pre-service teachers’, a second suggestion would be to focus directly on increasing pre-service teachers’ PEETE since the two components were found to be positively correlated. One recommendation to increase pre-service teachers’ PEETE, and indirectly increase their EK, would be to include more service-learning opportunities in their coursework connected to EE practices. This idea is elaborated on further in the opportunities to increase pre-service teachers’ PEETE section later in this chapter.

**PEETE and number of positive childhood environmental activities.**

Additional results from the current study indicated there was a small, positive correlation between PEETE and total number of positive childhood environmental activities. In other words, increasing the number of environmental activities that children are exposed to could potentially influence a future teachers’ PEETE, consequently leading to future pre-service teachers who are environmentally responsible in their adult lives. This is supported by earlier research in which the
frequency of childhood play in green spaces was correlated strongly with the frequency of nature-based activities among adult urban residents (Hosaka et al., 2018). Therefore, investments should be made to increase opportunities for children to be exposed to more environmental activities in the hopes of generating environmentally responsible adults. This can be done both in the classroom, as well as after school hours.

For example, *Wisconsin’s Plan to Advance Education for Environmental Literacy and Sustainability in PK-12 Schools* (WDPI, 2011) proposed strategies to ensure all students graduate environmentally literate such as providing field experiences (field trips) as part of the regular school curriculum. School field trips to local nature centers or zoos/aquariums would allow children to be exposed to more environmental activities. Additionally, a simple way for teachers to increase children’s exposure to environmental activities is through the incorporation of EE into their daily coursework such as utilizing a school forest or local park. This would expose children to more environmental activities such as playing outside, reading a nature-related book, hiking or bird-watching.

However, opportunities to increase the frequency of children’s exposure to environmental activities should happen outside of school hours as well. For example, parents should actively seek out opportunities in their local communities in which environmental activities are offered. Additionally, parents can offer more unstructured time to play outside. At the same time, local parks/nature centers should offer more programs in which children and their families are exposed to positive childhood environmental activities such as canoeing, camping, fishing/hunting, or just a place to play outside per the pre-service teachers’ responses in this study. These were all highly selected activities that influenced pre-service teachers’ outlook on the environment as a child. Programs such as these might just be the spark needed to increase positive nature-related behaviors in individuals later on in life.
Regardless of where children are exposed to environmental activities, the current study suggests that positive childhood environmental activities influence pre-service teachers’ confidence teaching EE materials (PEETE). Therefore, if pre-service teachers were exposed to more positive childhood environmental activities, associated with green spaces, at a younger age this could potentially trigger and cultivate confidence teaching EE materials when they reach adulthood. Further research is needed to explore this topic.

**EK and number of positive childhood environmental activities.**

Current results indicate that the relationship between pre-service teachers’ EK and the number of positive childhood environmental activities they selected were not significant. The results of this finding are unclear. Non-significant findings could be due to a violation of certain assumptions. For example, the lack of correlation between EK and positive childhood environmental activities could be because the analytical method assumed that both variables were 1) continuous, which they were not, and 2) had a linear relationship, which may not have been the case. Another suggestion for why these two variables were not significantly correlated could be because the focus of this question was on the quantity of positive childhood environmental activities pre-service teachers experienced based on the total number of activities they selected. However, the survey question did not emphasize the frequency in which each activity was completed. For example, if a pre-service teacher selected camping as an activity that positively influenced their outlook on the environment as a child, it is unknown whether they went just once as a child, multiple times a year, or spent an entire summer in their tent. Additionally, the potency of that positive childhood environmental activity was not evaluated in the current study. For example, if a pre-service teacher went camping once with their family as a child in Yellowstone National Park then the potency of the experience may be different than if they just went camping at a local county park. Therefore, two suggestions for future research would be to include a follow
up question on the Student Survey in which pre-service teachers could indicate the frequency in which they completed an environmental activity. In addition, a follow up question addressing the potency of the experience could also be included. These suggestions could provide further insight into the actual relationship between EK and the number of positive childhood environmental activities.

RQ 2: Different Age Levels

The second research question of the study was:

Do pre-service teachers seeking to teach different age levels show significant differences in EK and PEETE? If so, then how?

Results for the second research question suggest that pre-service teachers seeking to teach secondary-aged students have higher levels of EK than the three other age level categories: early childhood, elementary, and both early childhood and elementary. Furthermore, over 80% of secondary students passed the EK exam, yet a low percentage of pre-service teachers from the other three categories passed the EK exam. This difference in EK between pre-service teachers seeking to teach secondary-aged students versus those seeking to teach younger-aged students was not surprising. For example, pre-service teachers seeking to teach secondary-aged students (different age level) might major in natural sciences, but minor in education. They are required to complete coursework in life, physical, and earth sciences as part of their degree requirements. Consequently, coursework for pre-service secondary teachers is more science intensive than those seeking to teach younger-aged students. Another consideration is that secondary students may be more motivated to learn science and environmentally related information based on their chosen coursework. In other words, outside factors such as motivation may influence EK or PEETE scores, but that is outside the scope of this project.
The results of the current study align with earlier research in which elementary school teachers were found to have limited EK (Michail et al., 2006). This is problematic because if pre-service teachers seeking to teach younger students have limited EK, then they may potentially be unprepared to teach our youth about current environmental issues our society faces in their future classrooms. One suggestion to combat low EK scores for pre-service teachers seeking to teach younger children would be to focus on increasing their PEETE, and ultimately their EK, through a specialized science/EE content course such as that done by Menon and Sadler (2016). In other words, a science course specifically designed for pre-service early childhood and elementary teachers to learn to integrate understanding of science concepts with pedagogical models. This idea is elaborated on further in the *opportunities to increase pre-service teachers’ PEETE* section later in this chapter.

**RQ 3: Childhood Environment**

The third research question emphasized by this study was:

Do pre-service teachers from different childhood environments show significant differences in EK and PEETE? If so, then how?

Results suggest that pre-service teachers from different childhood environments did not differ significantly in their EK or their PEETE. In other words, pre-service teachers who grew up in more rural settings, such as rural farm or rural non-farm or small town, did not differ significantly in EK, nor PEETE, from pre-service teachers who spent their childhoods in more urban settings, such as suburban or small city or large city, environments as predicted. The original hypothesis for this research question inferred that pre-service teachers who grew up in more rural childhood environments would be *more* informed about environmental topics based on their proximity to natural areas. However, this was not the case. Therefore, inferences regarding pre-service teachers’ EK and PEETE should not be based on their childhood environment.
Although there was not a statistically significant difference in EK between participants from different childhood environments in the current study, earlier research by Goldman et al. (2006) suggested that childhood environment was significant in influencing Israeli pre-service teachers’ environmental behavior. For example, Israeli pre-service teachers who grew up in rural areas had significantly higher scores for citizen action, nature related leisure activities, and environmental activism than those that grew up in urban areas. In other words, pre-service teachers’ childhood environments may affect other components of environmental literacy, such as environmental behavior but not necessarily EK. Further research is needed to explore the relationship between other environmental literacy components, EK and PEETE.

**RQ 4: Factors Influencing Environmental Knowledge**

The fourth research question posed by this study was:

Of the factors that were measured, what factors are most important in explaining whether pre-service teachers passed the EK exam?

**PEETE score.**

Pre-service teachers’ PEETE scores were a significant factor in predicting whether pre-service teachers passed the EK exam. Results indicated that for every unit of increase on the 78-point PEETE scale, pre-service teachers were 1.06 times more likely to pass the EK exam. These results reconfirmed those found in RQ 1 and better account for competing explanations. The positive relationship between EK and PEETE still holds up while controlling for most of the pertinent factors all at the same time. The more confident pre-service teachers are in teaching EE materials, indicated by a higher PEETE score, the more likely they are to pass the EK exam. Once again, results indicate that in order to increase pre-service teachers’ EK, emphasis should be placed on building pre-service teachers’ confidence teaching EE materials. Therefore, another suggestion to increase pre-service teachers PEETE would be for TPPs to incorporate opportunities for their
pre-service teachers to complete field experiences at local environmental stations or nature centers. This idea is elaborated on further in the opportunities to increase pre-service teachers’ PEETE section later in this chapter.

**Gender.**

Of the 241 pre-service teachers that completed the Student Survey, 27 were males and 213 were females. The low number of male pre-service teachers was not surprising, since the field of education is predominantly female. Gender was by far the strongest predictor when measuring the likelihood that pre-service teachers would pass the EK exam. Results from SQ 4 also supported this, indicating that mean scores for EK and PEETE were significantly higher for male pre-service teachers than females. Male pre-service teachers not only had higher EK scores than female pre-service teachers, but also a larger percentage of males passed the EK exam. The disparity in EK scores between genders aligns with earlier research. In fact, Robelia and Murphy (2012) presented results from 15 publicized state and national environmental surveys, all of which found that women scored lower on the EK questions than men. One suggestion to reduce the gender gap in EK is through more inquiry-based coursework such as an inquiry-based science/EE course versus a traditional science content course that does not include teaching methods as a topic. An opportunity such as this could further build pre-service teachers’ EK, in addition to their EE teaching efficacy. This idea is elaborated on further in the opportunities to increase pre-service teachers’ PEETE section later in this chapter.

**Different age levels.**

Another factor that played a significant role in predicting whether pre-service teachers passed the EK exam was based on what school-aged students they sought to teach upon graduation: secondary-aged students or younger school-aged students (early childhood, elementary, or both early childhood and elementary). As mentioned earlier in RQ 2, pre-service teachers seeking to
teach secondary-aged students scored significantly higher on EK than the other three categories. Therefore, it was not surprising that the results of the logistic regression indicated that pre-service teachers seeking to teach secondary-aged students were 4.36 times more likely to pass the EK exam than those seeking to teach younger school-aged students.

One hypothesis for explaining the difference in odds ratio would be if more male pre-service teachers were seeking to teach secondary-aged children than female pre-service teachers, based on earlier results that indicated a gender gap in EK. However, a cross-tab analysis between pre-service teachers in different age levels and their gender indicated this was not the case. Of the 29 students who sought to teach secondary-aged children, only 9 were males while the other 20 were females. Therefore, results once again suggest that differences in coursework may play a significant role in the differing levels of EK between pre-service teachers seeking to teach secondary-aged students and those seeking to teach younger-aged students, since those teaching secondary-aged students take additional related courses.

**Institution type.**

Lastly, institution type was a significant factor in predicting whether pre-service teachers passed the EK exam. Pre-service teachers enrolled in private TPPs were 2.13 times less likely to pass the EK exam than those enrolled in public TPPs. Interestingly, institution type was a determining factor in predicting whether pre-service teachers passed the EK exam, but when it came to average EK scores between public and private TPP students, such as that addressed in SQ 3, institution type did not play a significant role. One hypothesis for why pre-service teachers attending private TPPs were less likely to pass the EK exam could be a result of their instructors. For example, private TPPs usually have a smaller pool of faculty because they tend to be smaller institutions. Therefore, the professors might have to teach a greater variety of courses, potentially reducing their opportunity to specialize in a particular topic. In other words, instructors at private
TPPs may have less capacity, in regard to expertise, passion or time, to teach any particular course at the same depth or intensity that a specialist could.

This is in sharp contrast to instructors who work for public TPPs. Public TPPs usually have a larger pool of faculty which may allow for professors to specialize in certain topics such as those relating to the environment. Through this specialization, they may be able to better relay environmental content to their public TPP students. However, this is just one hypothesis for why pre-service teachers attending public TPPs were 2.13 times more likely to pass the EK exam than their private TPP peers. Further research is needed to explore why this might actually be the case.

Sub-Research Questions

SQ 1: Student status.

EK was found to be significantly higher for upper level pre-service teachers, I already have a bachelor’s degree, compared to lower level pre-service teachers: sophomores, juniors and seniors. This was not surprising since NEETF studies found the most significant factor in the varying levels of adult EK was whether or not they had a college education (Coyle, 2005). Coyle (2005) suggested that EK is acquired over a lifetime through jobs, friends, television, etc. However, classes/courses are another way that pre-service teachers are exposed to environmental information. In other words, one hypothesis for the difference in EK between student status categories is that I already have a bachelor’s degree have higher EK because they have been exposed to more environmental information based on life experience and completed coursework.

Based on this hypothesis it was expected that I already have a bachelor’s degree students would have higher EK levels than seniors, seniors higher than juniors, and juniors higher than sophomores. However, this was not the case since the only significant difference in EK was between I already have a bachelor’s degree students compared to the other three categories. No
statistically significant differences were found between sophomores, juniors and seniors in regard to EK. Therefore, another explanation for the significant difference in EK between student status categories could be based on intrinsic interest levels of pre-service teachers. For example, a previous study indicated that non-traditional students had higher levels of intrinsic motivation for learning than traditional aged students (Bye et al., 2007). Therefore, one hypothesis for why EK scores were statistically significant for I already have a bachelor’s degree compared to the other groups, but not between the three lower level groups, was that motivation and interest to learn information may be different between non-traditional pre-service teachers versus traditional pre-service teachers. Additionally, Brophy and Good’s (1984) expectancy-value theory may also highlight why I already have a bachelor’s degree students had higher levels of EK. For example, maybe these older students have a higher level of expectancy regarding information about the environment, in addition to valuing our planet. This combination, high expectancy and high value, might explain why their motivation for learning might be different than their younger counterparts. This, in and of itself, may shed light on their willingness and interest to learn environmental concepts that ultimately affect their EK, but additional research is needed.

As for PEETE, no significant differences were found between the four student status categories. Based on the current study’s results, there seems to be a pattern in which EK was found to be significantly different between groups, but PEETE was not. This suggests that there may be confounding factors in the analyses when studying PEETE. For example, in the case of student status, a confounding factor may be the fact that pre-service teachers in this study have not completed their science methods course. Maybe science methods courses are where pre-service teachers build their confidence to teach environmental concepts. This might explain why no significant differences in PEETE were found between student status groups. However, this is
outside the scope of this project and further research is needed to address this potential confounding factor.

**SQ 2: Self-assessed knowledge.**

Results from post-hoc analyses indicated that there were statistically significant differences in self-assessed knowledge between all three categories (above average, average, below average) for both EK and PEETE. In regard to PEETE, results were not surprising that these two factors (self-assessed knowledge and PEETE) went hand-in-hand because they were both self-assessments. It can be inferred that a pre-service teacher who ranked themselves highly on one would likely do so on the other. As for EK, pre-service teachers who *perceived* their EK to be higher than their peers (above average) did in fact score higher on the EK exam than their peers in other categories. On the other hand, those that *perceived* their EK to be lower than their peers (below average) did in fact score lower on the EK exam. Results suggest that pre-service teachers’ perceptions of their EK (self-assessed knowledge) may be indicative of their actual EK proficiency on the EK exam. However, further research is needed since this relationship was only studied at the surface level.

Of interesting note is the role that gender may play on pre-service teachers’ self-assessed knowledge. As previously stated, national results indicated that self-assessed knowledge was higher among males than females (NEETF, 1997, 2001). Furthermore, another study showed that males also had significantly higher self-assessed knowledge than females (Cooper et al., 2018). Based on descriptive statistics, the current study suggested a similar trend. For example, of the 23 pre-service teachers that selected *below average*, zero were males. In other words, male pre-service teachers may indeed have a higher degree of self-assessed knowledge, in regard to understanding environmental issues, compared to their female peers.
These surface level findings suggest that the gender gap discussed in RQ 4 may also be present when pre-service teachers compare their self-assessed knowledge to their peers. Female pre-service teachers may need extra encouragement to build their confidence teaching environmentally related concepts, in addition to providing them extra resources to increase their EK. One suggestion would be for TPPs to request pre-service teachers complete a quick survey upon being accepted to the TPP pertaining to their self-assessed knowledge. For those that fall on the lower spectrum, such as below average students, extra care should be taken early on in their academic careers to provide them the necessary resources to build their confidence about issues relating to the environment. This idea is elaborated on further in the investigate pre-service teachers’ self-assessed knowledge section later in this chapter.

**SQ 3: Institution type.**

As mentioned earlier in RQ 4, there were no significant differences in average EK or PEETE scores between pre-service teachers enrolled in public versus private TPPs. However, institution type was found to be a statistically significant factor in predicting whether pre-service teachers passed the EK exam. For further interpretations of the results see RQ 4.

**SQ 4: Gender.**

As mentioned earlier in RQ 4, there was a significant difference in average EK and PEETE scores between male and female pre-service teachers. Male pre-service teachers had significantly higher EK and PEETE than females. For further interpretations of results and suggestions for reducing the EK gender gap see RQ 4.

**SQ 5: Major.**

Results indicated that pre-service teachers majoring in natural sciences had significantly higher EK compared to those majoring in education (early childhood or elementary); however, PEETE was not found to be statistically significant between majors. These results mirrored those
found in RQ 2 even though analysis included two separate demographic questions, *different age levels* and *major*. A cross-tab analysis indicated that nearly all of the students who chose natural sciences as their major, also indicated that they sought to teach secondary-aged students (different age level). Similarly, nearly all of the students who chose education as their major, also indicated that they sought to teach early childhood, elementary, or *both early childhood and elementary* aged students (different age level). In other words, although SQ 5 and RQ 2 attempted to study different research topics, results were nearly identical between the two research questions. Therefore, inferences about these results are included in the RQ 2 discussion section.

**Additional Findings**

**Primary sources of environmental information.**

Additional findings highlight other key points of interest. For example, previous studies indicated that media was by far the leading source of environmental information for adults (Coyle, 2005). These reports from the early 2000’s supported the idea that most American adults relied mainly on traditional media sources (TV, newspapers) to satisfy their environmental information needs. However, current results suggest this might no longer be the case for pre-service teachers. Pre-service teachers indicated *classes/courses, movies/documentaries, and social media* as the top three primary sources in which they learned about environmental information. Therefore, future research is needed to explore these potential avenues for disseminating environmental information to not only increase pre-service teachers’ awareness about environmental issues, but also the general public.

**Environmental misconceptions.**

Interpreting results from individual EK items also highlighted key pieces of information. Of concern is that only 44% of pre-service teachers correctly identified motor vehicles as the
largest contributor of carbon monoxide to air pollution (EK2). Furthermore, descriptive statistics indicated that 46% of pre-service teachers *incorrectly* selected factories and businesses as the largest contributor of carbon monoxide for EK2. This is problematic because misinformation may be as much of a problem as lack of information when it comes to carbon emissions. For example, if more pre-service teachers were aware that their personal vehicles contribute more to air pollution than factories and businesses, then it may encourage them to modify their behaviors. This could include making a conscious choice to walk to class versus driving in order to reduce their carbon footprint.

However, this might not be the only misconception held by pre-service teachers. For example, the 1998 National Report Card specifically examined the public’s belief in environmental “myths” (NEETF, 1998). One of the original 1998 myth questions was included in the Student Survey and pertained to water pollution (EK4). In the current study, results indicated that 23% of pre-service teachers selected the environmental myth answer choice (waste dumped by factories) versus the correct answer choice (surface water running off yards, city streets, paved lots, and farm fields). In other words, there is evidence that environmental misconceptions are still present even after 20 years.

In more recent events, multiple studies have indicated that environmental misconceptions may also be present regarding climate change education. For example, a national study by Plutzer et al. indicated that while “most U.S. science teachers include climate science in their courses, their insufficient grasp of the science may hinder effective teaching” (2016, p. 664) More specifically, 30% of teachers in the study emphasized that recent global warming “is likely due to natural causes, while 12% did not emphasize human causes at all” (2016, p. 664). Additionally, other studies in both the U.S. and Greece showed that elementary school teachers did not have sufficient EK, and often held misconceptions about environmental issues, such as acid rain, ozone
layer depletion, greenhouse effect, and renewable energy sources (Khalid, 2003; Michail et al., 2006). An NPR story indicated that 86% of teachers believe that climate change should be taught in schools, while more than 80% of parents in the U.S. support the teaching of climate change. However, more than half (55%) of the surveyed teachers did not cover climate change topics in their own classrooms or even talk to their students about it (Hurt, 2019). This same NPR story identified that nearly two-thirds (65%) of teachers did not include climate change discussions because it was outside of their subject areas. Therefore, it is key that these misconceptions, including those about climate change, are addressed in the TPPs so that it can be addressed in their future classrooms.

Data from ten years of NEETF surveys strongly imply that the media plays a large role creating these environmental misconceptions (Coyle, 2005). Current results indicated that social media could be an avenue to dispense information to further debunk these environmental misconceptions. For example, social media platforms such as Facebook, Instagram, or Twitter could create 5-minute “environmental hot topics” videos, posts, or photos that highlight common misconceptions the public has about global environmental issues. These “environmental hot topics” could include information about wetlands, household hazardous waste, nuclear waste storage, carbon emission etc. since these were EK topics in which pre-service teachers seemed to hold misconceptions. This idea could potentially increase awareness about environmental issues and reduce the chances of the public being misinformed about important environmental topics.

**Recommendations for TPPs**

Although the current study suggests that pre-service teachers in science methods courses across Wisconsin’s TPPs have low EK, similar results can be found for students and adults of all ages (Coyle, 2005; Kaplowitz & Levine, 2005; NEETF, 1997, 2001; Robelia & Murphy, 2012).
The biggest concern when interpreting the low EK results from the past 20 years of data is not necessarily that there is a lack of knowledge of environmental facts. The goal is not for pre-service teachers to become "environmental encyclopedias." Instead, EE is more about understanding important causal relationships – what might cause air and water pollution, what happens to trash after it is thrown away, what contributes to species loss, and how different parts of a moving system affect one another. Furthermore, it is key that pre-service teachers have the ability to sort out those connections. Low EK scores in pre-service teacher populations offers potential for them to misunderstand the connections between these causal environmental relationships since many of these environmental problems are not apparent without background knowledge. This may lead to avoidance behaviors in their future classrooms due to unfamiliarity with EE topics (Bandura, 1977). Therefore, the true challenge is to equip pre-service teachers with a set of decision-making and problem-solving approaches that they can use in their future classrooms to educate students about global environmental issues.

Pre-service teachers should be encouraged to learn about environmental issues our society faces through regular exposure in their coursework. Nearly 65% of pre-service teachers in the study identified classes/courses as a primary source from which they learn about environmental topics. Yet, multiple students from different TPPs indicated a lack of EE inclusion in their TPP coursework. Additionally, multiple instructors from different TPPs suggested that there was a lack of EE incorporation based on Instructor Survey responses. In other words, if multiple pre-service teachers, and their instructors, are indicating a lack of EE inclusion into TPP coursework, then this is problematic. Extra emphasis should be placed on integrating EE concepts into TPP coursework since pre-service teachers indicated that coursework is their primary source for environmental information.
One suggestion to help better equip pre-service teachers to teach about global environmental issues in their future classrooms is through the incorporation of the revised *Wisconsin Standards for Environmental Literacy and Sustainability* (WDPI, 2018) in their TPP coursework. These standards were written to be accessible for any educator to guide curriculum design and lessons, both inside and outside of the classroom, as well as across multiple subject matters such as science, social studies, and mathematics. The standards also incorporate systems thinking to better help pre-service teachers make links between causal environmental relationships. TPP course instructors are encouraged to make explicit connections to these standards through existing lessons. Additionally, instructors can design new units of study that integrate the standards and performance indicators to bridge multiple subject areas such as in a science or social studies methods courses. Of special note, TENFEE has a book of EE activities linked to the new standards under review to further aid with the incorporation of EE into TPPs. The environmental literacy and sustainability standards, in addition to the EE activities book, circle back to two of the three major groups of elements that May (2000) found to contribute to EE teaching efficacy in schools (educational content standards and student performance standards).

**Opportunities for TPPs to increase pre-service teachers’ PEETE.**

Results from RQ 4 suggest that even small gains in pre-service teachers’ PEETE scores significantly increased the likelihood that pre-service teachers would pass the EK exam. Therefore, the current study suggests four ways for TPPs to increase pre-service teachers PEETE. The first suggestion would be for TPPs to invest in mastery experiences related to EE practices in an attempt to increase pre-service teachers’ PEETE. Bandura (1997) identified mastery experiences as the most valuable, authentic source for enhancing self-efficacy. For example, TPPs could provide opportunities for students to shadow/teach at local nature centers or environmental stations as part of their field/practicum experience. This is an example of a mastery experience (Bandura, 1997)
that would allow pre-service teachers the opportunity to personally experience teaching successes and failures while interacting with students of all ages in a non-formal setting. For example, at the University of Wisconsin-Stevens Point, pre-service teachers minoring in EE complete a 4-credit, semester long EE practicum experience at the local environmental station. The EE practicum experience is usually completed their junior year. Additionally, this practicum experience provides pre-service teachers the opportunity to develop weekly lesson plans based on EE principles and teach that lesson to visiting K-12 students. The development of weekly EE lesson plans may also increase pre-service teachers’ self-efficacy through verbal persuasion (Bandura, 1997), as the course instructor provides feedback on submitted lesson plans.

As a current employee at the environmental station in which these pre-service teachers complete their EE practicum experience, the researcher directly interacts with these pre-service teachers on a weekly basis. Through personal experience and informal conversations, the researcher has seen tremendous growth in pre-service teachers’ EE teaching efficacy through the completion of this semester long practicum experience. Therefore, if other TPPs were to incorporate similar field/practicum experiences at local environmental stations or nature centers into their programs, then this may increase pre-service teachers’ PEETE.

Secondly, current results indicated that the number one place that pre-service teachers are learning about the environmental is in their coursework. Therefore, one suggestion to increase pre-service teachers’ PEETE would be for TPPs to invest in more opportunities for students to learn about the environment in their coursework. An example of such opportunity would be to include more service-learning projects connected to EE practices based on results from Bernadowski et al. (2013). Bernadowski et al. (2013) indicated that students who engaged in service-learning as part of a course requirement, as opposed to voluntarily choosing a service-learning opportunity, felt more positively toward their preparedness and ability to teach children. The course requirement
component is key because the instructor can help pre-service teachers predict situations and role play how to best cope with unforeseen situations. Whereas, if pre-service teachers voluntarily choose to partake in a service-learning project there is little support for them in which to ask questions and they must make their own connections. Bernadowski et al. (2013) inferred that pre-service teachers’ self-perceptions, knowledge, and skills could be more easily maximized through service-learning projects to improve self-efficacy.

An example of an EE service-learning opportunity based off of Bernadowski et al.’s (2013) work would be a semester long mentorship in which a pre-service teacher is paired with a school-aged student. The pre-service teacher would correspond with that student bi-weekly, sharing information about a variety of environmental topics in regard to their local community. Then, at the end of the semester, create and deliver an age-appropriate lesson about an environmental topic of their choosing for that student through a one-on-one experience. An opportunity such as this would allow pre-service teachers the opportunity to build their confidence relaying environmental information to school-aged children while personally experiencing successes and failures (mastery experience). Additionally, pre-service teachers would feel supported by their course instructor who can aid with questions and provide feedback (verbal persuasion). Bandura (1997) identified mastery experiences and verbal persuasion as potential avenues to increase self-efficacy. In other words, if more EE infused service-learning opportunities were available in TPP coursework, this might increase pre-service teachers’ PEETE and, indirectly their EK.

Thirdly, results indicated that pre-service early childhood and elementary teachers have low levels of EK. Therefore, one suggestion to increase their EK, and possibly their PEETE, would be for TPPs to consider substituting their traditional science content course requirement for a specialized science/EE content course specifically designed for pre-service early childhood and elementary teachers. Menon and Sadler (2016) provided evidence that pre-service teachers
enrolled in a specialized physics content course experienced positive changes in their science teaching efficacy beliefs (Menon & Sadler, 2016). Therefore, similar recommendations may also apply in Wisconsin TPPs. A specialized science/EE course may provide pre-service teachers the opportunity to learn to integrate environmental concepts with pedagogical models. The course could include a lecture/lab format centered around EE practices in which inquiry-based hands-on investigations, collaboration, team work, and group discussions are incorporated, all of which could be applicable in their future classrooms. A course such as this would allow pre-service teachers to observe their instructors modelling the EE practices (vicarious experience), and potentially increase their physiological and emotional state. Both of these have been found to increase self-efficacy (Bandura, 1997). In other words, if Wisconsin TPPs were to require a specialized science/EE content course for pre-service teachers seeking to teach early childhood, elementary, and both early childhood and elementary aged students, then this may increase their PEETE and EK. Further encouraging them to incorporate EE practices into their future classrooms.

Lastly, based on the significant difference in PEETE scores between male and female pre-service teachers, one suggestion would be for TPPs to invest in opportunities to increase pre-service teachers’ PEETE for all genders. One such suggestion would be to include more inquiry-based coursework such as that done by Avery and Meyer (2012). Avery and Meyer (2012) found that an inquiry-based science course positively influenced pre-service elementary teachers’ self-efficacy for science and science teaching. More specifically, an inquiry-based EE course may have similar results in Wisconsin TPPs in order to increase pre-service teachers’ PEETE, especially since a large percentage of pre-service elementary teachers in the current study were females. An inquiry-based EE class would allow pre-service teachers numerous opportunities to identify environmental problems and design experimental procedures to solve those problems. Furthermore, they could infer concepts and then apply those concepts to new environmental
situations. This would allow pre-service teachers the chance to increase their confidence teaching EE, as well as understand that EE and science are active processes of inquiry rather than just a body of knowledge. Examples of inquiry-based EE activities designed for teacher educators can be found in work done by Franzen et al. (2017). This collection of instructional materials provides multiple examples of inquiry-based science/EE activities. However, adding additional coursework to TPPs is not always possible. Therefore, the next best solution would be for teacher educators to incorporate EE inquiry-based activities into traditional science content courses such as in a laboratory portion of the class, or even incorporating EE activities into science methods and social studies methods courses. Opportunities such as this could further build pre-service teachers’ EE teaching efficacy, in addition to their EK.

**Investigate pre-service teachers’ self-assessed knowledge.**

As mentioned earlier in SQ 2, current results suggest that pre-service teachers’ perceptions of their knowledge about the environment (self-assessed EK) may be indicative of their actual EK proficiency on the EK exam. Therefore, one suggestion would be for TPPs to request pre-service teachers complete a quick survey upon being accepted to the TPP pertaining to their self-assessed knowledge. For those that fall on the lower spectrum, such as *below average* students, extra care should be taken early on in their academic careers to provide them the necessary resources to build their confidence about issues relating to the environment. This information could then be used by academic advisors to direct students with lower self-assessed knowledge towards classes, courses, or other outside resources that could further inform them about environmental issues, in addition to building their confidence teaching EE materials. This, in and of itself, may be a key piece to increasing EK and PEETE of pre-service teachers who self-identify as having low levels of self-assessed knowledge about environmental issues.
EE certificate.

Currently, pre-service teachers have the opportunity to minor in EE at one or more Wisconsin TPPs. However, in the near future Wisconsin DPI will no longer require pre-service teachers to complete a minor as part of their program requirements. This, in turn, may decrease the opportunity for pre-service teachers to learn about EE practices through their coursework. Therefore, one suggestion would be for TPPs to offer EE certificates instead of an EE minor. This would allow pre-service teachers the opportunity to take a concentrated set of environmental classes in order to expand their knowledge of environmental topics and it would not be as big of a commitment as a minor.

Identify common environmental misconceptions in coursework.

The current study indicates that pre-service teachers may hold misconceptions about certain global environmental issues which could potentially be passed on to their future classroom students. One avenue to address pre-service teachers’ environmental misconceptions could be through their classes/courses since a large portion of students selected this as their primary source for obtaining environmental information. For example, science methods instructors could include an assignment in which pre-service teachers are assigned common environmental misconceptions that were found in the current study such as the main causes of air and water pollution, nuclear waste and household garbage disposal, primary role of a wetland, and hazardous household wastes. Their task would be to create a lesson plan in which they not only address the misconception, but also inform their peers of the correct answer. This example could increase pre-service teachers’ EK by building their awareness, and overall, their potential connection to local and global environmental issues.
Recommendations for EE Professionals

One suggestion to help better equip pre-service teachers would be to increase the collaboration between non-formal EE centers, such as those that work at nature centers or environmental stations, and local TPPs. Non-formal EE centers should be encouraged by their administrators to reach out to local TPPs and provide additional support to professors and administrators in educating pre-service teachers about EE practices. For example, pre-service teachers could shadow non-formal educators, or, better yet, be allowed to design and implement their own EE lesson plans at the nature center. This would help build pre-service teachers’ confidence teaching EE materials while better equipping them to educate their future students about EE practices.

Furthermore, if classes/courses are the number one place that pre-service teachers are learning about environmental issues, then continual efforts should be made to help TPP course instructors to incorporate more EE practices into their TPP curriculum. For example, local nature centers could hold workshops for professor professional development. This would allow the opportunity to build a community of formal and non-formal environmental educators in which ideas and curricular resources could be shared.

Lastly, non-formal environmental educators should provide programs in which common environmental misconceptions are addressed and clarified. For example, programs should address surface water run-off, air pollution, nuclear waste storage, etc. Programs such as these should be offered to local school groups, after school programs, summer campers, or even addressed during staff training to help spread awareness about local and global issues we are facing.
Future Research

While this study has forged significant new understandings concerning the connection between pre-service teachers’ EK and PEETE, future research is necessary for further advances. First, the current study selected pre-service teachers based on their enrollment in a science methods course; however, its intention was not to measure potential changes in pre-service teachers’ EK, nor PEETE based on science methods curriculum. Furthermore, previous research indicated that significant gains were made in personal science teaching efficacy after a semester long science methods course (Morrell & Carroll, 2003). This would be particularly interesting since an earlier study in Wisconsin indicated that many times EE is integrated into a science methods course (Ashmann & Franzen, 2015). Therefore, future research could include an evaluation of pre-service teachers’ EK and PEETE pre/post a science methods course to see if increases in either occurred over the course of a semester.

A second suggestion would be to measure EK and PEETE of in-service teachers and non-formal EE educators across Wisconsin, such as instructors at nature centers, environmental stations, state parks, national parks, etc. Comparisons could then be made between pre-service teachers, in-service teachers, and non-formal educators’ EK and PEETE. This may allow further insight into opportunities to expand EE practices and to build an environmentally literate population.

One focus of the current research was to measure the correlation between EK and PEETE. However, little research has been done to study PEETE. Therefore, another suggestion for future research would be to see if there is a correlation between pre-service teachers’ PEETE and other components of environmental literacy such as environmental competencies, dispositions, and behavior, not just EK. For example, there was not a significant difference between a pre-service teachers’ childhood environment and their EK, nor PEETE. However, Goldman et al. (2006)
suggested that childhood environment was significant in influencing Israeli pre-service teachers’ environmental behavior. Therefore, studying other components of environmental literacy would allow a broader understanding of pre-service teachers’ PEETE and factors that influence it.

Another suggestion would be to further investigate the relationship between EK and positive childhood environmental activities. As mentioned earlier, no significant relationship was found between these two factors in the current study. However, the current study focused solely on the total number of positive childhood environmental activities. It failed to include a section in which pre-service teachers could elaborate on the frequency in which that activity was completed and the potency of that experience. Further research is needed to shed more light on how the frequency of the positive childhood environmental activity affects the EK and PEETE of pre-service teachers and the potency of each of those activities.

Summary

This chapter has discussed the conclusions and implications of this study. It addressed the goals of the study by further echoing the objectives laid out in Chapter 1. The study assessed the EK and PEETE of upper level pre-service teachers while further articulating the significant role that EE plays in TPPs regarding pre-service teachers’ EK and PEETE. Recommendations are provided to suggest possibilities for diversifying and expanding the scope and practice of EE in TPPs. These recommendations are connected in their pursuit of fostering EK and PEETE in pre-service teachers in the hopes that it will help move us in the direction of an environmentally literate population through the education of their future classroom students.
REFERENCE LIST


Hurt, A. (2019, April 22). Most Teachers Don't Teach Climate Change; 4 In 5 Parents Wish They Did [Radio broadcast episode]. https://www.npr.org/2019/04/22/714262267/most-teachers-dont-teach-climate-change-4-in-5-parents-wish-they-did


APPENDIX A:

STUDENT SURVEY

The Student Survey was a one-time, online Qualtrics survey composed of three parts: EK, PEETE, and demographic questions. The survey instrument was designed by the researcher but comprised of questions borrowed from other research instruments. The 12 EK questions were developed by the NEETF in 1997. The 13 PEETE questions were selected from Moseley et al.’s EETEBI (2016). Finally, the 11 demographic questions were inspired by a 1997 WCEE environmental literacy survey and an unpublished graduate student master’s thesis (O’Brien, 2007).

The survey was distributed to pre-service teachers in science methods courses across Wisconsin by their science methods instructors during class time, within the first eight weeks of the Fall 2018 semester. The survey began with a welcome paragraph, in addition to, an informed consent to participate in human subject research.

Student Survey Welcome Paragraph
You are being invited to take part in a Student Survey designed for pre-service teachers in science methods courses across Wisconsin. The survey is part of a graduate thesis project. It will take approximately 10 minutes of your time and is completely voluntary. Through this study, we hope to understand the role of environmental education in teacher preparation programs to further encourage environmental literacy in K-12 classrooms.

Informed Consent to Participate in Human Subject Research
Summary of Research: Caroline Blake, Graduate Student at the University of Wisconsin-Stevens Point is conducting a study to determine Wisconsin pre-service teachers’ environmental knowledge and its potential connection to their environmental education teaching efficacy. You are being asked for your consent to participate in this study. Benefits of participation in this study include gaining valuable information about how environmental content knowledge of future teachers may be linked to their confidence to teach environmental education material in their future classrooms.

Details of Research:
A. Purpose: The purpose of this study is to assess pre-service teacher environmental knowledge, personal environmental education teaching efficacy, and links between the two.
B. **Procedures:** As part of the study, you will be asked to complete an anonymous online survey.

C. **Risks or Discomforts:** Participating in this study should pose no significant risk to you, though it is possible that you will feel discomfort if you do not know an answer. Participating in this study will not affect your grade for the course and the course instructor will not have access to your responses.

D. **Benefits to the Participant or Others:** It is possible that participation in this study may encourage you to think about your level of environmental knowledge and your confidence in teaching environmental education material in your future classrooms.

E. **Possible Alternative Procedures:** If you are uncomfortable using your personal computer or smart device to complete the survey, then your instructor should grant you permission to go to a campus computer lab to complete the survey.

F. **Confidentiality:** For the purpose of the study, the information that you provide will be recorded anonymously. No information will be released that could identify you. Furthermore, your course instructor will not be able to view your score. All completed online surveys will be kept on a computer that is password protected. In addition, the survey results will be stored in a password protected document. The passwords will not be available to anyone not directly involved in this study. Data will be destroyed at a later date.

G. **Rights of Participant:** If you want to withdraw from the study, at any time, you may do so without penalty. Any information collected on you up to that point would be destroyed.

Once the study is completed, I would be glad to give you the results. In the meantime, if you have any questions, please contact:

Caroline Blake  
Graduate Student  
College of Natural Resources  
University of Wisconsin – Stevens Point  
Stevens Point, WI 54481  
(715) 346-2711  
Cblak710@uwsp.edu

If you have any complaints about your treatment as a participant in this study or believe that you have been harmed in some way by your participation, please call or write:

Anna Haines, PhD  
Professor, Natural Resource Planning  
Director, Center for Land Use Education  
800 Reserve Street  
College of Natural Resources  
University of Wisconsin, Stevens Point and Extension  
Stevens Point, WI 54481  
715.346.2386  
irbchair@uwsp.edu

Although Dr. Haines will ask your name, all complaints are kept in confidence.

Your completion and submission of the survey to the researcher represents your consent to serve as a subject in this research.
Part 1: Environmental Knowledge

The following questions will measure your pre-existing environmental content knowledge that you, may or may not, have accumulated thus far in your lifetime. Please do not use any outside sources to respond to these questions. It is important to note only your responses, not those of other outside sources. Mark only one response for the next 12 statements. If you do not know the answer, please mark “Don’t know.”

EK1: There are many different kinds of animals and plants, and they live in many different types of environments. What is the word used to describe this idea? Is it…
   a. Multiplicity
   b. Biodiversity
   c. Socio-economics
   d. Evolution
   e. Don’t know

EK2: Carbon monoxide is a major contributor to air pollution in the U.S. Which of the following is the biggest source of carbon monoxide? Is it…
   a. Factories and businesses
   b. People breathing
   c. Motor vehicles
   d. Trees
   e. Don’t know

EK3: How is most of the electricity in the U.S. generated? Is it…
   a. Burning oil, coal, and wood
   b. With nuclear power
   c. Through solar energy
   d. At hydroelectric power plants
   e. Don’t know

EK4: What is the most common cause of pollution of streams, rivers, and oceans? Is it…
   a. Dumping of garbage by cities
   b. Surface water running off yards, city streets, paved lots, and farm fields
   c. Trash washed into the ocean from beaches
   d. Waste dumped by factories
   e. Don’t know

EK5: Which of the following is a renewable resource? Is it…
   a. Oil
   b. Iron ore
   c. Trees
   d. Coal
   e. Don’t know
EK6: Ozone forms a protective layer in the earth’s upper atmosphere. What does ozone protect us from? Is it...
   a. Acid rain
   b. Global warming
   c. Sudden changes in temperature
   d. Harmful, cancer-causing sunlight
   e. Don’t know

EK7: Where does most of the garbage of the U.S. end up? Is it in...
   a. Oceans
   b. Incinerators
   c. Recycling centers
   d. Landfills
   e. Don’t know

EK8: What is the name of the primary federal agency that works to protect the environment? Is it the...
   a. Environmental Protection Agency (the EPA)
   b. Department of Health, Environment, and Safety (the DHES)
   c. National Environmental Agency (the NEA)
   d. Federal Pollution Control Agency (the FPCA)
   e. Don’t know

EK9: Which of the following household wastes is considered hazardous waste? Is it...
   a. Plastic packaging
   b. Glass
   c. Batteries
   d. Spoiled food
   e. Don’t know

EK10: What is the most common reason that an animal species becomes extinct? Is it because...
   a. Pesticides are killing them
   b. Their habitats are being destroyed by humans
   c. There is too much hunting
   d. There are climate changes that affect them
   e. Don’t know

EK11: Scientists have not determined the best solution for disposing of nuclear waste. In the U.S. what do we do with it now? Do we...
   a. Use it as nuclear fuel
   b. Sell it to other countries
   c. Dump it in landfills
   d. Store and monitor the waste
   e. Don’t know

EK12: What is the primary benefit of wetlands? Do they...
   a. Promote flooding
   b. Help clean the water before it enters lakes, streams, rivers, and oceans
   c. Help keep the number of undesirable plants and animals low
   d. Provide good sites for landfills
   e. Don’t know
Part 2: Personal Environmental Education Teaching Efficacy

The Tbilisi Declaration states that “Environmental education is a learning process that increases people’s knowledge, awareness about the environment and associated challenges, develops the necessary skills and expertise to address challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action” (United Nations Educational, Scientific, and Cultural Organization, 1978, p.2)

Please indicate the degree to which you agree or disagree with each of the 13 statements below. Please answer the questions to the best of your ability. There are no right or wrong answers since these are based on your beliefs about your ability to teach environmental topics.

<table>
<thead>
<tr>
<th>#</th>
<th>PEETE Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEETE1</td>
<td>I can find effective ways to teach about the environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>PEETE2</td>
<td>In spite of my best efforts, I cannot teach about the environment as well as I can teach about other topics.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>PEETE3</td>
<td>I understand the strategies to effectively teach environmental concepts.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>PEETE4</td>
<td>I do not believe that I am effective when facilitating environmental education activities.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>PEETE5</td>
<td>I cannot teach about the environment effectively.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>PEETE6</td>
<td>I understand environmental concepts well enough to be effective in teaching those concepts.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Part 3: Demographics

Demo 1: Name of College or University you are currently attending: __________________

Demo 2: What is your major?
   a. Education (early childhood or elementary)
   b. Natural Sciences
   c. Humanities
   d. Social Sciences
   e. Mathematics
   f. If other, please list_____________________________________

Demo 3: What level will you be licensed to teach upon graduation?
   a. Early Childhood
   b. Elementary
   c. Secondary
   d. All Ages (licensing level for music, art, and foreign languages)
   e. Both Early Childhood and Elementary
   f. If other, please list___________
Demo 4: What is your current student status? *If you already have a bachelor’s degree, only select option e:*

- a. First Year
- b. Sophomore
- c. Junior
- d. Senior
- e. I already have a bachelor’s degree and am currently seeking a teaching license

Demo 5: Do you identify as

- a. Male
- b. Female
- c. Other

Demo 6: The Tbilisi Declaration states that “Environmental education is a learning process that increases people’s knowledge, awareness about the environment and associated challenges, develops the necessary skills and expertise to address challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action.”

*Please indicate the degree to which you agree or disagree with the following statement:*

“Environmental education, as defined by the Tbilisi Declaration, is well represented in the required coursework of your institution’s teacher preparation program.”

- a. Strongly Disagree
- b. Disagree
- c. Somewhat Disagree
- d. Somewhat Agree
- e. Agree
- f. Strongly Agree
- g. If you care to elaborate on why you agree or disagree with this statement, please explain here_____________________________

Demo 7: Compared to other students your age, how well do you think you understand issues related to the environment?

- a. Below Average
- b. Average
- c. Above average

Demo 8: Mark as many of the activities below that *positively* influenced your outlook on the environment as a child:

- a. Fishing/hunting
- b. Hiking
- c. Gardening
- d. Camping
- e. Snowshoeing/skiing
- f. Attending summer camp
- g. Reading a nature-related book
- h. Playing outside
- i. Canoeing/kayaking
- j. Bird-watching
- k. Visiting zoos/aquariums
- l. Visiting nature centers
- m. Biking
- n. Watching "Animal Planet" or similar movies/shows
- o. Others __________________
Demo 9: What are your primary sources of environmental information (pick up to three)?
   a. TV news programs  
   b. Movies/Documentaries  
   c. Radio  
   d. Magazines/newspaper (print or online)  
   e. Classes/courses  
   f. Social Media (Facebook, YouTube, Instagram, Twitter)  
   g. Books/library  
   h. Friends/relatives  
   i. None of the above  
   j. If other, please list___________________________________________

Demo 10: In what kind of environment did you spend the majority of your childhood?
   a. Rural Farm  
   b. Rural Non-Farm  
   c. Suburban  
   d. Small Town (less than 2,500 people)  
   e. Small City (between 2,500 - 50,000 people)  
   f. Large City (greater than 50,000 people)  
   g. If other, please explain ______________________________________

Demo 12: The majority of my childhood was spent
   a. in Wisconsin  
   b. in another state. Please provide the name of the state _____________  
   c. in another country. Please provide the name of the country __________
APPENDIX B:
INSTRUCTOR SURVEY

The Instructor Survey was a one-time, online Qualtrics survey composed of four questions.
The survey began with a welcome paragraph, in addition to an informed consent to participate in
human subject research. The instrument was designed by the researcher to better understand how
environmental education was incorporated at each of Wisconsin’s TPPs. The survey was
distributed to science methods instructors at the same time as the Student Survey.

Instructor Welcome Letter
Thank you for your participation in this research. This study seeks to examine Wisconsin pre-
service teachers’ environmental knowledge and its potential correlation to their personal
environmental education teaching efficacy. This survey will ask for basic information about your
science methods course and how environmental education is incorporated into your teacher
preparation program. Please provide answers to the best of your ability. It is estimated that
completion of the questionnaire will take approximately 5 minutes. If you have any questions or
concerns, please contact Caroline Blake at cblak710@uwsp.edu

Informed Consent to Participate in Human Subject Research
Summary of Research: Caroline Blake, Graduate Student at the University of Wisconsin-Stevens
Point is conducting a study to determine Wisconsin pre-service teachers’ environmental
knowledge and its potential connection to their personal environmental education teaching efficacy. In addition, this study will collect information from science methods course instructors
about how environmental education is incorporated into their institution’s teacher preparation
program. You are being asked for your consent to participate in this study. Your participation is
completely voluntary. The expected duration of your participation in this study should take
approximately 5 minutes. The benefit of participating in this study includes providing valuable
information about how environmental education is incorporated into teacher preparation programs
across Wisconsin.

Details of Research:
A. **Purpose:** To gather more information about the incorporation of environmental education
in your institution’s teacher preparation program. As well as, assess pre-service teacher
environmental knowledge, personal environmental education teaching efficacy, and the
links between the two.
B. **Procedures:** As part of this study, you will participate in an online questionnaire to provide
information about the inclusion of environmental education at your institution. The
questionnaire will ask four simple questions. It is estimated that this questionnaire will take
between 5 minutes to complete.
C. **Risks or Discomforts:** Participating in this study should pose no significant risk to you in anyway. There is no right or wrong answer.

D. **Benefits to the Participant or Others:** As a result of your participation in this study you will give insight into how environmental education is incorporated into teacher preparation programs across Wisconsin.

E. **Possible Alternative Procedures:** This information can be obtained by interviewing you if you so choose.

F. **Confidentiality:** For the purpose of the study, the information that you provide will be recorded anonymously. No information will be released that could identify you. All completed online surveys will be kept on a computer that is password protected. In addition, the survey results will be stored in a password protected document. The passwords will not be available to anyone not directly involved in this study. Data will be destroyed at a later date.

G. **Rights of Participant:** If you want to withdraw from the study, at any time, you may do so without penalty. Any information collected on you up to that point would be destroyed.

Once the study is completed I would be glad to give you the results. In the meantime, if you have any questions, please contact:

Caroline Blake  
Graduate Student  
College of Natural Resources  
University of Wisconsin – Stevens Point  
Stevens Point, WI 54481  
(715) 346-2711  
Cblak710@uwsp.edu

If you have any complaints about your treatment as a participant in this study or believe that you have been harmed in some way by your participation, please call or write:

Anna Haines, PhD  
Professor, Natural Resource Planning  
Director, Center for Land Use Education  
800 Reserve Street  
College of Natural Resources  
University of Wisconsin, Stevens Point and Extension  
Stevens Point, WI 54481  
715.346.2386  
irbchair@uwsp.edu

Although Dr. Haines will ask your name, all complaints are kept in confidence.

*Your completion and submission of the survey to the researcher represents your consent to serve as a subject in this research.*
Instructor Survey Questions

Q1 Name of Institution you are employed with: _______________________

Q2 Title of the course the Student Survey was administered in (if it was distributed in multiple courses, please list all courses): _______________________

Q3 The Tbilisi Declaration states that “Environmental education is a learning process that increases people’s knowledge, awareness about the environment and associated challenges, develops the necessary skills and expertise to address challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action.”

Please indicate the degree to which you agree or disagree with the following statement: “Environmental education, as defined by the Tbilisi Declaration, is well represented in the required coursework of your institution’s teacher preparation program.”

a. Strongly Disagree
b. Disagree
c. Somewhat Disagree
d. Somewhat Agree
e. Agree
f. Strongly Agree
g. If you care to elaborate on why you agree or disagree with this statement, please explain here _______________________

Q4 Where in your program do pre-service teachers learn about environmental education concepts and how to teach about the environment? Please be as inclusive as possible. _______________________

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APPENDIX C:

PILOT STUDY

A pilot study was conducted at the University of Wisconsin-Stevens Point in April 2018 before the research instruments were launched in August 2018. The following email was sent to the science method instructor who agreed to distribute the survey to his students.

Pilot Study Survey Email
April 26, 2018

Hello pre-service teachers,

You are being requested to partake in a pilot study survey for a graduate student thesis project. It is completely voluntary and should take no more than 10 minutes of your time. The survey is compatible with both personal computers and smart devices; however, please do not use outside sources to answer the questions. If interested, please fill out the survey below no later than Wednesday, May 9th.

Furthermore, the researcher, is looking for 3-4 students who would be willing to set up a time to meet, either on-campus or by phone, to get student feedback about the survey before it is officially launched in September 2018. The interviews should take no more than 10 minutes to complete. They would be conducted between April 30th and May 15th, 2018 (or when is most convenient for the participant). If interested in providing valuable feedback about the survey please fill out the survey first, then email Caroline Blake, cblak710@uwsp.edu.

Student Survey link: https://uwsp.az1.qualtrics.com/jfe/form/SV_87mFd6x5C2MFlo9
A preliminary database provided by the Wisconsin Society of Science Teachers was used as a starting point to gather the correct contact information for science methods instructors across Wisconsin’s 33 TPPs. The researcher sent out an email in April 2018 asking if “said contact” was indeed a science methods instructor at their TPP. If they were not, then they were asked to provide the contact information for the correct person. This information was used to create the study’s contact list.

**Contact Gathering Email**

April 16, 2018

Dear Professor,

I am looking for the contact information for the science methods professor at your university. I was informed that you may be this person. Is this correct? If not, would you mind providing me the name/email of the professor I should contact? Thank you.

Sincerely,

Caroline Blake
Graduate Student
College of Natural Resources
University of Wisconsin-Stevens Point
APPENDIX E:
INQUIRY EMAILS

Once an initial science methods instructor contact list was built, three inquiry emails were sent out to science methods instructors over the course of a four-month period asking about their availability/willingness to participate in the study. Inquiry email one was sent out in early May. Inquiry email two was sent out a week later. The final email was sent out in August two-weeks before the launch of the research project.

If, at any point, an instructor agreed to partake in the study, they were not sent any further inquiry emails and were added to the study’s contact list. However, if an instructor either declined to partake, or never responded to the three inquiry attempts, they were not included in the study’s contact list.

Inquiry Email One

May 2, 2018
Hello Professor,

My name is Caroline Blake and I am a graduate student in Environmental Education at the University of Wisconsin-Stevens Point. I am working with Dr. Becca Franzen (UW-Stevens Point) and Dr. Scott Ashmann (UW-Green Bay) to evaluate the potential connection between pre-service teachers’ environmental knowledge and their confidence teaching environmental education material in their future classrooms. I am recruiting science methods course instructors across Wisconsin’s 33 teacher preparation programs to help distribute a one-time online survey to their science methods students in Fall 2018. I am contacting you because I have been informed that you are a science methods course instructor (if this is not the case, please share with me who is the correct person at your institution so that I may get in contact with them).

I am inquiring about your availability/willingness to 1) distribute a Qualtrics survey link to the students in your science methods course(s) during class time within the first eight weeks of the Fall 2018 semester, which should take no more than 10 minutes of class time. 2) Complete a 5-minute Qualtrics survey link designated for science methods course instructors.

Please contribute to this project by alerting me (within the next week) as to whether or not you are willing to participate in this research. If you have any questions or comments on my project, I would certainly be willing to discuss it further. Thank you for your time and efforts.

Sincerely,

Caroline Blake
Graduate Student
University of Wisconsin-Stevens Point
Inquiry Email Two

May 9, 2018

Hello Professor,

I sent to you an email last week about participating in my graduate research project. I am reaching out to science methods course instructors across Wisconsin’s 33 teacher education programs. For my thesis project, I plan to conduct a one-time online survey to assess the correlation between environmental knowledge and personal environmental education teaching efficacy of pre-service teachers completing science methods courses in Fall 2018. I am inquiring about your availability/willingness to 1) complete a 5-minute Instructor Survey and 2) distribute a 10-minute Student Survey during class time to your science methods students within the first eight weeks of the fall semester.

For more details please see the forwarded message below. If I do not hear from you within the next week, I will attempt to connect with you by phone. Please contact me with any questions, concerns, or ideas. Thank you for your time and efforts.

Sincerely,
Caroline Blake
UWSP Graduate Student

Final Inquiry Email

August 5, 2018

Hi Professor,

I sent you a couple of emails at the end of the Spring semester to invite you to partake in my graduate research project but never heard back from you (see messages below). I realized that it may have been a busy time in the semester and that you may have been unable to respond to my emails. Therefore, I am sending one final follow up email to invite you to partake in this research opportunity (the survey will be launched to professors across the state in two weeks). If I do not hear from you then I assume you do not wish to have [Insert TPP] partake in this statewide research project. I hope to hear from you.

Best Regards,
Caroline
Once science methods instructors agreed to partake in the research project, they were contacted four additional times throughout the course of the Fall 2018 semester. First, they were sent a “pre-survey instruction email” two-weeks before the start of the Fall semester. This email provided information about the study, instructions for survey distribution, and the timeline of the project.

Next, two reminder emails were sent to instructors during the semester to prompt them to distribute the Student Survey and complete the Instructor Survey by November 1st. The final form of communication between the researcher and instructors included a conclusory thank you email for their help with the project.

Pre-Survey Instruction Email

August 28, 2018

Dear Professor,

I reached out to you in early May in which you agreed to facilitate and participate in this research project. Through your efforts, we will be able to better understand the potential connection between environmental knowledge and personal environmental education teaching efficacy among pre-service teachers across Wisconsin’s teacher education programs. This cover letter includes information about the research components, as well as instructions for in-class facilitation of the Student Survey.

This study involves two online instruments: A Student Survey and an Instructor Survey. The Student Survey measures pre-service teachers’ environmental knowledge along with their personal environmental education teaching efficacy. I have attached a PowerPoint slide to this email that introduces the research topic AND includes the direct link to the Student Survey. The Student Survey will need to be distributed by you to your science methods students within the first eight weeks of the Fall 2018 semester or by November 1st, 2018 during class time (see instructions for in-class facilitation below). It is compatible with both personal computer devices and smartphones to make the survey accessible to multiple audiences. It is estimated that the survey should take no longer than 10-15 minutes to complete. If you are teaching multiple science methods courses, please distribute the survey link to your multiple sections/courses.
As for the Instructor Survey, it is a chance for the researcher to gain insight about how environmental education is incorporated into your institution’s teacher preparation program. Please complete the following questionnaire within the first eight weeks or by November 1st, 2018 of the semester. It should not take more than 5-minutes to complete (Instructor Survey URL: https://uwsp.az1.qualtrics.com/jfe/form/SV_8wFKSq66sq8s6T). If you teach multiple science methods courses, please list all of the science methods courses in which you distributed the Student Survey in Question Two of the survey.

I hope that your class has a successful semester and can gain something valuable from this research. I appreciate your time and willingness to help me with this project. If you have any questions about this process, please contact me.

Sincerely,
Caroline Blake
University of Wisconsin-Stevens Point
Environmental Education Graduate Student

Instructions

1. Please distribute this survey in-class (within the first eight weeks or by November 1st at the latest) to reduce the risk of students looking up the environmental knowledge questions on the internet in an unsupervised setting.
   a. Feel free to forward this email directly to your students right before class or when you are in-class so that they do not accidentally mistype the survey link into their personal devices.

2. Show PowerPoint slide to your class (attached to email):

   ![PowerPoint Slide](image)

3. Inform the students who they are voluntarily being asked to participate in a 10-15-minute online research study that will require them to have a personal computer or smart device with them. If they do not have access to either of these, or if they do not want to participate, then they may be excused from class to go to a computer lab or to carry on with their daily lives.

4. Provide students with approximately 10-15 minutes in-class to complete the survey by November 1st, 2018.
Two-Week Reminder Email

October 15, 2018

Dear Science Methods Instructors,

This is a friendly two-week reminder to please complete the following tasks by
**Thursday, November 1st** at 11:59pm.

1. Distribute the **Student Survey** link to your science methods students **in-class** (10-15 minutes)
   - **Link to Student Survey**: https://uwsp.az1.qualtrics.com/jfe/form/SV_8BmC7wHjRIqoutn

2. Complete the **Instructor Survey** (5 minutes)
   - **Instructor Survey URL**: https://uwsp.az1.qualtrics.com/jfe/form/SV_8wFKSq66sq8s6tT.
     *If you teach multiple science methods courses, please list all of the science methods courses in which you distributed the Student Survey in Question Two of the survey.*

If you have already completed these tasks, please disregard this message. For more detailed instructions, see email thread below. I will send a final email reminder the morning of October 31st. Thank you in advance for your time and willingness to help me with my thesis project.

Best Regards,

Caroline Blake
University of Wisconsin-Stevens Point
Environmental Education Graduate Student

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Final Reminder Email

October 31, 2018

Dear Science Methods Instructors,

This is a final reminder to please complete the following tasks by **Thursday, November 1st** at 11:59pm.

1. Distribute the **Student Survey** link to your science methods students **in-class** (10-15 minutes)
   - **Link to Student Survey**: https://uwsp.az1.qualtrics.com/jfe/form/SV_8BmC7wHjRIqoutn

2. Complete the **Instructor Survey** (5 minutes)
- **Instructor Survey**
  **URL:** https://uwsp.az1.qualtrics.com/jfe/form/SV_8wFKSqi6sq8s6tT. *If you teach multiple science methods courses, please list all of the science methods courses in which you distributed the Student Survey in Question Two of the survey.*

  If you have already completed these tasks, please disregard this message. This will be the **final** email reminder before the survey is closed. Thank you in advance for your time and willingness to help me with my thesis project. I have collected data from nearly 200 students! However, I have only heard back from 11 out of the 22 institutions that verbally agreed to partake in the survey back in May so please help me out and send out/complete those surveys 😊

  Best Regards,

  Caroline Blake  
  University of Wisconsin-Stevens Point  
  Environmental Education Graduate Student

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**Conclusory Thank You Email**

November 14, 2018

Dear Professor,

I would like to thank you for your participation in my research project to better understand the connection between pre-service teacher environmental knowledge and their environmental education teaching efficacy. It was a successful semester for me as a researcher and I hope for you and your students as well. I had over 240 science methods students complete the survey from across 17 of the 33 Wisconsin teacher preparation programs.

The next steps in my research process will be analyzing data, making conclusions from the results, and writing my final findings in a report. As this process is completed, I will distribute the results to you.

This process will take time, so I thank you in advance for your patience regarding the results. If you have any questions or needs concerning this research project in general, please do not hesitate to contact me. I have included the official answers to the “environmental knowledge” student survey questions to potentially promote further discussions about environmental related topics in your future courses.

I am excited for the conclusion of this project and to offer you information about pre-service teachers’ environmental knowledge and environmental education teaching efficacy. Thank you for your participation and good luck with the upcoming semester.

Thanks,

Caroline Blake  
University of Wisconsin-Stevens Point  
Environmental Education Graduate Student