A CAUSAL-COMPARATIVE STUDY OF THE IMPACT OF MEANINGFUL WATERSHED ENVIRONMENTAL EXPERIENCES ON THE ACADEMIC ACHIEVEMENT OF MIDDLE SCHOOL STUDENTS

by

Gina R. Mason

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Meaningful watershed educational experiences (MWEE) are student-centered, problem solving-oriented environmental educational experiences in which students investigate local environmental issues leading to civic engagement and informed action. The four components of an MWEE include issue definition, outdoor field experience, synthesis and conclusion, and action projects. While multiple benefits have been shown to be gained through participation in environmental education, this study's aim was to observe the impact MWEEs have on academic achievement in middle school students. This quantitative, ex post facto, causal-comparative study examined the impact MWEEs had on students' achievement scores, as measured by Pennsylvania System of School Assessment (PSSA) scores. The study compared the ELA, math, and science achievement scores of a sample of eighth grade students in Pennsylvania ($N = 1067$) and examined the impact of exposure to MWEE ($n = 233$) compared to students who have not been exposed to MWEE ($n = 834$). A MANOVA was used to analyze data. There was a statistically significant difference between students' PSSA scores based upon students' MWEE participation status. The findings of this study may aid educators in determining whether to address the environmental literacy expectations mandated in both national and state legislation and standards through the incorporation of the MWEE into their school's curriculum. Recommendations for future research include using a method for determining the instructional methods and curriculum of MWEE implementation, exploring educator and student demographics, prior experiences, and attitudes and expanding the sampling population beyond the ELIT.

Keywords: meaningful watershed educational experiences (MWEE), environmental education (EE), Pennsylvania System of School Assessment (PSSA), environmental literacy, academic achievement, nature-based learning (NBL), project-based learning (PBL)

Copyright Page

Dedication

This work is dedicated to those who strengthened me through love, guidance, friendship, and inspiration and to those whose shoulders I have climbed and those who will climb yet higher; to the dreamers, mentors, torchbearers, and persisters.

Acknowledgments

I would like to thank my dissertation committee for their guidance during this journey. Dr. Wendt, your leadership, sage advice, and patience was invaluable. Dr. Ford, your expertise and encouragement was always welcomed. I am eternally grateful to the two of you for your roles in this milestone.

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To my family, thank you for your support. I am truly blessed. And lastly, to God be the glory for all that I am, all that I have, and providing me the strength to do all things.

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List of Abbreviations

Attention deficit disorder (ADD)

Chesapeake Bay Foundation (CBF)

Chesapeake Bay Program Education Workgroup (CBPEW)

Chesapeake Bay Watershed (CBW)

Data Recognition Corporation (DRC)

Education for Sustainable Development (ESD)

End-of-Grade (EOG)

English Language Arts (ELA)

Environmental Education (EE)

Environmental Education Act, 1970 (EEA)

Environmental Literacy Indicator Tool (ELIT)

Environmental Literacy Plan (ELP)

Environmental Protection Agency (EPA)

Environmentally Responsible Behavior (ERB)

Environment as an Integrating Context for Learning (EIC)

Local Education Agency (LEA)

Meaningful Watershed Educational Experience (MWEE)

National Environmental Education Act, 1990 (NEEA)

National Environmental Policy Act (NEPA)

National Oceanic and Atmospheric Administration (NOAA)

Nature-Based Learning (NBL)

No Child Left Behind (NCLB)

North American Association for Environmental Education (NAAEE)

Pennsylvania Department of Education (PDE)

Pennsylvania Information Management System (PIMS)

Pennsylvania System of School Assessment (PSSA)

Place-Based Learning (PBL)

Project-Based Learning (PBL)

Science, Technology, Engineering, and Math (STEM)

Social-Emotional Learning (SEL)

United Nations Educational, Scientific, and Cultural Organization (UNESCO)

CHAPTER ONE: INTRODUCTION

Overview

The implementation of environmental education (EE) programs provides academic, economic, environmental stewardship, health, and other benefits to students. However, due to testing pressures many school districts choose not to incorporate EE programs into their curriculum, forfeiting documented benefits. This study aimed to explore the impacts of EE implementation, specifically meaningful watershed educational experiences (MWEE), on eighth grade students' Pennsylvania System of School Assessment (PSSA) standardized test scores in order to add to current understanding of the influence, if any, of MWEEs on students' academic achievement. Chapter One discusses the background, historical context, social context, conceptual framework, problem statement, purpose statement, significance of study, research questions, and definitions.

Background

Record-breaking, 2020 tied with 2016 for the hottest year ever documented since record-keeping began in 1880, and both 2021 and 2022 continued this deadly trend (Di Liberto, 2021b; NASA, 2022). In addition, Arizona, California, Colorado, Montana, New Mexico, Utah, Wyoming, and Canada each set a new all-time maximum temperature in 2021 (Di Liberto, 2021b). The United Kingdom and the Vatican City set all-time maximum temperatures in 2022, while Oklahoma and Utah broke records for the most consecutive days with temperatures over 100 degrees F (NASA, 2022; NOAA, 2022a). This record-breaking trend was predicted in 2017 in the U. S. Global Change Research Program's (USGCRP) Fourth National Climate Assessment report. The National Oceanic and Atmospheric Administration (NOAA) declared seven of the highest annual global temperatures have occurred since 2014 and each of the top 10 since 2005

(Di Liberto, 2021a). Temperature changes are not benign (Intergovernmental Panel on Climate Change [IPCC], 2018, 2022; Scott & Vare, 2018). Temperature impacts human health (Center for Disease Control [CDC], 2020; Schramm et al., 2020), energy use (Environmental Protection Agency [EPA], 2017), agriculture (Tobin et al., 2017; Wolfe et al., 2018), water resources (Martin, 2021), natural ecosystems (Williams et al., 2020), infrastructure (Kim et al., 2019), economics (Bretschger & Karydas, 2019), national security (Busby, 2021; Pinson et al., 2021), and more (IPCC, 2018, 2022; USGCRP, 2017). In addition to global temperatures rising, droughts, floods, wildfires, extreme storms, land cover changes, sea-level rise, and ocean acidification are all environmental issues predicted by USGCRP's (2017) report due to climate change. Unfortunately, these climate change impacts are becoming routine (IPCC, 2018). Massive wildfires, historic flooding, and deadly heatwaves occurred around the globe in 2019-2022 including devastating fires in Australia, California, Brazil, and the Artic; deadly floods in Kentucky; and killer heatwaves in the Pacific Northwest, Italy, Europe, and Asia (Masters, 2021; NASA, 2022; NOAA, 2022b). As of June 2022, there were already nine billion-dollar weather disaster in the United States (Masters, 2022). However, climate change is not the only environmental threat (Scott & Vare, 2018). Pollution, loss of biodiversity, and resource deletion are also major environmental issues that must be addressed (Kinslow et al., 2019; Scott & Vare, 2018; Szczytko et al., 2019).

The Lancet Commission on Pollution and Health (Landrigan et al., 2018) claimed pollution is the number one environmental cause of premature death and disease worldwide causing three times more deaths than from malaria, AIDS, and tuberculosis combined, and 15 times more than from war and violence (Landrigan et al., 2018). While these environmental issues are daunting, some actions can be taken to mitigate these problems (IPCC, 2018, 2022;

Landrigan et al., 2018; Scott & Vare, 2018; USGCRP, 2017, 2018). However, it will take a citizenry who is committed to becoming stewards of their environment, or environmentally literate citizens (IPCC, 2018; Kinslow et al., 2019; Li & Monroe, 2018). The method of becoming environmentally literate begins with EE (Kinslow et al., 2019; Szczytko et al., 2019).

Theoretical Underpinning

The conceptual grounding for this study consists of a conceptual framework depicting the gravity of advancing environmental literacy through EE. The primary goal of EE is developing environmental literacy by fostering productive responsible citizens (Environmental Education Act [EEA], 1970; Kinslow et al., 2019; Roth, 1992; Szczytko et al., 2019). If preparing students to become productive citizens should be a universal educational goal, developing and fostering environmental literacy should therefore be a key objective of any education program (Biswas, 2020; Disinger & Roth, 1992; Roth, 1992). In addition, EE provides a plethora of documented academic, economic, health, and other benefits (Ardoin et al., 2018; Becker et al., 2017; Berman et al., 2008; Chawla, 2018; Kaplan & Kaplan, 2011; Kuo et al., 2018; Kuo et al., 2019; Williams, 2017; Zint et al., 2014). The importance and relevance of developing environmental literacy through EE are well documented, particularly with today's environmental issues (Chawla, 2018). Given this pressing need, this study's research questions aimed to provide information to aid educational stakeholders in implementing EE to foster environmental literacy.

Environmentally Literate

Being literate involves ways of thinking, acting, and valuing (Michaels & O'Connor, 1990). Scientific literacy pertains to the ability to utilize evidence and data to evaluate claims (Shaffer et al., 2019). Environmental literacy extends beyond mere scientific literacy. Environmental literacy incorporates economic, geographic, historical, political, and social literacy aspects as well (Roth, 1992). Environmental disasters such as the Dust Bowl of the 1930s spurred the need for EE (McCrea, 2006). The Dust Bowl, also known as the dirty thirties, created devastating dust storms that demonstrated the impact of not utilizing sustainable resource management practices (Worster, 1986). The soil of the Great Plains area was degraded due to improper farming techniques exasperated by drought. The soil had become infertile and blew thousands of miles away causing one of the worst economic and environmental disasters in U. S. history (Worster, 1986). During this period, Wisconsin became the first state requiring preservice teachers to be versed in conservation practices (McCrea, 2006).

Public awareness of environmental issues increased during the 1960s. Rachel Carson's (1962) book *Silent Spring*, based upon sound science and written for the general public, highlighted the dangers of the pervasive use of inadequately-studied synthetic pesticides (Carter & Simmons, 2010; Scott & Vare, 2018). Carson's book resonated with both citizens and politicians alike, sparking an environmental awakening (DeMarco, 2017; Scott & Vare, 2018; Valenti, 2019). Environmental degradation events such as the Cuyahoga River catching on fire due to being so contaminated from oil, debris, and sewage also raised the public's environmental awareness (DeMarco, 2017; EPA, 2018; Lewis, 1985; Stevenson, 2007). In fact, during the Industrial Revolution, Ohio's Cuyahoga River was so contaminated it caught fire more than a dozen times between 1868 and 1969 (Marquis, 2009).

This environmental awakening spurred both national and international acts including the passing of major environmental laws, such as the National Environmental Policy Act (NEPA) of 1969 (P. L. 91-190) and the EEA of 1970 (P. L. 91-516) (Carter & Simmons, 2010; DeMarco, 2017; Marquis, 2009). The term environmental literacy was first penned in an Audubon article in the 1960s due to widespread environmental issues (Roth, 1968). Shortly after, President Richard

Nixon used the term in his speeches relating to the passage of the first National Environmental Education Act (EEA, 1970; Roth, 1992). This legislation recognized the deteriorated environmental quality across the U. S. and emphasized the need to promote EE at the elementary and secondary levels as well as the community (EEA, 1970). In 1990, the U. S. Congress passed the National Environmental Education Act (NEEA) of 1990 (P. L. 101-619). Pennsylvania followed suit in 1993 by adopting the Environmental Education Act of 1993, which embraced Environment and Ecology standards for all K-12 students. Together, these acts, among others, demonstrated the importance of EE and environmental literacy (Hollweg et al., 2011).

However, the landscape of education was altered tremendously with the passing of the No Child Left Behind Act (NCLB) in 2001 (NCLB, 2002). The purpose of NCLB was to improve academic achievement for all students. NCLB mandated standardized testing with the expectation that all students would reach the proficient level. The Pennsylvania proficient performance level descriptors state students demonstrate comprehension of informational and literary text by using textural evidence and solving practical and real-world problems (Pennsylvania State Board of Education, 2015, 2018). Improving test scores quickly became the driving factor in many educational decisions across the nation (Craig & Marshall, 2019; Gruenewald & Manteaw, 2007).

The importance of environmental literacy, however, was not forgotten. In 2002, Pennsylvania adopted the Environment and Ecology Academic Standards (22 Pa. Code § 4.12, 1949/2014; PDE, 2002). In 2014, Pennsylvania's governor signed the Chesapeake Bay Watershed Agreement (CBWA) which included the educational goal: "enable every student in the region to graduate with the knowledge and skills to act responsibly to protect and restore their local watershed" (Chesapeake Bay Foundation [CBF], 2014, p. 13). As a result of the

CBWA, a local education agencies' (LEAs') curriculum should: "continually increase students' age-appropriate understanding of the watershed through participation in teacher-supported, meaningful watershed educational experiences (MWEEs) and rigorous, inquiry-based instruction, with a target of at least one MWEE in elementary, middle, and high school" (CBF, 2014, p. 13).

MWEEs are learner-centered experiences focusing on investigating local, student-selected environmental issues, leading to informed action and civic engagement (Sprague et al., 2019). The four essential elements of a MWEE include defining an issue, outdoor field experiences, synthesis and conclusions based upon investigation, and stewardship and civic interaction (Smith et al., 2020). While NCLB's (2002) purpose was to raise the academic achievement of all students, the educational goal of the CBWA was to equip students with the knowledge and skills to become active stewards of their environment, thus becoming environmentally literate. MWEEs may potentially be one EE method able to address the educational goal of NCLB and the CBWA, fostering environmental literacy. There are multiple stakeholders who have diverse, vested interests in the dividends rendered from the addition of a quality environmental education program into a school's curriculum including environmentalists, the community, and academia (Ardoin et al., 2018; Ernst & Erickson, 2018; Moyer & Miller, 2017; O'Hare et al., 2020; White et al., 2018; Zint et al., 2014). Environmentalists are concerned with environmental stewardship and protecting the environment (Ernst & Erickson, 2018; Goldman et al., 2018; O'Hare et al., 2020). The community benefits socially from improvements in health, reduction in crime rates, economic rewards, and more (Talebpour et al., 2020; Williams, 2017). Educational stakeholders are attentive to the impact academic programs have on their LEAs' standardized testing scores (Bartosh et al., 2006; Ernst & Erickson, 2018; Koretz, 2017; Lieberman & Hoody, 1998; Shapiro et al., 2006). While this study alluded to the concerns of the environmental, community, and social benefits, the focus of this study was to determine what impact, if any, MWEEs have on students' academic achievement.

Problem Statement

Smith et al. (2020) claimed that administrative support is crucial to implementing EE in schools. In addition, Gruenewald and Manteaw (2007) stated, "Teachers and administrators, especially under the pressures of NCLB, often need to be convinced that whatever curricular approach they adopt will enhance student achievement" (p. 177). One often utilized strategy to increase achievement scores is to increase time students spend specifically in English language arts (ELA) and math. However, that strategy places stress upon an already tight schedule (Farbman, 2015). Class schedules are tight due to the curriculum requirement of addressing the large number of mandated standards. While some researchers tout the benefits of increasing instructional time (Fisher et al., 2015; Long, 2014), others claim students are receiving an inferior education due to the narrowing of the content and the emphasizing of didactic pedagogy (Booher-Jennings, 2005; Diamond, 2007; Koretz, 2017).

In addition, this strategy does not take advantage of the potential benefits achieved through EE (Bartosh et al., 2006; Diamond, 2007; Kane et al., 2018; Mazyck et al., 2020). Gruenewald and Manteaw (2007) recommended more studies be conducted correlating academic achievement with EE to advance EE implementation in schools. Bartosh et al. (2006) conducted research on this relationship between academic achievement and EE in Washington state utilizing the Washington Assessment of Student Learning (WASL) standardized test. Bartosh et al. suggested EE could contribute to students' academic achievement on standardized tests and recommended further studies to be conducted analyzing direct student measures of EE on academic achievement. Jordan and Chawla (2019) stated the priority EE topics for future research include learning outcomes, including how learning in a classroom compares with learning in nature and how to effectively apply research to practice. Since MWEEs directly attend to academic achievement, MWEEs may be the vehicle to address these recommendations.

While multiple studies have been conducted using MWEEs (Ernst & Erickson, 2018; Haines, 2016; McConnell et al., 2020; McGuire, 2012; McGuire Nuss et al., 2019; Moyer & Miller, 2017; Reynolds et al., 2021; Zint et al., 2014), there is a lack of published research examining the impact MWEEs have on academic achievement on standardized tests. Due to this lack of data, educational stakeholders may be less likely to incorporate MWEEs into the curriculum. The problem is that there has not been adequate research identifying the impact MWEEs have on academic achievement on standardized tests. Due to this gap in research, students may not be provided with the opportunity to become environmentally literate, thus not equipped to address the daunting environmental issues facing society.

Purpose Statement

The purpose of this quantitative, causal-comparative ex post facto study was to examine the impact of MWEEs on the academic achievement of eighth grade students in Pennsylvania. According to Gall et al. (2007), a causal-comparative study is appropriate due to the naturally-occurring, independent variables that are not able to be manipulated with controlled experience. Thus, the ex post facto design was the preferred method to examine the comparison groups. The independent variable was the student’s participation status. The independent variable has two levels: participation in MWEEs and non-participation in MWEEs. MWEE occurs when students explore environmental issues within their watershed through hands-on, inquiry-based, problem-based learning and implement their solution via action projects (Ernst & Erickson, 2018; Moyer

& Miller, 2017; Sprague et al., 2019; Zint et al., 2014). The dependent variables were the proficiency levels achieved in ELA, math, and science on the eighth grade PSSA. The participants were students who were enrolled in the eighth grade in Pennsylvania middle schools in 2017-2018 where the students did or did not participate in a MWEE based upon the Chesapeake Bay's Environmental Literacy Indicator Tool (ELIT) results (Measurement Incorporated [MI], 2014; Sickler, 2018).

Significance of the Study

A significant amount of research has been conducted on EE's positive impact on students academically, socially, and environmentally (Ardoin et al., 2018; Jordan & Chawla, 2019; Kuo et al., 2019). Ardoin et al. (2018) reviewed and analyzed 119 peer-reviewed empirical EE studies focusing on K-12 students over a 20-year span, finding many positive, environmental outcomes including attitudes, dispositions, knowledge, and skills from a wide diversity of offerings. In addition, Ardoin et al.'s findings suggested positive outcomes in academic achievement and civic engagement even though only 9% of the studies measured soley non-environmental related outcomes. Enhanced measurement studies with a focus on dispositions, behavior, broadened and diversified measured outcomes, and longitudinal studies are warranted (Ardoin et al., 2018). However, many educational stakeholders are still hesitant to incorporate EE due to the fixation on mandated standardized test scores (Craig & Marshall, 2019; Diamond, 2007; Ernst & Erickson, 2018; Kopkin et al., 2018; Koretz, 2017; Ledwell & Oyler, 2016; McGuire Nuss et al., 2019; Redding & Nguyen, 2020). Due to the pressures of accountability stemming from NCLB, proponents of EE must demonstrate how EE fosters measurable student achievement in tested content areas (Gruenewald & Manteaw, 2007). To encourage educational stakeholders to implement MWEEs, thereby allowing students to develop environmental literacy and the skills to address environmental problems, there is a need to determine whether MWEEs impact state-mandated standardized test scores (Kuo et al., 2019). MWEEs may also benefit students academically, behaviorally, mentally, physically, and socially (Rickinson & McKenzie, 2020) while also improving environmental literacy.

This present study aimed to address a gap in the existing literature concerning the impacts of MWEEs on state-mandated, standardized test scores (Bartosh et al., 2006; Jordan & Chawla, 2019; Kuo et al., 2019; Lieberman & Hoody, 1998). This study may also provide empirical significance by focusing on the academic achievement impacts, therefore addressing the concerns of Ardoin et al. (2018), who claimed researchers were more likely to measure environmental concerns versus academic ones and suggested researchers conduct focused outcome studies by selecting a precise interest.

This study addresses Ardoin et al.'s recommendation by focusing on academic achievement. Thus, it may provide insight to educators in school districts who have not yet implemented the MWEE by perhaps providing documentation to support the academic benefits of MWEE implementation. The results of this study may also be useful to the Chesapeake Bay Program's Educational Workgroup (CBPEW) in supporting local efforts to create and implement comprehensive strategies to foster student environmental literacy (Edwards & Larson, 2020; Jordan & Chawla, 2019; Kuo et al., 2019; Rickinson & McKenzie, 2020). This study is intended to add to the existing body of knowledge on the impact of MWEEs on the academic achievement of middle school students based upon their standardized test scores. This study may or may not encourage schools to implement MWEEs, which may foster environmental literacy.

Research Question

The research question for this study is as follows:

RQ: Is there a difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status?

Definitions

1. *Academic Standard* – Academic standard is what students should know and be able to do at a particular grade level (PA Code, 2020).
2. *Climate Change* – Climate change is a long-term alteration in earth's average weather patterns locally, regionally, and globally primarily driven by human activities such as fossil fuel burning (National Aeronautics and Space Administration, 2021).
3. *Digital Native* – A digital native a person who has grown up immersed in technology (Prensky, 2001).
4. *Education for Sustainable Development* – Education for sustainable development is type of education empowering learners to make decisions promoting environmental and cultural diversity (Leicht et al., 2018).
5. *Environment as an Integrating Context for Learning (EIC)* – EIC is a type of pedagogy employing natural and socio-cultural environments as the context for student learning or outdoor education (State Education and Environment Roundtable, 1999).
6. *Environmental Education* – Environmental education is the continuous learning process in which individuals become aware of their environment and acquire knowledge, experiences, skills, and values to solve environmental problems (Vaughan et al., 2003).
7. *Environmental Literacy* – Environmental literacy is the ability to make informed environmental decisions and be willing to act upon those decisions (Hollweg, et al., 2011).

8. *Environment and Sustainability Education* – The environment and sustainability education was founded to promote environmental literacy by connecting the environment through experiential learning (NEEF, 2015).
9. *Formal Education* – Formal education is instruction that takes place in pre-school, primary, secondary, and higher education facilities as well as training for professionals such as teachers ("Belgrade Charter," 1975).
10. *Historically Underperforming Students* – Historically underperforming students are economically disadvantaged students, English language learners, and students with disabilities in relation to PSSAs (PDE, 2018).
11. *Nature-Based Learning* – Nature-based learning is an educational approach using the natural world as the context for learning (Chawla, 2018).
12. *Nature-Deficit Disorder* – Nature-deficit disorder is the atrophied awareness and cost of alienation from nature (Louv, 2008).
13. *Non-Formal Education* – Non-formal education is any instruction for youth and or adults outside of the K-12 school or higher education system ("Belgrade Charter," 1975).
14. *Meaningful Watershed Educational Experience (MWEE)* – MWEE is a hands-on, inquiry-based, problem-based learning activity where students implement the solution they developed via research and action projects (Sprague et al., 2019).
15. *Pennsylvania System of School Assessment (PSSA)* – PSSA is a criterion-referenced, standards-based test developed and implemented by the PA Department of Education (DRC, 2019).

16. *Place-Based Learning (PBL)* – PBL is the process of using the environment and local community to teach concepts in any subject, also called outdoor education or place-based education (Sobel, 2004, 2020).
17. *Sustainability* – Sustainability emphasizes the ideals of conservation in which natural resources are used in a way that ensures their availability for future generations (Newman, 2011).

CHAPTER TWO: LITERATURE REVIEW

Overview

Chapter Two presents the conceptual framework for the basis of this study and-a synthesis of the literature concerning the environmental, community/social, and academic benefits achieved through the implementation of meaningful watershed educational experiences (MWEEs). While a litany of research exists displaying the benefits of EE, there is a scarcity of research on the influence that MWEEs have on students' academic achievement. This study aims to fill this gap. This chapter presents a foundation to the argument for the benefits of the possible inclusion of MWEEs into schools' curriculum.

Conceptual Framework

Environmental Literacy

The gravity of environmental literacy has been acknowledged at every level, locally (Chesapeake Bay Program Working Group [CBPWG], 2001), nationally (North American Association for Environmental Education [NAAEE], 2019), and globally (United Nations [UN, 1973). The U. S. government acknowledged the need for an environmentally astute citizenry by the passage of the EEA of 1970 and the NEEA of 1990. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) declared the goal of EE:

> To develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones. (UNESCO-UNEP, 1978, p.2)

Therefore, the overarching goal of EE is to develop an environmentally-literate citizenry (Hufnagel et al., 2018; Kil, 2016; Moyer & Miller, 2017; NAAEE, 2019; O'Hare et al., 2020; Scott & Vare, 2018). An environmentally-literate person possesses the knowledge, skills, and dispositions to make informed decisions concerning the environment and to act to solve environmental problems within their community and globally (Jordan & Chawla, 2019; Kuo et al., 2019; Moyer & Miller, 2017; NAAEE, 2019). Globally, three seminal conferences occurring in the 1970s solidified the importance of environmental literacy.

The first event was the 1972 United Nations Conference on the Human Environment in Stockholm, Sweden, which resulted in the establishment of the United Nations Environment Programme (UNEP; Vandeveer, 2000). With 114 government delegations, approximately 300 non-government organizations, and over 1,500 members of the press, the Stockholm convention was the first global conference focused on the environment (Engström, 1973). The conference examined humans' negative impact on the environment and expressed the need for environmental literacy through knowledge and action:

> A point has been reached in history when we must shape our actions throughout the world with more prudent care for their environmental consequences. Through ignorance or indifference, we can do massive and irreversible harm to the earthly environment on which our life and well-being depend. Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes. (UN, 1973, p. 3)

The Stockholm Declaration produced seven proclamations, 26 principles, 109 recommendations, an action plan as well as a Resolution (UN, 1973). Principle 19 and Recommendation 96 explicitly addressed the need for EE (UN, 1973). EE was to be "interdisciplinary in approach, in school and out of school, encompassing all levels of education and directed toward the general public, in particular the ordinary citizen living in rural and urban areas, youth and adult alike" (UN, 1973, p. 24). EE training was also recommended for professional workers including teachers. EE as recommended was to be interdisciplinary and pervasive.

The second conference, the International Workshop on Environmental Education, held in Belgrade, Yugoslavia in 1975 ,was hosted by the UNESCO and the UNEP, resulted in the *Belgrade Charter: A Global Framework for Environmental Education* (Carter & Simmons, 2010; UNESCO-UNEP, 1978). The Belgrade Charter (1975) stressed the importance of EE as per Recommendation 96 of the Stockholm conference and developed six EE objectives:

1. Awareness: to help individuals and social groups acquire an awareness of and sensitivity to the total environment and its allied problems.
2. Knowledge: to help individuals and social groups acquire basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.
3. Attitude: to help individuals and social groups acquire social values, strong feelings of concern for the environment and the motivation for actively participating in its protection and improvement.
4. Skills: to help individuals and social groups acquire the skills for solving environmental problems.
5. Evaluation ability: to help individuals and social groups evaluate environmental measures and education programmes in terms of ecological, political, economic, social, esthetic and educational factors.

6. Participation: to help individuals and social groups develop a sense of responsibility and urgency regarding environmental problems to ensure appropriate action to solve those problems. (UNESCO-UNEP, 1978, p. 3)

The third event, the Intergovernmental Conference on Environmental Education, was held in Tbilisi, Georgia, previously part of the USSR, in 1977. The Tbilisi Conference, convened by UNESCO with organizational assistance from UNEP with over 300 participants in attendance, addressed environmental problems, the role of education, and current efforts and achievements in EE and resulted in the Tbilisi Declaration and 41 recommendations (Carter & Simmons, 2010; Ferguson, 2011; UNESCO, 1978). The Tbilisi Declaration underscored the importance of EE to foster environmental literacy (Ferguson, 2011). This declaration states, "Education utilizing the findings of science and technology should play a leading role in creating an awareness and better understanding of environmental problems" (UNESCO, 1978, p.24).

Environmental Literacy in Pennsylvania

Recognizing the vital importance of fostering environmental literacy among its citizens, Pennsylvania established strong advocacy for EE on multiple fronts. In 1971, Pennsylvania's Constitution was amended to include an environmental rights amendment, Article 1, Section 27. Pennsylvania also adopted Environment and Ecology Academic Standards (K-12) in 2002. According to these standards, all schools are required to include instruction on wetlands and watersheds; renewable and nonrenewable resources; environmental health; integrated pest management; ecosystems and their interactions; agriculture and society; humans and environment; threatened, endangered, and extinct species; and environmental laws and regulations (Liang & Richardson, 2009). In addition, in 2013, the Pennsylvania Environmental

Literacy Plan (ELP) was developed by Pennsylvania's Advisory Council (PAC) which represents all of Pennsylvania's environmental agencies, associations, and organizations.

Even though the enactment of EE has been advocated for globally, nationally, and in Pennsylvania for over five decades, and the urgency of learning to live sustainably is vital given today's daunting environmental problems of climate change, pollution, loss of biodiversity, and resource depletion, EE proponents seem to have to continually battle to incorporate these concepts into the curriculum (Ardoin et al., 2018; EEA, 1970; NEEA, 1990; NAAEE, 2019; Palmer, 1998/2006). Understanding how EE is related to conservation behaviors is paramount to address environmental issues (Ballard et al., 2017). If the potential impact MWEEs have on academic achievement can be implied, administrators and other educational stakeholders may be more inclined to incorporate MWEEs. The inclusion of MWEEs into a school's curriculum as directed by the CBWA and Pennsylvania ELP may improve standardized test scores; allow multiple environmental, community, social, and academic benefits to be realized; and promote environmental literacy (Morales-Doyle, 2017).

Related Literature

Environmental Literacy Through Environmental Education

Environmental active involvement, attitudes and values, knowledge, personal investment and responsibility, sensitivity, skills are the six major areas of environmental literacy which when groups together create four strands: knowledge, skills, affect, and behavior (Roth, 1992). Through EE, people move through stages of environmental literacy: 1) awareness, 2) concern, 3) understanding, and 4) action (Roth, 1992). A continuum of three levels of environmental literacy exists, nominal, functional, and operational (Roth, 1992). A person at the nominal level has basic awareness and appreciation of environmental issues.

A functionally environmentally-literate person has a broader understanding, is able to think critically and creatively, and identifies issues, interactions, and valuing. An operationally-literate person has moved beyond functionality and routinely evaluates consequences and impacts of decisions and actions, and advocates through action (Disinger & Roth, 1992; Roth, 1992). NAAEE developed the K-12 Environmental Education: Guidelines for Excellence (2019) guidance document which depicted four strands to foster environmental literacy which include: questioning, analysis, and interpretation skills; environmental processes and systems; skills for understanding and addressing environmental issues; and personal and civic responsibility. According to NAAEE (2019), there are nine environmental education core principles:

- Systems and system thinking: systems and system thinking is the concept that the complex world is comprised of parts that can be understood separately. Relationships and interactions among the parts must be addressed to gain a deeper understanding. This includes the interacting biological, chemical, and physical processes and aspects of our world.
- Human well-being: well-being is inextricably tied to environmental health. Thus, forming an interdependence relationship between humans and our environment.
- Equity and inclusion: environmental education is inclusive, equitable, and respectful to all regardless of talents, backgrounds, experiences, or perspectives.
- The importance of where one lives: by making personal connections to local communities, people are able to gain a better appreciation prior to being able to tackle broader issues.

- Roots in the real world: direct experience in the actual environment and issues through investigation, analysis, and problem solving is the most effective way to develop deeper understanding, knowledge, and skills leading to stewardship.
- Integration and infusion: environmental education is interdisciplinary. Natural sciences, social sciences, and humanities are all interconnected, and students learn best when the curriculum is integrated accordingly.
- Lifelong learning: critical and creative thinking, communication, collaboration, and decision making are all skills developed through environmental education that are essential life skills.
- Sustainability: environmental education is future focused. Environmental, economic, and social responsibility is key (NAAEE, 2019, p.12).

EE should be implemented in an interdisciplinary manner and be pervasive throughout the entire educational journey of students from primary school through secondary school and beyond (UNESCO, 1978). EE treats the environment as a medium for and topic of investigations as well as incorporating conservation ethics, values, and attitudes, ultimately leading to stewardship (Moyer & Miller, 2017; NAAEE, 2019; Palmer, 1998/2006). To achieve this goal, when students learn about the environment, both in the classroom and outdoors, students build concern, experience, and the call for action through the holistic development of knowledge and understanding, concepts, skills and attitudes (Moyer & Miller, 2017; NAAEE, 2019; Palmer, 1998/2006).

Empirical, hands-on, inquiry, and problem-based EE projects present an opportunity to address multiple interests of various stakeholders (Sprague et al., 2020). In the modern, technologically-gorged society, many people are losing their connection to nature and, thus, the multiple health, cognitive, social, economic, and regenerative benefits of communing with nature are being forfeited (Becker et al., 2017; Hackett et al., 2020; Louv, 2011, 2012, 2016). The benefits gained from EE include benefits to students' mental health (Gustafsson et al., 2012), stress relief (Wells & Evans, 2003), academic achievement (Lieberman & Hoody, 1998), and development of agency (Blanchet-Cohen & Reilly, 2017). MWEEs may provide the avenue to encourage all students to actively engage; develop critical thinking, problem-solving, communication, and soft skills; learn content; and achieve success (Sprague et al., 2020).

Environmental literacy transcends mere knowledge of environmental concepts to the adoption of pro-environmental behaviors and actions (Leicht et al., 2018). Both the NAAEE and the National Environmental Education Foundation (NEEF) utilize the definition proposed by Hollweg et al. (2011) to define an environmentally-literate person as "someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act upon these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life" (pp. 2-3). According to NEEF (2015), the goal of environmental literacy is for everyone to understand "that they can be part of the solution" (p. 10).

The inclusion of EE may assist students in developing environmental literacy. To do so, students must not only learn the cognitive aspects of environmental concepts such as knowledge, abilities, and skills, but also develop environmental attitudes which can impact behavior (Fung & Ellis, 2017; Hollweg et al., 2011). The goal of EE is to equip students with the tools to be able to make environmentally-sustainable decisions and act upon them (NAAEE, 2019). As society is rife with environmental turmoil-due to pollution, resource depletion, loss of biodiversity, overpopulation, and climate change, having an environmentally-literate society is of paramount importance (García-González et al., 2020; National Academies of Sciences, Engineering, and Medicine, 2021; USGCRP, 2017, 2018).

Nature-Deficient Disorder

The proliferation of technology has reduced both the time people spend in face-to-face communication as well as in nature (Edwards & Larson, 2020; Louv, 2011, 2012; Small & Vorgan, 2008; White et al., 2018). Technology has become an integral part of students' daily lives both inside and outside of the classroom, deeming students "digital natives" (Prensky, 2001, p.1). Contemporary students are inundated with iPads, cell phones, video games, and smart devices with virtual assistant artificial intelligence (AI) technology (Edwards & Larson, 2020; White et al., 2018).

This skyrocketing exposure to technology has altered students' brain physiology and cognitive functions influencing how they think, feel, and behave (Lopez-Fernandez, 2021; Prensky, 2001; Small et al., 2009; Small & Vorgan, 2008; Williams, 2017). Some of these changes can be beneficial, such as sharpened visual stimuli reaction time and the ability to process information rapidly (Olson, 2012; Prensky, 2001). However, stress and digital burnout are also a result of today's technological culture which can lead to addiction, depression, impaired cognition, and a decrease in people and communication skills (Lopez-Fernandez, 2021; Louv, 2008; Olson, 2012; Small & Vorgan, 2008; Williams, 2017).

As a result, many children today tend to suffer from Nature-Deficit Disorder (Louv, 2008, 2011), the atrophied awareness and cost of alienation from nature. Research links physical, mental, and spiritual health directly to a person's association with nature in multiple arenas (Edwards & Larson, 2020; Kaplan & Kaplan, 2003, 2011; Kuo & Sullivan, 2001; Louv, 2008, 2011, 2012, 2016; Matsuoka, 2010; Moore, 1981; Ulrich, 1984; van den Berg et al., 2003).

Williams (2017) claimed the exclusion of nature has increased irritability, obesity, vitamin D deficiency, loneliness, anxiety, narcissism, distractibility while reducing sociability~~,~~ and cognitive nimbleness. Owen (2016) suggested promoting the advantages of nature-based learning (NBL), such as improved engagement and positive attitudes, may reduce the current disconnect between students and nature. Researchers recommend fostering the hybrid mind by creating a balance between technology and nature (Hackett et al., 2020; Louv, 2011, 2012). By implementing quality, school-based EE, specifically hands-on, inquiry-based, problem-based projects such as the MWEEs, students are provided the avenue to develop a balance between technology and nature and are afforded the benefits of nature (Scott & Vare, 2018) while also fostering environmental literacy (NAAEE, 2019). While improved social, emotional, and physical wellbeing derived from EE are therapeutic, these improvements do not overtly address the academic benefits of EE. The MWEE has the potential to address the academic realm as well.

Environmental Education

Both the scope and history of EE are broad and meandering (Scott & Vare, 2018). NAAEE (2021a) used the metaphor of an umbrella to describe EE’s extensive purview while McCrea (2006) used the concept of a multibranched tree to illustrate the diversity of the field of EE. In addition to being multidisciplinary (UN, 1972), EE is polyonymous. While the EE nomenclature used may be synonymous and interchangeable for many, some view a clear distinction between certain types of learning and EE (Jordan & Chawla, 2019). This diversity of nomenclature could lead to confusion. Frequently used labels of EE programs include nature study, conservation education, outdoor education (OE), environmental studies (Kaushik & Kaushik, 2004), environmental science (Carter & Simmons, 2010), NBL (Jordan & Chawla, 2019), environmental and sustainability education (ESE; Rickinson & McKenzie, 2020), environment as an integrating context for learning (EIC; (State Education and Environment Roundtable, 1999), environmental issues forums (EIF; Simmons, 2018), education for sustainable development (ESD); green education (Newman, 2011), and education for a sustainable future (Newman, 2011). Some of these labels are more synonymous than others.

Some of the interests, purposes, and names of EE have changed throughout history (Scott & Vare, 2018). In 1762, Rousseau published *Emile,* which advocated the use of the environment in education (McCrea, 2006; Rousseau, 1762/2012). During the 1800s, Agassiz, Emerson, Thoreau, Marsh, and Geddes continued the precursory path towards EE (Carter & Simmons, 2010; McCrea, 2006). Jackman (1891), with the publishing of *Nature Study for the Common School*, initiated the first labeled type of EE–the nature study movement (McCrea, 2006). Liberty Hyde Bailey, the first President of the American Nature Study Society, rejected using the term EE due to its ambiguity in 1905 (McCrea, 2006). In 1911, Comstock published the *Handbook of Nature Study*, which remains a useful teaching resource while Dewey's *Experience in Nature*, which promoted student-centered pedagogy used in EE, was published in 1925 (McCrea, 2006). During the 1930s, with devastating consequences of the Dust Bowl, EE shifted to be more conservation-based (McCrea, 2006). It was not until 1948 when the term EE was thought to be first used professionally in public at the International Union for the Protection of Nature (IUPN) conference in Paris by Thomas Pritchard, the Deputy Director of the Nature Conservancy in Wales (McCrea, 2006). Leopold's (1949) *A Sand County Almanac* set the stage for the upcoming environmental awakening of the 1960s sparked by Carson's (1962) *Silent Spring* (Carter & Simmons, 2010). During the 1960s, a plethora of environmentally-focused legislation was enacted to include the Wilderness Act of 1964, the Clean Air Act of 1965, and the Solid Waste Disposal Act the same year as well as the Species Conservation Act of 1966 and the Wild and

Scenic River Act of 1968 (Carter & Simmons, 2010). The first journal on EE, *Environmental Education,* renamed the *Journal of Environmental Education* which is still currently in publication, was published in 1969 by Professor Clay Schoenfeld (McCrea, 2006). Dr. William Stapp, a professor at the University of Michigan, and his students defined EE in the first edition (McCrea, 2006). This environmental focus continued in the 1970s. The National Environmental Policy Act of 1969 (NEPA; P. L. 91-190) was enacted January 1, 1970. The first Earth Day organized by Senator Gaylord Nelson and Harvard law student, Denis Hays, drew an estimated 20 million participants across the U. S. on April 22, 1970 (Carter & Simmons, 2010). NEEA of 1970 (P. L. 91-516) passed in October of 1970, officially declared the importance of EE and environmental literacy. Founded in 1971, the National Association for Environmental Education, now the North American Association for Environmental Education (NAAEE), continues to advocate for EE and environmental literacy.

Types of Environmental Education

Nature study, outdoor education, rural studies, and conservation education were titles given to early EE (Scott & Vare, 2018). By the end of the 1970s, environmental literacy was recognized as the goal of EE (Scott & Vare, 2018). During the UN Conference on Environment and Development in Rio de Janeiro, Brazil in 1992, Chapter 36 of Agenda 21 shifted EE towards sustainable development (McCrea, 2006). The UN General Assembly declared 2005-2014 as the Decade of Education for Sustainable Development (McCrea, 2006). The focus on sustainability is one of NAAEE's (2019) core principles. Sustainability is the ability to meet the needs of today without jeopardizing the ability to satisfy the needs of the future (NEEF, 2015). As NAAEE is nearing its 50th year anniversary, the organization continues to promote its mission "To use the power of education to advance environmental literacy and civic engagement to create a more equitable and sustainable future. We work with educators, policymakers, and partners throughout the world" (NAAEE, 2021b, "Mission, Vision, and Strategy" section).

Education for a Sustainable Future. Education for a Sustainable Future, similar to Green Education (Newman, 2011), Environmental Education for Sustainability (Department of Conservation, 2017), and Environmental and Sustainability Education (NEEF, 2015), advances a multidisciplinary, overarching framework depicting the interconnections and interdependencies between the environment, people, and the economy with the ultimate drive towards sustainability (Newman, 2011). While the previous international Stockholm and Tbilisi conferences laid the groundwork for the push towards sustainable development, the Bruntland Commission's World Commission on Environment and Development Our *Common Future* report (UN, 1987) developed the concept of sustainable development (Scott & Vare, 2018). Coupled with Talloires Declaration (UNESCO, 1990) 10-point action plan's call to action, the impetus to higher education's entry into EE with sustainability being the focus was forged (Newman, 2011; UNESCO, 1990). Sustainable development became the focus of Rio's 1992 Earth Summit and its action plan, *Agenda 21* (Scott & Vare, 2018). NAAEE's (2019) other essential underpinnings of EE include systems and systems thinking, human well-being, equity and inclusion, the importance of where one lives, roots in the real world, integration and infusion, and lifelong learning. Along with various names, multiple avenues and locations are utilized to implement EE including outdoor education opportunities, field trips, on-site investigations, virtual exposure, school gardens, schoolyards, and playgrounds. Dunkley (2016) suggested natural settings provide spaces to nurture environmental literacy.

Nature-Based Learning. Nature-based learning (NBL), like place-based learning (Sobel, 2004, 2020), environment as an integrating context for learning (State Education and

Environment Roundtable, 1999), and outdoor education (Jeronen et al., 2017) are educational approaches using nature as the context for learning (Chawla, 2018). NBL can occur anywhere with anyone. NBL encompasses the learning that occurs when students are exposed to nature whether it is through nature-based activities in natural settings, or where natural elements such as animals, plants, and water are brought inside (Jordan & Chawla, 2019). NBL includes formal, structured activities in schools and outdoor field trips as well as informal free play in green places such as home yards and schoolyards as well as non-formal occurrences such as camps, nature centers, and parks (Dunkley, 2016).

The label NBL was first introduced in a grant application to the United States National Science Foundation (NSF) in 2015 to coordinate similar studies scattered across various disciplines (Chawla, 2018; Jordan & Chawla, 2019). Kuo et al. (2019) conducted a review of existing research of nature's impact on environmental stewardship, personal development, and academic functioning. NBL differentiates itself from EE by focusing on more academic educational outcomes such as test scores, grades, and graduation rates and less EE-oriented topics such as conservation ethics (Jordan & Chawla, 2019). According to NAAEE's K-12 Environmental Education: Guideline for Excellence (2019), "EE is a key tool in creating healthier and more civically-engaged communities" (p. 8.)

Environmental Science. Environmental science (ES), dedicated to studying the impact of human systems on earth's biological, chemical, and physical environmental systems (Fester & Valenzuela, 2021), is a branch of science similar to environmental studies (Kaushik & Kaushik, 2004). ES focuses on the broad-based multidisciplinary aspects of EE such as ecology, natural resources management, biodiversity, and human environmental impacts. ES may concentrate more on the technical aspects and not on environmental ethics (Kaushik & Kaushik, 2004). Due to EE’s concept of stewardship (Gough, 2002; Schönfelder & Bogner, 2020), some science educators do not embrace EE or environmental literacy. Stewardship is the reason some science teachers do not consider EE to be a real science (Dillon, 2016). Fester and Valenzuela (2021) claimed that ES is widely viewed as less important than more traditional sciences such as biology, chemistry, and physics.

Environmental Issues Forums. Environmental Issues Forums (EIF) were developed in 2014 through a partnership between NAAEE and the Kettering Foundation (Simmons, 2018). EIFs are a type of EE where a group of people with diverse ideas on a particular environmental topic have a facilitated discussion. One of the goals of EIFs is to increase public dialogue on environmental issues such as climate change. By providing people with diverse views an opportunity to gain a shared understanding of an environmental problem, the hope is the participants can develop a shared action plan to address the issue. The forums are led by neutral, trained moderators using an issue discussion guide to frame the issue (Simmons, 2018).

Benefits of Environmental Education

Multiple stakeholders have diverse vested interests in the dividends rendered from the addition of a quality EE programming into a school’s curriculum including environmentalists, the community, and academia (Ardoin et al., 2018; Ernst & Erickson, 2018; Jordan & Chawla, 2019; Moyer & Miller, 2017; O’Hare et al., 2020; White et al., 2018; Zint et al., 2014). Environmentalists are concerned with environmental stewardship and protecting the environment (Ernst & Erickson, 2018; Goldman et al., 2018; O’Hare et al., 2020). The community benefits socially from improvements in health (Oh et al., 2017), reduction in crime rates, economic rewards, and more (Talebpour et al., 2020; Williams, 2017).-Academic stakeholders-are attentive to the impact educational programs have on their local education agencies’ (LEAs) standardized testing scores (Bartosh et al., 2006; Craig & Marshall, 2019; Ernst & Erickson, 2018; Koretz, 2017; Lieberman & Hoody, 1998; Shapiro et al., 2006).

Environmental Benefits. Problem solving is at the heart of environmental stewardship. Aldo Leopold (1949) championed the concept of environmental stewardship, which is the protection and sustainable use of nature. Stewardship is the ultimate goal of environmental education to increase environmental quality, social equity, and economic prosperity in a sustainable fashion (Jordan & Chawla, 2019; Kuo et al., 2019; Moyer & Miller, 2017; NAAEE, 2019). Youth have the power, agency, and ability to contribute to conservation efforts (Ballard et al., 2017). Through the implementation of the MWEE framework, 93% of teachers reported an increase in students' environmental awareness (McGuire, 2012; McGuire Nuss et al., 2019). Environmental awareness is a precursor of environmental literacy. Thus, MWEEs may improve environmental literacy which may lead to environmental stewardship and improved watershed health (Smith et al., 2020).

One key finding that influences students' agency pertains to the connection to local, real-world issues (Ballard et al., 2017; Flanagan et al., 2019). When students participate in real, complex, scientific problem-solving opportunities, students feel empowered and motivated (Ballard et al., 2017; Flanagan et al., 2019). Personal resolve and human agency replace passivity and the acceptance of the status quo (Flanagan et al., 2019). MWEEs provide such a vehicle, ultimately leading to stewardship. Local environmental projects such as habitat enhancement, invasive species removal, planting native plants, and minimizing pesticide application not only improve the environment but also provide academic, social, and community benefits (Clayborn et al., 2017). By participating in MWEEs, students take ownership of their environment, and ownership begets stewardship (Flanagan et al., 2019).

EE promotes environmental hope which can strengthen pro-environmental behavior (Ballard et al., 2017; Kerret et al., 2020; Ojala, 2012, 2015). EE has been shown to have long-term impacts on the development and implementation of pro-environmental behaviors (Breunig & Russell, 2020). A person's connectedness to nature, which can be strengthened through EE (Pensini et al., 2016), has a strong relationship to ecological behavior (Brody & Ryu, 2006; Otto & Pensini, 2017). Spending time outdoors in more natural settings may elevate positive emotions such as feelings of awe, joy, and happiness, which improve emotional well-being, mental health, and prosocial behavior (Ballew & Omoto, 2018) as well as enhance positive learning outcomes when paired with effective programming, implementation, and pedagogical approaches (Becker et al., 2017; Dale et al., 2020; Kuo et al., 2019).

EE can produce life-long environmental impacts which may ultimately produce social benefits for the community (Breunig & Russell, 2020; Hutchenson et al., 2018). Research suggests pro-environmental behavior in addition to well-being can be developed and enhanced through EE implementing environmental hope-enhancing programs (Kerret et al., 2020). EE participation strengthens environmental attitudes, behaviors, and community sustainability practices (Ardoin et al., 2018; Calvente et al., 2018; Kil, 2016; Mullenbach & Green, 2018; Pensini et al., 2016).

Community and Social Benefits. Multiple researchers have suggested that there is a wide array of community and social benefits to be gained from incorporating nature into a person's daily life (Ardoin et al., 2018; Ballew & Omoto, 2018; Chawla et al., 2014; Corvalan et al., 2005; Jordan & Chawla, 2019; Louv, 2016; Sprague et al., 2020; Ulrich, 1984; Zocher & Hougham, 2020). Kerret et al. (2020) claimed students who are exposed to inquiry-based environmental education programs such as the MWEE are more likely to foster a positive view of nature and thus become stewards of their environment. Students are, therefore, more likely to be exposed to the community and social benefits gained through the interaction with and improvement of their environment (Kerret et al., 2020).

The social benefits include improved health; reduced stress (Chawla et al., 2014); better emotional, mental, physical, and overall health (Oh et al., 2017; Sprague et al., 2020); and improved mental well-being (Corvalan et al., 2005; Kerret et al., 2020; Louv, 2016; Pensini et al., 2016). Cardiovascular health (Coutts et al., 2010; de Jesus Crespo & Fulford, 2018; Mitchell & Popham, 2008), heat-related illnesses (de Jesus Crespo & Fulford, 2018), obesity rates, and psychological health can all be improved through the increased access to nature which EE encourages (Jennings & Gaither, 2015). Mental health and well-being, active citizenship, social behavior, overall health, and environmental awareness are all benefits of time spent in nature participating in outdoor activities (Rocher et al., 2020). Frumkin (2001) stated that nature in multiple forms can improve health to include animals, which research links to reduced cardiovascular disease, lower blood pressure, cholesterol, triglycerides, and stress. Plants as well as landscapes also have been shown to reduce stress and improve both physical and mental health, including the reduction of fear and anger, and enhance mental alertness, cognitive performance, and attention (Frumkin, 2001). Oh et al. (2017) claimed that a review of six research articles suggests exposure to nature or forest therapy showed both psychological and physiological impacts including reduction in hypertension, stress, depression, and anxiety and improvements in cardiac, pulmonary, and immune function.

Pirchio et al. (2021) conducted two studies evaluating the effect of four outdoor education experiences on over 300 fourth through sixth grade students compared to control groups consisting of over 400 students who did not participate in NBL. The intervention groups demonstrated improved psychophysical wellbeing, prosocial behavior, and connectedness to nature (Pirchio et al., 2021). Oh et al. (2017) suggested positive health impacts on anxiety, cardiac and pulmonary function, depression, emotional response, hypertension, immune function, and stress due to time spent in nature. Walsh (2011) claimed that human's divorce from nature causes disruptions in diurnal rhythms, mood, and sleep which negatively impact mental health, obesity, and wellbeing. According to Li and Sullivan (2016), attention spans and stress levels are improved for students who can view green landscapes through their classroom windows, showing enhancements in cognitive and psychological health.

Developing an effective partnership between the community and the school through EE contributes positively to the school, environment, and community (Alkaher & Gan, 2020). The community/social benefits of stress reduction, improving focus, building competence, forming supportive social groups, and improving resilience (Chawla et al., 2014) influence the academic arena as well. The community benefits provided through EE include reduction in crime, increase in property value, decrease in heating and cooling costs, increased economic value through the increase of purchasing power and reduction of stormwater management costs (Ardoin et al., 2018; Chawla et al., 2014; Frumkin, 2001; Hackett et al., 2020; Jordan & Chawla, 2019; Kuo et al., 2019; Pensini et al., 2016; Sprague et al., 2020; Ulrich, 1984; Zocher & Hougham, 2020).

Academic Benefits. Multiple studies have demonstrated possible benefits achieved by incorporating nature into the classroom including the reduction of absenteeism, attention-deficit-disorder (ADD) symptoms, depression, mental fatigue, and stress as well as increased attention spans, cooperation, and conflict resolution skills, focus, memory, motivation, problem-solving, self-esteem, and improved classroom behavior (Ardoin et al., 2018; Becker et al., 2017; Berman et al., 2008; Kaplan & Kaplan, 2011; Kuo et al., 2019; Lieberman & Hoody, 1998; Williams, 2017). EE and learning in natural settings provide multiple academic benefits (Dettweiler et al., 2017; Lieberman & Hoody, 1998; Ohly et al., 2016; Scogin, 2016). Increased student motivation that is evident with the implementation of quality, inquiry-based EE programs such as the MWEE (Ardoin et al., 2018; Craig & Marshall, 2019; Jordan & Chawla, 2019; Moyer & Miller, 2017; NAAEE, 2019; Sprague et al., 2020).

Research indicates the ability to concentrate may be restored through the exposure to natural environments (Ohly et al., 2016). Short-term cognitive impacts of lack of exposure to nature include a reduction of attention, while the long-term impacts of the withdrawal of nature result in reduced academic performance (Walsh, 2011). Research suggests that intrinsic motivation wanes during adolescence, which impacts academic achievement (Gnambs & Hanfstingl, 2016). Intrinsic motivation EE with an outdoor component improves student motivation, competence, autonomy, and student-teacher relatedness (Dettweiler et al., 2017) as well as increased student engagement (Scogin, 2016). Student self-reported engagement appears to be a better indicator of student learning than teacher-reported engagement (Frensley et al., 2020). In a quasi-experimental study, outdoor teaching seemed to enhance the learning of mathematics and motivation (Fägerstam & Samuelsson, 2014) as well as student engagement (Frensley et al., 2020). Nature-based education inspires curiosity and overall Science, Technology, Engineering, and Math (STEM) capacity (Sprague et al., 2020).

Qualitative studies indicate that observed benefits of utilizing the environment as an integrating context for learning (EIC) suggested improvement in academic achievement in reading, writing, math, science, and social studies via standardized assessments; reduction in disciplinary issues and classroom management problems; and improved engagement and enthusiasm (Lieberman & Hoody, 1998). Additional academic benefits derived from EE included improved school performance, higher educational attainment, and enhanced career outlooks (Hutchenson et al., 2018). In addition to the outright cognitive benefits of environmental education, multiple studies demonstrate the academic benefits gained through the inclusion of environmental education by fostering the softer, noncognitive skills such as social, emotional, and personality factors (Ardoin et al., 2018; Moyer & Miller, 2017; O'Hare et al., 2020; Sprague et al., 2020).

Social and emotional learning (SEL) facilitates academic performance while developing skills beyond academic content such as problem solving, decision making, and social skills while reducing behavioral issues and stress all which are core principles addressed through environmental education (Mahoney et al., 2018; NAAEE, 2019; Sprague et al., 2020). Systemic implementation of SEL programing provided stronger results (Berman et al., 2018; Jones & Kahn, 2017; Mahoney et al., 2018). Multiple avenues are utilized to implement EE including outdoor education opportunities, fieldtrips, on-site investigations, virtual exposure, and school gardens. In addition to improvement in the social type benefits of self-concept, motivation, self-esteem and sense of community, positive impacts in both direct (grades, test scores, grade point averages [GPAs]) and indirect (social skills, collaboration, discipline) academic outcomes in science, math, and ELA have been shown in schools utilizing garden-based learning (Blair, 2010; Schneider et al., 2017; Williams & Dixon, 2013).

Lieberman and Hoody (1998) also conducted a qualitative EE nationwide study including schools in California, Washington, Oregon, Colorado, Minnesota, Iowa, Texas, Ohio, Kentucky, Florida, New Jersey, Maryland, and four schools from Pennsylvania. 40 total schools were studied across the U. S. to include 15 elementary schools, 13 middle schools, and 12 high schools. Many schools utilized authentic assessments, GPAs, and standardized tests to evaluate academic achievement. In1995, 12 % more of Park Forest Elementary's fifth graders who participated in their EE program outscored similar schools on the PSSA in reading and 20% more in math. In 1998, students in Huntingdon Area Middle School outscored other schools in their assessment region in both reading and math, while Radnor Middle School EIC students scored significantly better than students in the control group in both reading and writing.

Hindrances to Implementing EE

Even with such a robust history,-legislative support, and documented benefits, the actual implementation of EE has not yet reached fruition (Carter & Simmons, 2010; Rickinson & McKenzie, 2020). Part of the reason-EE is not fully integrated into schools' curriculum-may be due to the interdisciplinary nature of EE (Chawla, 2018; Lieberman & Hoody, 1998; Nilsen et al., 2019; Stevenson, 2007; UNESCO, 1978). EE includes the interrelationships between both natural and social systems (Roth, 1992). EE is more than just environmental science, learning about the natural world. EE includes the examination of the integration of cultural, economic, political, and social structures as well as natural systems and processes (Chawla, 2018; PDE, 2002; UNESCO, 1978). This complexity of EE may lead to a reluctance of some educators to embrace it (McGuire, 2012; Moseley et al., 2016; Moyer & Miller, 2017; Palmer, 1998/2006).

Another reason EE is not widely implemented is the misunderstanding of what true environmental education entails. The essential underpinnings of EE include systems and systems thinking, human well-being, equity and inclusion, the importance of where one lives, roots in the real world, integration and infusion, lifelong learning, and sustainability (NAAEE, 2019). Moseley et al. (2016) claimed the classroom teacher's role is critical in advancing environmental literacy. However, McGuire Nuss et al. (2019) claimed that many teachers lack the experience, confidence, or background required to develop and implement EE. Edwards-Jones et al. (2018)

also claimed that teachers lack both confidence and training. Many current teachers lack critical EE knowledge or experience and professional development ,and training for preservice teachers is frequently lacking or insufficient (Haines, 2016; McGuire, 2012; Moseley et al., 2016). Crim et al. (2017) stated that preservice teachers continue to receive limited exposure to EE during their teacher preparation programs. Smith et al. (2020) claimed over 75% of formal (K-12) educators were not familiar with MWEEs. Funding, transportation, and lack of administrative support were also noted as hindrances to implementing EE (McGuire, 2012; McGuire Nuss et al., 2019).

True EE also includes stewardship (Nilsen et al., 2019; UNESCO-UNEP, 1978). This call to action, activism, may be viewed as political, which may also deter stakeholders from implementing EE (Carter & Simmons, 2010; Chawla, 2018; Rickinson & McKenzie, 2020; Stevenson, 2007). Dillon (2016) claimed while science teachers are sometimes willing to teach the scientific content of EE, they are not willing to teach the environmental values or stewardship portion of EE. Wals et al. (2014) contended that due to the complex nature of pressing environmental challenges, science educators and EE educators must develop a mature, symbiotic relationship to address climate change, pollution, loss of biodiversity, and resource depletion.

Edwards-Jones et al. (2018) contended that there are four types of problems with implementing EE: people, place, resource, and policy type issues. Some problems dealing with people include teachers not feeling competent and the lack of EE preservice instruction and professional development tied to the high EE multidisciplinary complexity (Haines, 2016; McGuire, 2012; Moseley et al., 2016). The lack of suitable local green spaces is a major place-based hindrance that also relates to resource issues due to the cost of transportation and staff training (Edwards-Jones et al., 2018). Policy concerns include the dominance of high-stakes testing, time constraints, and lack of administrative support due to these pressures as well as the complexity of EE (Edwards-Jones et al., 2018). While each of these types of hindrances is valid, the impact of NCLB cannot be understated. The purpose of NCLB was admirable:

> The purpose of [the No Child Left Behind Act] is to ensure that all children have a fair, equal, and significant opportunity to obtain a high quality education and reach, at a minimum, proficiency on challenging State academic achievement standards and state academic assessments. This purpose can be accomplished by (1) ensuring that high quality academic assessments, accountability systems, teacher preparation and training, curriculum, and instructional materials are aligned with challenging State academic standards so that students, teachers, parents, and administrators can measure progress against common expectations for student academic achievement. (NCLB, 2002, Sec. 1001.1)

However, NCLB's implementation created unintended issues. The focus on accountability and achievement dominated the discourse and practice of education and pushed EE to the periphery (Reid, 2011).

Due to standardized testing pressures (Craig & Marshall, 2019; Haines, 2016; McGuire Nuss et al., 2019) and lack of awareness of potential benefits, many school districts choose not to incorporate EE programs into their curriculum, thus forfeiting documented benefits (Bartosh et al., 2006; Disinger & Roth, 1992; Ernst & Erickson, 2018; Lieberman & Hoody, 1998; Mazyck et al., 2020; Shapiro et al., 2006). Edwards-Jones et al. (2018) claimed that administrative support was vital in implementing EE due to the curricular time constraints and performance measures pressures. LEAs unable to demonstrate annual yearly progress (AYP) were threatened with cuts in federal funding and takeovers of schools (Gruenewald & Manteaw, 2007). In the universal attempt to increase standardized test scores, multiple curricular changes, programs, and strategies have been implemented nationwide (Craig & Marshall, 2019; Geiger et al., 2020; Kownacki et al., 2020; Redding & Nguyen, 2020). One often-invoked strategy to improve achievement scores increases time students spend specifically learning ELA and math (Farbman, 2015; Fisher et al., 2015; Koretz, 2017). However, the strategy of increasing time spent on ELA and math has received mixed reviews (Farbman, 2015). While some researchers tout the benefits of increasing instructional time (Fisher et al., 2015; Long, 2014), others claim students are receiving an inferior education due to the narrowing of the content and the emphasizing of didactic pedagogy (Booher-Jennings, 2005; Diamond, 2007; Haines, 2016; Koretz, 2017). Class schedules are tight due to the curriculum requirement of addressing the substantial number of mandated standards (Craig & Marshall, 2019). In addition, the strategy of increasing time spent on ELA and math does not take advantage of the multitude of benefits provided through EE nor does it address the environmental literacy mandates (Bartosh et al., 2006; Diamond, 2007; Kane et al., 2018; Mazyck et al., 2020).

Scott and Vare (2018) claimed EE's influence in its current form "remains at the margins of young people's experiences in school. It generally owes any impact more to teacher enthusiasm than to school leadership, policy, or values" (p. 228). The MWEE may provide the structure and tools to overcome these hindrances and the reluctance of educators to incorporate EE into the curriculum. With such a plethora of benefits for multiple stakeholders, the roadblocks of incorporating EE should be explored as well as what may motivate educators to implement MWEEs. Improving standardized test scores tends to serve as a significant motivator when enhancing curriculum, educational programs, policies, and instructional strategies (Kopkin et al., 2018; Ledwell & Oyler, 2016; Redding & Nguyen, 2020). This study will evaluate the effectiveness of implementing MWEEs on improving academic performance on standardized tests while affording added benefits of EE and enhancing environmental literacy.

Meaningful Watershed Educational Experience

MWEEs are learner-centered activities focused on investigating local environmental issues which lead to informed action and civic engagement (Sprague et al., 2019). MWEEs connect standards-based classroom instruction and learning with outdoor field investigations, creating a deeper understanding of the students' natural environment (CBP, n.d.). With the overall goal to promote student citizenry, MWEE's are local, watershed-focused scientific investigation-based experiences (CBP, n.d.). The value of students engaging in local issues enhances the ability of students to make connections between individual actions and environmental consequences (Vedwan, 2011). MWEEs should be a local watershed-based, systemic, inclusive, and sustained part of schools' standards-based curriculum that involves outdoor inquiry-based investigations and actions (CBP, 2001). MWEEs should incorporate the use of equipment, measurements, observations, collecting and interpreting data, and analysis and synthesis (CBP, 2001). The three phases of a MWEE include preparation, action, and reflection (CBP, 2001). The organization of the MWEE addresses the recommendation of multiple EE advocates. The first recommendation of the Tbilisi Declaration states:

> EE should bring about a closer link between educational processes and real-life, building its activities around the environmental problems that are faced by particular communities and focusing analysis on these by means of an interdisciplinary, comprehensive approach which will permit a proper understanding of environmental problems. (UNESCO, 1978, p. 25-26)

MWEEs satisfy each aspect of this declaration.

In addition, MWEEs can address the directives of each of the three different researched-based PBLs approaches, project-based learning (PBL; Buck Institute for Education [BIE], 2021), problem-based learning (PrBL; Craig & Marshall, 2019) as well as place-based learning (PBL; Sobel, 2004, 2020). Project-based learning incorporates standards-based content and 21st-century skills such as problem-solving, collaboration, communication, and critical thinking and includes seven essential elements: a question or challenging problem, sustained inquiry, student voice and choice, authenticity, reflection, critique and revision, and public product (BIE, 2021). PrBL is also an inductive instructional method where learners work collaboratively to develop and solve authentic, open-ended problems (Craig & Marshall, 2019).

The Chesapeake Executive Council, consisting of the governors of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia, the mayor of the District of Colombia, the chair of the Chesapeake Bay Commission, and the administrator of the EPA, signed the 2014 Chesapeake Bay Watershed Agreement on June 16, 2014 (CBF, 2014; Moyer & Miller, 2017). Equipping every student with the knowledge and skills required to become a steward able to protect and restore their local watershed was a major educational goal of the agreement (CBF, 2014; Ernst & Erickson, 2018; Moyer & Miller, 2017). To meet this goal, students are expected to participate in teacher-supported, rigorous, inquiry-based instruction MWEE at least once in each elementary, middle and high school (CBF, 2014; Ernst & Erickson, 2018; Zint et al., 2014). The Chesapeake Bay Program (CBP) developed the MWEE framework in 2011(Smith et al., 2020). A MWEE is student driven and must satisfy four criteria:

1. Students must identify and investigate an environmental problem, issue, or question.
2. Students must participate in at least one outdoor field experiences, collect data necessary which help answer their research questions and dictate their actions.

3. Students must take action by addressing at least one environmental problem at a personal or societal level.
4. Students must analyze, assess and share their findings. (CBFEW, n.d.; Ernst & Erickson, 2018; Moyer & Miller, 2017).

Some key conditions and processes which assist students to acquire environmental knowledge, adopt roles, learn skills, and promote stewardship actions include providing an ongoing, authentic, problem-focused, local community-based program such as the MWEE (Ballard et al., 2017). By providing students the opportunity for repeated, authentic experiences, students are encouraged to build connections to a place and contribute to authentic science research (Ballard et al., 2017). Students given the opportunity to take responsibility and ownership for rigorous data collection and analysis, to communicate and disseminate their findings, and take action provide academic, social/community, and environmental benefits (Ballard et al., 2017). MWEEs may be the vehicle to attain these benefits.

MWEE Application

Reynolds et al. (2021) provided an example MWEE lab activity using a Winogradsky column to teach biochemical processes of life and energy flow in ecosystems in a partnership between seventh-grade teachers, students, and a local university. McConnell et al. (2020) reported conducting an MWEE with the partnership of a university and fourth-grade students concerning a local environmental problem of their choosing, within their local watershed, and nutrient pollution. McGuire Nuss et al. (2019) focused on addressing obstacles of implementing MWEEs including lack of teacher efficacy, time, funding, administrative support, and transportation issues, and building MWEE capacity by providing professional development and mentoring. Ernst and Erickson (2018) also provided insight into the impact of mentoring teachers on the implementation of MWEEs. Haines (2016) reported on the benefits of incorporating MWEE instruction on preservice teaching self-efficacy. Zint et al. (2014) evaluated MWEE's effectiveness in fostering environmentally-responsible behaviors (ERBs), reporting students who participated in MWEEs increased in five of eight environmental stewardship characteristics. Students improved in the areas of knowledge of ecology, issues, actions, individual locus of control, and intention to act. Other prior studies discussed the applicability of MWEEs for instructional strategies for assorted topics and partnerships (Moyer & Miller, 2017). This study attempted to answer the question of whether there is statistically significant difference between middle schools' eighth grade students PSSA scores who participated in a MWEE as compared to students who did not.

Potential Benefits of MWEE

MWEEs increase student engagement and enthusiasm for learning, support student achievement, promote environmental stewardship, and civic responsibility, and advance 21st-century skills such as critical thinking, problem-solving, and communication skills (Sprague et al., 2019). School administrators may be more likely to incorporate MWEE into the curriculum if the academic impacts, if any, of implementing MWEEs were directly highlighted (Bartosh et al., 2006; Lieberman & Hoody, 1998). Multiple studies demonstrate the positive effect of nature-based learning on cognitive function (Bartosh et al., 2006; Lieberman & Hoody, 1998; Sprague et al., 2020). Critical STEM skills such as problem-solving, resilience, teamwork, critical thinking perseverance, and leadership are also shown to be improved through environmental experiences, as well as more concrete improvement in-class behavior and graduation rates (Kuo et al., 2019; Lumber et al., 2017). Research suggests that EE provides behavioral, cognitive, emotional, and social benefits as well (Dale et al., 2020). While studies do demonstrate multiple academic benefits of incorporating EE into the curriculum, these studies do not overtly address the bottom line of many school administrators, standardized test scores (Craig & Marshall, 2019). The current literature does not address MWEEs' impact on Pennsylvania state-mandated standardized test scores.

Pennsylvania and the Environment

The Commonwealth of Pennsylvania has served as a national leader in the environmental and EE front. According to the Declaration of Rights, Article 1, Section 27 of the Pennsylvania Constitution:

> The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and aesthetic values of the environment. Pennsylvania's public natural resources are the common property of all people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people. (Penn. Const. 1971 amend. § 27)

The Pennsylvania Environmental Education Act of 1993, which was amended in 2008 (P.L. 940, Act 71), recognized the need for the study of the environment as an essential educational component and graduation requirement for students in Pennsylvania (P.L.105, No.24, 1993). This act acknowledges the need for an environmentally-educated citizenry to promote environmental stewardship, environmental protection, and sound resource management.

Pennsylvania Environmental Literacy Plan

In the ELP, eight areas for both formal and non-formal educators were examined: school systems, early childhood education, pre-service education, professional development, partnerships, life-long learners, funding and implementation, sustainable practices, healthy living, and the environment. Four goals were developed to address these eight areas. The first goal states “every student in the region graduates with the knowledge and skills to make informed environmental decisions” (Pennsylvania Advisory Council [PAC], 2013, p. 1). The second goal states “all educators in the region, responsible for instruction about or in the environment, have access to sustained professional development opportunities, tools, and resources that support their efforts to provide students with high-quality environmental education” (PAC, 2013, p. 1). Goal number three states “every school in the region maintains its buildings, grounds, and operations to support sustainable environmental and human health outcomes” (PAC, 2013, p. 1). The fourth and last goal states, “the education community in the region functions in a unified manner and coordinates with key national, regional, and state programs to represent the full suite of information and opportunities available for PK-12 and other audiences” (PAC, 2013, p. 1). The plan also includes recommendations, action steps, and providers for each of the goals.

The first recommendation concerning the school system addressed the state’s academic standards, which for PA include environment and ecology standards as well as science and technology and engineering education. The first recommendation includes incorporating EE into the curriculum (PAC, 2013). The second recommendation deals with the assessment of EE to include preparing for the Pennsylvania System of School Assessment (PSSA), which includes EE. The third recommendation pertains to meaningful outdoor experiences, which MWEEs address directly.

Academic Standards

According to the Pennsylvania Public School Code, Title 22, Chapter 4.11(1949/2014), the purpose of public education is to prepare students for life as an adult by addressing their intellectual and developmental needs, challenging them to achieve at their best. Collectively with their families and community stakeholders, public education should prepare students to become self-directed, responsible, involved citizens and life-long learners (22 Pa. Code § 4.11, 1949/2014). Opportunities to acquire knowledge and skills, develop integrity, process information, think critically, work independently, collaborate with others, and adapt to change are to be provided in a public education (22 Pa. Code § 4.11, 1949/2014). An academic standard is defined as "what a student should know and be able to do at a specific grade level" (22 Pa. Code § 4.3, 1949/2014). Like many other states, Pennsylvania only began implementing standards-based education in the mid-1990s (PDE, 2013). Pennsylvania's first adopted standards were in mathematics and reading, writing, speaking and listening in January, 1999 (PDE, 2013). Table 1 provides information on current academic standards in Pennsylvania (see Table 1).

Table 1

Pennsylvania State Board of Education Current Academic Standards

Subject Areas	Effective Date
Environment and Ecology and Science and Technology	January 5, 2002
Arts and Humanities; Civics and Government; Economic; Family and Consumer Sciences; Geography; Health, Safety, and Physical Education; and History	January 11, 2003
Career Education and Work	July 8, 2006
Pennsylvania Core Standards – English Language Arts; Mathematics; Reading and Writing in History, Social Studies; and Science and Technology	March 1, 2014

Note. Adapted from the Pennsylvania Code Title 22 Chapter 4 (22 Pa. Code § 4.11, 1949/2014).

The Pennsylvania Department of Education developed the assessment anchors for each subject area and grade level assessed by the PSSA. The Pennsylvania State Board of Education adopted these assessment anchors. Assessment anchors, a subset of the academic standards, define the academic content and skills assessed by the PSSA (Pennsylvania State Board of Education, 2021).

Pennsylvania Environment and Ecology Standards. Students in Pennsylvania are expected to understand the components of ecological systems and their interrelationships with technologies and social systems. The incorporation of the disciplines of agricultural diversity, government, resource management, and the impact of human actions on natural systems play a role in the environment and ecology standards. These standards are trans-disciplinary, cutting across multiple subjects to include science, social studies, ELA, mathematics and more. These standards inherently address the 21st-century skills such as critical thinking, problem solving, and other STEM skills. The environment and ecology standards were adopted January 5, 2002 (22 Pa. Code § 4.12, 1949/2014; PDE, 2002).

The original and only environment and ecology standards officially adopted by the Pennsylvania State Board of Education consists of nine standards: 4.1 Watersheds and Wetlands; 4.2 Renewable and Nonrenewable Resources; 4.3 Environmental Health; 4.4 Agriculture and Society; 4.5 Integrated Pest Management; 4.6 Ecosystems and their Interactions; 4.7 Threatened, Endangered and Extinct Species; 4.8 Humans and the Environment; and 4.9 Environmental Laws and Regulations (PDE, 2002). The 2002 standards establish essential elements, what students should know and be able to do, for grades four, seven, 10, and 12 which increase in difficulty as students mature (PDE, 2002). On June 1, 2009, the Pennsylvania Department of Education approved an edited version of the Academic Standards of Environment and Ecology, but the

State Board of Education never officially adopted this version. The update standards were offered as a voluntary resource and are posted on the PDE's official website. The updated version reduced the number of standards from nine to five: 4.1 Ecology; 4.2 Watersheds and Wetlands; 4.3 Natural Resources; 4.4 Agriculture and Society, and 4.5 Humans and the Environment (PDE, 2009). Several other changes are incorporated into the 2009 standards to include providing standards for grades 3-8, 10, and 12. The 2009 standards also provide expectations for teaching science as inquiry. In 2020, the PDE under the direction of the State Board of Education began the process of revising Pennsylvania's environment and ecology, science, and technology standards.

On July 16, 2022, Pennsylvania amended their academic standards. The new standards included Pennsylvania Integrated Standards for Science, Environment, Ecology, Technology and Engineering (Grades K-5); Pennsylvania Integrated Standards for Science, Environment and Ecology (Grades 6-12); and Pennsylvania Technology and Engineering Standards (Grades 6-12), which will take effect on July 1, 2025. The new standards, which mirror the Next Generation Science Standards, include a fifth domain, Environmental Literacy and Stewardship (Pennsylvania State Board of Education, 2022).

Next Generation Science Standards. The Next Generation Science Standards (NGSS) are K-12 science content standards that set the expectations of what students should know and be able to do (NRC, 2013). To improve science education for all students, the NGSS were developed and published in 2013. While EE exceeds the scope of science due to its interdisciplinary nature (Chawla, 2018; Nilsen et al., 2019), EE's close relationship with environmental science heightens the importance of NGSS regarding environmental literacy (Schönfelder & Bogner, 2020). NAAEE's Guidelines for Excellence (2019) extols the influence of NGSS on environmental literacy. The research-based NGSS, developed by an extensive team of educational and scientific leaders, emphasized the development of skills required to face the challenges of the 21st century (National Research Council [NRC], 2013). One sometimes confusing concept is that EE and environmental science, while very closely interdependent and intertwined, are different (Carter & Simmons, 2010). Environmental science focuses on science, facts, knowledge, and skills, whereas EE focuses on fostering environmental literacy and stewardship through action (Carter & Simmons, 2010).

The NRC, the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), Achieve, partnered with 26 lead state partners along with other stakeholders to develop the NGSS (NRC, 2013). Arizona, Arkansas, California, Delaware, Georgia, Illinois, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, North Carolina, Ohio, Oregon, Rhode Island, South Dakota, Tennessee, Vermont, Washington, and West Virginia are the states identified in 2011 that served as lead state partners in the development of the NGSS (NRC, 2013). The NGSS are based upon the National Research Council's (2012) *Framework for K-12 Science Education,* which was developed by a committee of scientific and educational experts in 2010-2011. As of 2019, 20 states and the District of Columbia have adopted the NCSS. Another 24 states have developed their own standards based upon the *Framework for K-12 Science Education* (NRC, 2012). At this time, Pennsylvania has not adopted the NGSS. However, Pennsylvania is currently in the process of updating their Environment and Ecology and Science and Technology standards

The NGSS facilitated three-dimensional learning: disciplinary core ideas (DCIs), science and engineering practices (SEPs), and cross-cutting concepts. Each of the three dimensions of science learning are distinct and equally important. SEPs describe scientists' investigation steps and engineering design. SEPs include: asking questions and defining problems; planning and carrying out investigations; analyzing and interpreting data; developing and using models, constructing explanations and designing solutions; engaging in argument from evidence; using mathematics and computational thinking; and obtaining, evaluating, and communicating information. Crosscutting concepts such as cause and effect assist students in exploring connections across the four science domains: earth and space science, engineering design, life science, and physical science. By making crosscutting concepts explicit, students develop a scientifically-based and coherent view of the world around them.

Pennsylvania System of School Assessment. Pennsylvania participated in a school-based state-wide assessment know as *Educational Quality Assessment* (EQA) in 1969-1970 through the 1987-1988 school year (Data Recognition Corporation [DRC], 2019). From 1984-1985 through 1990-1991 the *Testing for Essential Learning and Literacy Skills* (TELLS) was mandated statewide. In 1992 the PSSA program was established with school level only reporting on a three-year cycle (DRC, 2019). In 1995-1998, annual testing participation was required and student-level reporting was added (DRC, 2019). Due to the state adoption of the more rigorous Pennsylvania academic standards for reading, writing, speaking, and listening, and mathematics major structural changes occurred with the PSSAs with the results disseminated to students, parents, the school, community, and policymakers through the: (a) parent letter, (b) individual student report, (c) school summary report, (d) district summary report, and (e) interpretive guide (DRC, 2018, 2019).

Starting in 2000, the PSSA was deemed a standards-based, criterion-referenced assessment measuring student attainment of the approved standards with the label of advanced, proficient, basic, or below basic:

- **Advanced:** depicts superior academic performance, demonstrating thorough command and ability to apply skills, knowledge, and practices of the PA standards.
- **Proficient:** depicts satisfactory academic performance, demonstrating adequate command and ability to apply the skills, practices, and knowledge of the PA standards.
- **Basic:** depicts marginal academic performance, demonstrating partial command and ability to apply the skills, practices, and knowledge of the PA standards.
- **Below basic:** depicts inadequate academic performance, demonstrating minimal command and ability to apply the skills, practices and knowledge of the PA standards (DRC, 2018).

The passing of NCLB significantly changed education in American (NCLB, 2002). Meant to increase the academic achievement of all students in the United States, the NCLB Act mandated state standardized testing requirements with the expectation that all students would become proficient (Greene, 2015; Shapiro et al., 2006). Minor enhancements were incorporated to the PSSA from 2001-2003 (DRC, 2019). Significant structural changes to the PSSA occurred from 2003-2006 (DRC, 2018). Extensive test development and field testing was implemented (DRC, 2018). A major revision occurred in 2005 to incorporate the assessment anchors to address the adequate yearly progress (AYP) mandate of NCLB (DRC, 2019). To address updated requirements, the mathematics and reading PSSAs were developed in 2004, field tested in 2004, and implemented in 2005.

The original testing occurred in grades five, eight, and 11 (DRC, 2019). Mathematics and reading testing development for grades four, six, and seven started in 2004, was field tested in 2005, and was fully implemented in 2006 (DRC, 2019). Grade three testing for mathematics and reading was added in 2007 (DRC, 2019). A writing assessment was added to grades five and eight in 2006 (DRC, 2019). A science assessment was introduced in the spring of 2008 for grades four, eight, and 11 (DRC, 2018, 2019). Annual PSSAs were conducted from 2009-2012 without a change in content (DRC, 2018). Due to the adoption of the Pennsylvania Core Standards (PCS) in mathematics and ELA, the PSSAs were modified in grades three through eight in 2013-2015.

At the high school level, the 11^{th} grade PSSA and 12^{th} grade PSSA retest was eliminated in 2013. The algebra, biology, and literature keystone exams were introduced for high school students in 2013 (DRC, 2018, 2019). Part of Pennsylvania's plan to comply with the federal Every Student Succeeds Act (ESSA) and respond to requests from parents, students, teachers, and other educational stakeholders was to reduce the amount of time students spent testing by 20% for students in grades four through eight and 25% for students in third grade (Wolf, 2017). The PSSA test designs were therefore reevaluated in 2017 and 2018 to reduce the amount of time students spent testing (DRC, 2018). The ELA, math, and science assessments were reduced in length for the 2018 PSSA (DRC, 2018, Wolf, 2017).

According to DRC (2018), the PSSA's purpose is to determine how well students are acquiring the knowledge and skills depicted in the Pennsylvania Assessment Anchor Content Standards (Assessment Anchors) for ELA, mathematics, and science. There are two intended uses for the PSSAs (DRC, 2018). The first is to provide information for utilization in the district and school accountability systems. The second is to improve instructional and curricular instructional practices to assist students reach proficiency in the Pennsylvania Academic Standards (science) and Pennsylvania Core Standards (ELA and mathematics) (DRC, 2018). Unfortunately, the achievement gaps between subgroups, although smaller, still remained after NCLB (Greene, 2015; Laughter, 2016; Porter & Polikoff, 2007), specifically concerning historically-underperforming students (PDE, 2018), economically disadvantaged students, English language learners, and students with disabilities (Greene, 2015; Laughter, 2016; Porter, 2007; Porter & Polikoff, 2007; Reardon et al., 2019).

While there have been multiple studies that have showcased various environmental, community, and academic benefits associated with implementing quality, inquiry-based environmental education programs such as the MWEE, there are no published studies that compare MWEE participation and academic achievement on the PSSAs. Thus, this study aimed to address that gap in the literature. This study aimed to explore the impacts of EE implementation, specifically MWEEs, on eighth-grade students' standardized test scores to add to the current understanding of the influence of MWEEs, if any, on students' academic achievement to assist educational leaders to make informed curricular decisions concerning the inclusion of EE. While this study alluded to the concerns of environmental, community, and social benefits, the focus of this study was to determine what impact, if any, MWEEs have on students' academic achievement. Due to the tremendous pressure to improve test scores (Geiger et al., 2020; Kownacki et al., 2020), this study addressed MWEE's impact upon this significant concern of educational stakeholders (Acosta et al., 2020; Bartosh et al., 2006; Diamond, 2007; Haertel, 2018; Koretz, 2017; Lieberman & Hoody, 1998).

EE aims to equip students to become educated, environmentally literate, and active citizens who embrace environmental stewardship and community service. An environmentally-educated citizenry who is empowered may be able to address the environmental challenges facing them today such as pollution, loss of biodiversity, resource pollution, and climate change as well as develop the problem-solving skills to face the challenges of tomorrow. This study aims to assess the influence of MWEEs on academic achievement which may impact students' environmental literacy. MWEEs have the potential to address the varied interests of multiple stakeholders. MWEEs may or may not be an effective strategy for improving standardized test scores as well as providing for other academic benefits. MWEEs might be an instrument that provides a multitude of community benefits. MWEEs may also be a vehicle that leads students to become environmentally literate, thus stewards of nature.

Summary

With the celebration of the first Earth Day on April 22, 1970, in which more than 20 million Americans participated, the creation of the Environmental Protection Agency in 1970, and the founding of the National Association for Environmental Education (the predecessor of the North American Association for Environmental Education (NAAEE), the importance of environmental literacy has been acknowledged nationwide (Carter & Simmons, 2010; EPA, 2018; Lewis, 1985; McCrea, 2006). However, over 50 years have passed since these watershed events and the dire need for an environmentally-literate society is palpable. Scott and Vare (2018) claimed the way it is taught is crucial. Effective approaches involving students, outdoor learning, and how to take an active role in addressing local issues are vital (Scott & Vare, 2018). EE must graduate past knowledge and develop stewardship to achieve environmental literacy. MWEEs may be an avenue to achieve this.

Since the inception of NCLB (2002), educators have attempted to provide all students educational opportunities to achieve academic success (Craig & Marshall, 2019; Diamond, 2007;

Greene, 2015). While the goal of NCLB was to close the existing achievement gaps for every student, unfortunately, that goal has yet to occur (Koretz, 2017; Porter, 2007; Porter & Polikoff, 2007). Gaps still exist and every student has not achieved success (Laughter, 2016; Porter, 2007; Porter & Polikoff, 2007; Reardon et al., 2019). Therefore, the search continues for ways to increase achievement scores (Craig & Marshall, 2019). MWEEs may be one solution. In addition to the possibility of improving academic achievement in standardized tests, the MWEE may foster environmental literacy, thereby acknowledging the words of President Nixon which are just as prudent today:

> It is also vital that our entire society develop a new understanding and a new awareness of man's relation to his environment—what might be called "environmental literacy." This will require the development and teaching of environmental concepts at every point in the education process.
> (Nixon, 1970, p. vii)

CHAPTER THREE: METHODS

Overview

The purpose of this quantitative, ex post facto causal-comparative study was to gain a better understanding of the relationship between students' exposure to EE in the form of participation in a meaningful watershed educational experience (MWEE) and their academic achievement scores on the PSSA state mandated ELA, math, and science exams compared to students who did not experience a MWEE. Participation will be determined by the Chesapeake Bay Program's Environmental Literacy Indicator Tool (ELIT). Academic achievement was measured by schools' PSSA eighth grade scaled scores. This chapter included the research design, research question, hypothesis, participants and setting, instrumentation, procedures, and data analysis.

Design

The research design for this study was a quantitative, ex post facto causal-comparative design examining the effect of exposure to a MWEE experience for eighth grade students on student achievement scores (Creswell, 2014; Gall et al., 2007). This type of nonexperimental study is appropriate as it can be utilized when seeking to identify possible predictive relationships in naturally occurring (non-randomized) groups where the independent variable, in this case the participation in a MWEE, is present or absent with no manipulation of the independent variable (Gall et al., 2007; Lammers & Badia, 2004; Warner, 2013).

This study was a nonexperimental, ex post facto investigation due to the fact the data of MWEE participation as well as PSSA scores were already present. Achievement score data was collected by the request of archival data from school district administration. Participants for the study were identified by using purposeful convenience sampling. The study compared achievement scores of selected schools' eighth grade students on the Pennsylvania System of School Assessment (PSSA) in ELA, math, and science and determined if there was a statistically significant difference between PSSA scores for schools with students who have and who have not participated in a MWEE. The ex post facto design was an appropriate choice to evaluate the impact of the independent variable, MWEE participation, which occurred in the past (Gall et al., 2007; Lammers & Badia, 2004). This study attempted to determine if there is a difference in academic achievement in PSSA ELA, math, and science scores based upon participation in the MWEE EE program in eighth grade students.

The Independent variable (IV) for this quantitative, causal-comparative, ex post facto study was the student's participation status. The independent variable had two levels: participation in MWEEs and non-participation in MWEEs. The Environmental Literacy Indicator Tool (ELIT), a basic, voluntary, non-parametric survey, was used to determine if a school participated in a MWEE in order to obtain a sample for the IV (Sickler, 2018). This voluntary tool was administered to every LEA with at least 25% of their district's area within the Chesapeake Bay Watershed (CBW) to include schools within the District of Columbia, Delaware, Maryland, Pennsylvania, Virginia, and West Virginia. The total number of LEAs within the CBW is 328, which accounts for over two million students (Sickler, 2020). Within the CBW, 128 surveys were completed and returned by LEAs for a 39% overall response rate in 2017, which represents over 76% of the students within the CBW (Sickler, 2018). In Pennsylvania, there are 193 LEAs within the CBW, representing 555,482 students. In 2017, only 16% of LEAs responded. In 2019, 136 surveys were completed for a 41% overall response rate for the entire CBW with Pennsylvania's rate rising to 26% (Sickler, 2020).

The dependent variable was academic achievement, which was expressed in the scores of the state-mandated test in ELA, math, and science and measured by utilizing the PSSA eighth grade scaled scores. Students scoring in the advanced range were considered high achieving. Proficient scores were in the average achieving, while student scores in the basic or below range were considered low achieving. Pennsylvania uses these categories as performance indicators to determine the success of schools (Pennsylvania Department of Education [PDE], 2018). The PSSA was the appropriate measurement for this study as it is a criterion-referenced, standards-based assessment which measured student achievement based upon the Pennsylvania State Board of Education's adopted Pennsylvania academic standards (PDE, 2018).

Research Question

This study addressed the following research question:

RQ: Is there a difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status?

Hypotheses

The null hypothesis for this study is:

H_0: There is no difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status.

Participants and Setting

Population

In Pennsylvania, there are 500 public school districts within the state with a total student enrollment of 1,570,000 (Christ, 2019). Table 2 provides information on school classification in Pennsylvania. The average enrollment of a rural district is 1,675, urban, 11,517, and suburban 3,704 (Christ, 2019, see Table 2).

Table 2

Pennsylvania School Classification

Classification	*n*	% of LEAs	Enrollment	% of Students	Average Enrollment
Urban	28	5.6%	322,478	20.5%	11,517
Suburban	227	45.4%	837,128	53.3%	3,704
Rural	245	49%	410,455	26.1%	1,675
Total	500		1,570,062		

Note. Adapted from the Pennsylvania's 2019 State of Education Report (Christ, 2019).

Participants

The data for this study was archival. Data sets and cases for the study were drawn from a purposeful convenience sample of Pennsylvanian middle schools located in the Chesapeake Bay Watershed (CBW). The number of Pennsylvanian students residing within the watershed represented by a completed ELIT survey was 88,988 students; 30 Pennsylvania LEAs responded at the middle school level in 2017 and 66 in 2019 (Sickler, 2018, 2020, see Table 3).

Table 3

2017 PA Local Education Agencies within Chesapeake Bay Watershed MWEE Participation

	LEA		MWEE Participation		
	n	%	System-Wide	Some	None
Responded to ELIT	31	16%			
Elementary School	30		17%	37%	47%
Middle School	30		17%	37%	47%
High School	30		33%	47%	20%

Note. Adapted from the Chesapeake Bay Watershed 2017 Environmental Literacy Report which reports on the status of the 2016-2017 school year (Sickler, 2018).

A purposeful convenience sample was drawn from the LEAs that responded to the ELIT within the CBW of schools who participated in an MWEE and who did not participate in an MWEE based upon the ELIT results. While convenience sampling is not as desirable as random sampling, this sampling technique may be employed where it is not possible to sample randomly (Gall et al., 2007).

The sample size of this study consisted of 1067 cases, which exceeded both the target sample size of 100, and the required minimum, assuming a medium effect size of 66 with statistical power of .7 at the .05 alpha level (Gall et al., 2007; Warner, 2013). Middle school students' ages typically ranges from 11 to 14 years of age. Seventeen percent of middle school LEAs conducted a system-wide MWEE, 37% reported MWEEs being implemented in some classes but not the entire school or grade-level, and 47% indicated that no MWEEs were implemented in Pennsylvania in the 2016-2017 school year (Sickler, 2018). Four middle schools were sampled for this study. The sample consisted of one middle school whose students participated in a MWEE during middle school and three middle schools whose students did not participate in a MWEE during middle school. Pseudonyms will be utilized for participating schools and school districts.

Setting

The CBW is the largest estuary in the United States and covers 64,000 square miles includes parts of Delaware, Maryland, Pennsylvania, Virginia, West Virginia, and the District of Columbia (NOAA, 2018). Out of the 193 LEAs in the Chesapeake Bay Watershed in Pennsylvania and enrollment of 555,482 students, 31 total Pennsylvanian LEAs responded to the ELIT survey in 2017, for a 16% response rate (Sickler, 2018, see Table 3). The participation rate rose to 51 LEAs and 29% in 2019 (Sickler, 2020, see Table 4). Data from the ELIT represents 76% of the total student enrollment within the CBW (Sickler, 2018).

Table 4

2019 PA Local Education Agencies within Chesapeake Bay Watershed MWEE Participation

	LEA		MWEE Participation		
	n	%	System-Wide	Some	None
Responded to ELIT	51	26%			
Elementary School	66		18%	36%	45%
Middle School	66		18%	42%	39%
High School	68		26%	41%	32%

Note. Adapted from the Chesapeake Bay Watershed 2019 Environmental Literacy Report which reports on the status of the 2018-2019 school year (Sickler, 2020).

Instrumentation

There was one true statistically-valid instrument, the Pennsylvania System of School Assessment (PSSA), used to gather the data from existing datasets in this study and one tool to assist in sample selection, the Environmental Literacy Indicator Tool (ELIT). The PSSA is a criterion-referenced, standards-based assessment measuring student attainment of the approved PA state standards (DRC, 2018). The PSSA is an end-of-year, state-mandated standardized exam that was utilized to measure the dependent variables, academic achievement in ELA, math, and science (DRC, 2019). The ELIT, a non-parametric, basic survey indicated which schools participated or did not participate in the MWEE and was utilized for sample selection (Sickler, 2018, 2020).

Pennsylvania System of School Assessment

The dependent variable was measured utilizing the PSSA for ELA, math, and science developed for accountability measures. According to the PDE (2018), the purpose of the PSSA includes: providing information for use in district and school accountability systems and improving instructional and curricular practices to assist students in reaching proficiency in the state standards. The PSSAs are an end-of-grade (EOG) mandated standardized tests, developed by the Data Recognition Corporation (DRC) originally in 1992, being modified annually and field testing in 2014 (DRC, 2018). The PSSA is implemented by Pennsylvania’s Department of Education (PDE). The PSSA has adapted to meet the changes in academic standards and both federal and state testing requirements (DRC, 2019). The PSSA determines how well students gain the skills and knowledge for ELA, mathematics, and science for accountability and to improve instructional and curricular practices (DRC, 2019).

The ELA assessment measures reading, writing, multiple-choice, short answer, evidence-based select response, and text dependent analysis while the mathematics assessment measures numbers and operations, algebraic concepts, geometry, and data analysis and probability via multiple-choice and open-ended questions (DRC, 2018). The science assessment became fully operational in 2008 to address NCLB mandates (DRC, 2018). The science assessment, which is administered in fourth and eighth grades in Pennsylvania, incorporates the nature of science as well as biological, physical, and earth and space science (DRC, 2018).

The PSSA has been used in numerous studies (Barghaus et al., 2017; Greene, 2015; Hark et al., 2020; Shapiro & Gebhardt, 2012). Barghaus et al. (2017) employed the PSSA to evaluate elementary students' achievement and the relationship between the Problems in Classroom Engagement Scale (PCES) scores and external variables in Pennsylvania. The study showed the instrument's internal consistency (*rs* = .91-.93) and validity evidence from differential item functioning and factor analysis. Greene (2015) utilized the PSSA instrument to evaluate the effectiveness of the instructional method of using fading graphic organizers with writing prompts for secondary students in Pennsylvania. Hark et al. (2020) utilized the PSSA to evaluate the impact that glasses had on students' academic performance. In Shapiro and Gebhardt's (2012) response to interventions (RTI) study, the PSSA was employed to evaluate the effect of computer-adaptive tests (CAT) and curriculum-based measurements (CBM) as a screening measure representing predictive validity.

Validity

The PSSA was created to maximize reliability and validity via alignment, administrative requirements, field testing, fairness check, and training (DRC, 2018). As of 2000, with the Pennsylvania State Board approving a set of criteria defining advanced, proficient, basic, and below basic levels, the PSSA became a standards-based, criterion-referenced assessment utilized to measure students' attainment of Pennsylvania's academic standards in ELA and math, and it is administered annually (PDE, 2018).

Validity pertains to the interpretation of test scores and how test scores are used (American Educational Research Association [AERA] et al., 2014). Score validity is maintained through test development, administration, scoring, item analysis, scaling, linking, reporting, Rasch calibration, and reliability (DRC, 2018). Sources of validity evidence for the PSSA include: evidence based on test content, response processes, internal structure, relationships with other variables (DRC, 2019). The PSSAs were compared with other common assessments such as the Terra Nova and SAT to determine convergent validity as well as discriminant validity (Koger et al., 2004; Thacker et al., 2004).

Reliability

Reliability refers to the consistency of the scores when the testing procedure is replicated (AERA et al., 2014). Both test population heterogeneity and length can affect score reliability (DRC, 2018; Warner, 2013). The type of question as well as random conditions such as student fatigue, anxiety, illness, and scorers also have the potential to alter reliability. According to DRC, the reliability for group results is almost always higher than the reliability of individual scores. See Table 1 for the reliability and standard error of measurement (SEM) for the 2018 grade eight PSSA (DRC, 2018).

These reliability results based upon Cronbach's alpha internal consistency reliability coefficient, also known as coefficient alpha, are consistent with historical PSSA results with an overall test score reliability of 0.88 or above (DRC, 2018; Warner, 2013). Table 5 provides information on PSSA reliability and standard errors of measurements. As expected, the 2018 test reliabilities were slightly lower due to the reduced test lengths, thus actual versus predicted reliabilities were evaluated (DRC, 2018; Warner, 2013).

Table 5

Eighth-Grade 2018 PSSA Reliability and Standard Errors of Measurement

Subject	Reliability	*SEM*
Mathematics	0.92	3.32
ELA	0.89	3.92
Science	0.88	3.15

Note. Cronbach's alpha reliability coefficients and standard error of measurement (*SEM*) as adapted from the 2018 Pennsylvania System of School Assessment (PSSA) Technical Report (DRC, 2018).

English Language Arts

The 59-question, 2018 ELA assessment for sixth through eighth grades included the following categories: reading, writing, and text-dependent analysis. Multiple question types were used including passage-based and standalone multiple choice (MC), short answer (SA), evidence-based selected response (EBSR), and text-dependent analysis (TDA). The passage-based MC questions measured students' comprehension of the meaning of or inferences about the passage (DRC, 2019).

The reading MC consisted of four answer options with only one correct answer provided. Distractors included misinterpretation, unsound reasoning, predisposition, or casual reading errors. The standalone questions provided errors both grammatical or mechanical such as misspellings, verb tense, word choice, or punctuation (DRC, 2018). The EBSR consisted of two parts with the answer to part two dependent upon the answer for part one. Students utilized supporting details or examples to answer SA questions and were scored on a zero- to three-point scale. The TDA required students to read a passage and respond in essay format and were scored on a one to four point scale (DRC, 2018).

The grade eight 2018 ELA possible scaled scores ranged from 600 to 1640. The following cutoff scores determined performance levels: basic, less than 886, below basic to basic - 886, basic to proficient - 1000, and proficient to advanced - 1130 (DRC, 2018).

Mathematics

The 52-question, 2018 PSSA Mathematics sixth through eighth grade assessment encompassed four classifications: numbers and operations, algebraic concepts, geometry, and data analysis and probability. Multiple-choice (selected-response) and open-ended (constructed-response) testing types were used to assess various levels of knowledge and types of information (DRC, 2018). MC questions were useful for collecting information on academic achievement whereas open-ended type of questions was better at testing higher-level thinking skills (DRC, 2018). Due to the development of well-constructed scoring guides, trained scorers could efficiently score large numbers of assessments.

The MC questions consisted of four response options with one correct answer. Alternate answers with incorrect concepts, logic, and applications as well as computational errors were typically used as distractors. The open-ended questions, useful for measuring problem-solving skills, were scored on a zero through four-point scale and designed to take approximately 10 minutes to solve for each item. Students started with reading a problem and developed a solution. Tasks may have included constructing a graph, explaining reasoning, shading a figure, or performing calculations (DRC, 2018).

The grade eight 2018 mathematics possible scaled scores ranged from 600 to 1638. The following cutoff scores determined performance levels: basic, less than 905, below basic to basic

- 906, basic to proficient 1000, and proficient to advanced - 1108 (DRC, 2018). The grade eight 2018 science possible scaled scores ranged from 925 to 2337. The cutoff scores determined performance levels: basic, less than 924, below basic to basic - 1150, basic to proficient -1275, and proficient to advanced - 1465 (DRC, 2018).

Science

The 54 question, eighth grade science assessment consisted of the reporting categories: biological sciences, earth and space sciences, physical sciences, and the nature of science (DRC, 2018). Both multiple-choice and open-ended type of questions were utilized. The multiple-choice idents were either standalone or scenario-based items each with four answer choices with only one correct answer. Incorrect concepts, logic, or application of scientific principle distractors were used. The open-ended questions represented authentic problem-solving scenarios and may have included text, graphics, tables and charts. These questions were designed to challenge students' scientific thinking and application of skills (DRC, 2018).

Test Administration

All school personnel who administer the PSSA must complete annual training and certification. This assists in maintaining both the integrity and validity of the PSSA as well as standardizing the testing conditions. Students typically complete in spring of each academic year. The testing window for the 2018 PSSA was: ELA, April 9-April 13, 2018; mathematics, April 16-April 20, 2018; and science, April 23-April 27, 2018 (DRC, 2018). The window for make-ups was April 30-May 4, 2018. Students completed the assessment via a hard copy test booklet and answer document or online (DRC, 2018). The total estimated administration time per form for the 2018 PSSAs for eighth grade was 270-315 minutes for ELA, 170-200 minutes for mathematics, and 110-140 minutes for science. The total testing time is 470-655 minutes.

However, the PSSA allows for students extended time to complete their exams. Personnel scoring the PSSA have been trained and utilize the PDE-approved scoring guidelines (DRC, 2018).

Changes

Major changes occurred recently in both the development and administration of the PSSA. In 2017-2018, the PSSA was redesigned to reduce both the testing time and length (DRC, 2019). The eighth-grade mathematics assessment was reduced from 63 to 43 questions (72 points to 52 points). The ELA exam was reduced from 49 to 39 questions (84 points to 63 points). The science test was reduced from 49 to 43 questions (68 points to 48 points) (DRC, 2018). In the 2019-2020 school year, the PSSAs administration was cancelled entirely in response to the COVID-19 pandemic. Due to these changes the 2018 PSSA results were utilized for this study.

Chesapeake Bay Watershed Environmental Literacy Indicator Tool

The independent variable was measured using the Chesapeake Bay Program's 2019 ELIT see Appendix C. The ELIT is a basic, non-parametric survey to evaluate the progress of LEAs to achieving the 2014 CBWA environmental literacy goal of ensuring every student within the watershed graduates with the knowledge and skills to protect and restore their local watershed and to act environmentally responsible (Sickler, 2018). The ELIT was developed by the Chesapeake Bay Trust (CBT), NOAA Chesapeake Bay Office, and Measurement Incorporated in 2013 and piloted in 2014 (MI, 2014). It was not designed to provide parametric, analytical data. The purpose of the ELIT was to assist LEAs collect important information advancing the implementation of EE, therefore supporting the CBWA (Smith et al., 2020).

This tool is administered biennially to all LEAs in the six jurisdictions: The District of Columbia, Delaware, Maryland, Pennsylvania, Virginia, and West Virginia (Sickler, 2018).

There were 555,482 Pennsylvanian students within the Chesapeake Bay Watershed. In 2017, 31 out of Pennsylvania's 193 LEAs responded to the ELIT survey (see Table 3). In 2018, 51 LEAs responded (see Table 4).

There are five sections to the ELIT. Section I addresses environmental literacy planning. Section II of the ELIT pertains to student participation in MWEES, which is separated into three levels, one each for the elementary, middle, and high school levels. The middle school level contains six questions on participation, with three of the questions open boxes for elaboration of the previous answer. The questions relate to issue definition, outdoor field experience, action project, and synthesis and conclusions (see Appendix C for copy of ELIT, see Appendix B for the request for the ELIT data for this study). Section III covers sustainable schools. Section IV covers environmental education improvement efforts, while Section V provides the opportunity to provide feedback.

Procedures

Approval from Liberty University's Institutional Review Board (IRB) was secured (see Appendix A for IRB approval). ELIT data (2015-2019) was then procured through a written request sent to the NOAA Chesapeake Bay Office (see Appendix B for written request, see Appendix C for ELIT survey). The ELIT data was reviewed by the researcher to determine which middle schools' students were exposed to a MWEE and which schools' students were not. From this data, participants were selected utilizing the purposeful, convenience sampling method with a sampling size of at least 100 as per Warner's (2013) recommendation of sample size never being less than 40. All selected schools were provided with a letter informing them of the study and requesting PSSA data (see Appendix D for request letter). Names were removed to ensure anonymity. All data was maintained in a password-protected computer to ensure confidentiality.

Existing, archival eighth grade PSSA data was then received from school district administration and maintained in a password-protected computer to ensure confidentiality. The researcher was the only one conducting data retrieval, analysis, and syntheses, thus no additional training was required. The PSSA data was then correlated, analyzed, and examined concerning academic achievement in ELA, math, and science using SPSS software.

All personnel who administered the PSSA are classified as test administrators (TA) and were required to complete administration training to ensure testing protocols were followed. The training included training by the school assessment coordinator, online Pennsylvania State Test Administrator Training (PSTAT), and the review of applicable directions, user guides, and test administration handbook (PDE, 2020). TAs were responsible to ensure students understood and followed testing procedures. TAs created seating charts, actively monitored testing sessions, maintained a quiet and secure testing environment, collected testing material when students complete the assessments, counted, returned all testing material, and signed a certification statement.

Data Analysis

In this quantitative, causal-comparative, ex post facto study, a multivariate analysis of variance (MANOVA) was utilized to analyze the data for the RQ. Warner (2013) claimed the MANOVA can be utilized to compare the means of groups in nonexperimental studies evaluating differences in patterns of means on multiple *Y* outcome variables in groups that occur naturally. This test potentially provides more detailed information about the overall pattern of the response while reducing the inflated risk of Type I error, accounting for intercorrelations among *Y* outcome variables, and provides more adequate analysis in groups that do not differ significantly than when running multiple ANOVAs (Warner, 2013).

Foster (2017) recommended employing the MANOVA, an extension of the one-way ANOVA, as the dependent variables might be impacted by the introduction of the independent variable. The MANOVA considers the values of the dependent variables combined to be able to compare between groups (Foster, 2017). When utilizing the MANOVA, Foster stated the data should be screened to check for consistency and unusual scores. The existence of extreme outliers should be determined by creating a box and whisker plot for each group and variable. Assumption testing should be completed on multiple factors. The assumption of normality must be met to show that the population distributions are normal must occur for the groups. This was completed by creating histograms, conducting a Shapiro-Wilks (if sample size is <50) or Kolmogorov-Smirnov test (for sample sizes > 50). The assumption of multivariate normal distribution was determined by looking for a linear relationship between the pairs of dependent variables by plotting a scatterplot matrix for each group, looking for the cigar shape. The assumption of homogeneity of variance-covariance matrixes was tested in SPSS using Box's M test of equality of covariance. If this test fails, then Levene's test of homogeneity of variance should be ran via SPSS to determine where the problem exists. Finally, the absence of multicollinearity was determined. While all dependent variables should be moderately related, any correlation over .80 raises the issue of multicollinearity. Foster recommended using the Pearson Product Moment test.

The statistical software package, SPSS was used for descriptive statistics, data screening, determining distribution shapes, and detecting outliers by creating histograms and box and whisker plots, which were used to test the assumptions of normal distribution shape, independent observations, and tests for violations of homogeneity of variance-covariance (Warner, 2013). Measures of central tendency to include the mean, standard deviation, and range, were calculated for each dependent variable. In this study, the independent variable was the participation in an MWEE. The dependent variable was the academic achievement based upon the ELA, math, and science PSSA scores.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this study was to examine whether participation in a meaningful watershed educational experience (MWEE) impacted students' standardized test scores in the ELA, math, and or science Pennsylvania System of School Assessment (PSSA). The independent variable in this study was the MWEE participation status of eighth grade students. The participants' PSSA scores in ELA, math, and science were the dependent variables in this quantitative, nonexperimental, ex post facto, causal-comparative study. Chapter Four will review the research question, hypothesis, descriptive statistics, data screening, and assumption testing, and the results for the null hypothesis testing via a multivariate analysis of variance (MANOVA) will be presented.

Research Question

RQ: Is there a difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status?

Null Hypothesis

H01: There is no statistically significant difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status.

Descriptive Statistics

For this study, with a sample size of (N = 1067), the researcher created two groups from four separate middle schools from four different school districts within the same intermediate unit: treatment group (n = 233) and the comparison group (n = 834). The treatment group participated in a MWEE, while the comparison group did not participate in a MWEE. The total population of 1067 students completed the 2017-2018 PSSA in ELA, math, and science. Of the

1067 students, 233 students participated in a MWEE while the remaining 834 students did not.

When comparing the standardized PSSA scores from both districts, the mean was reported as the measure of central tendency. The standard deviation as the measure of variability was also calculated. As shown in Table 6, the middle school students who participated in the MWEE had a higher mean in ELA, math, and science.

Table 6

Means and Standard Deviations for Study Variables by MWEE Status

	Participated (*n* = 233)		Has NOT Participated (*n* = 834)	
	M	*SD*	*M*	*SD*
ELA	1053.09	80.03	1034.94	95.92
Math	1018.93	112.56	974.81	116.63
Science	1387.79	155.04	1343.19	179.14

Note. *N* = 1067.

Results

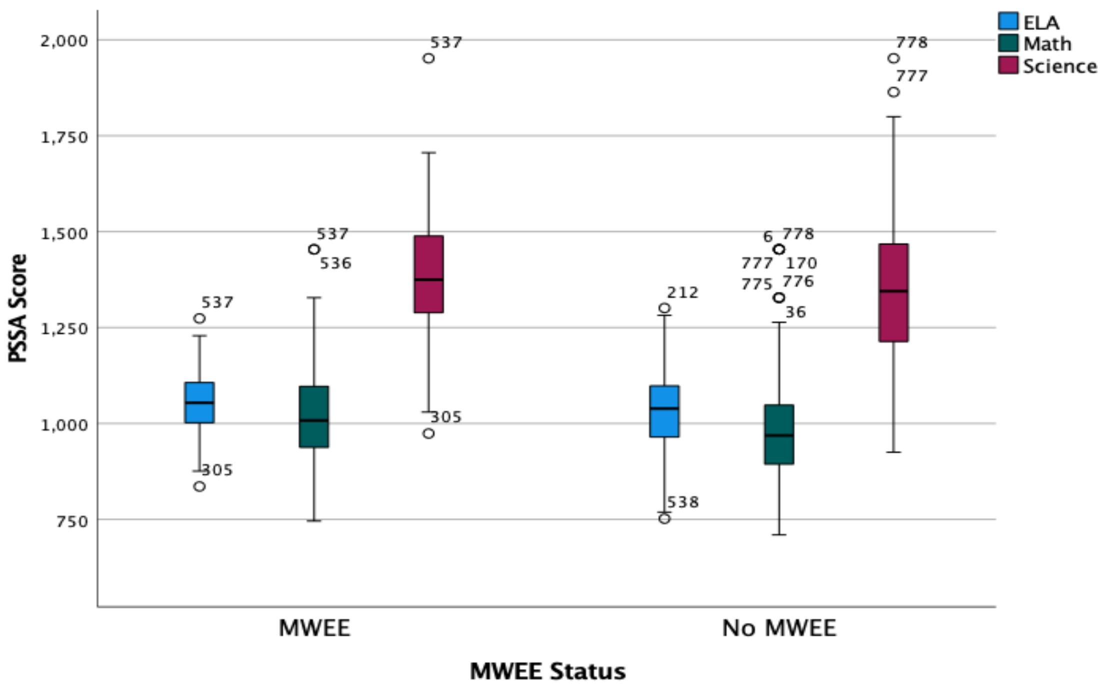
A multivariate analysis of variance (MANOVA) was utilized to test the difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status. According to Warner (2013), the MANOVA can be used to compare the means of groups with multiple variables in nonexperimental research situations. The MANOVA enables the researcher to evaluate multiple dependent variables (Green & Salkind, 2017).

Initial Data Screening

Data screening was performed to check for inconsistencies. Box and whisker plots were tabulated to screen the PSSA data for extreme outliers as recommended by Foster (2017). No extreme outliers were detected.See Figure 1 for the box and whisker plot for PSSA scores.

Figure 1

Box and Whisker Plot - PSSA Scores and MWEE Status



Assumption Testing

Assumption of Normality

Histograms were created to visually evaluate the normal population distribution of each of the dependent variables. Warner (2013) stated visual examination is deemed sufficient in most situations. Based upon the histograms, the assumption of normality was met. Figure 2 shows the histogram for ELA PSSA scores for each group. Figure 3 depicts the histogram for math scores, while Figure 4 displays the histogram for science PSSA scores.

Figure 2

Histogram - ELA PSSA Scores and MWEE Status

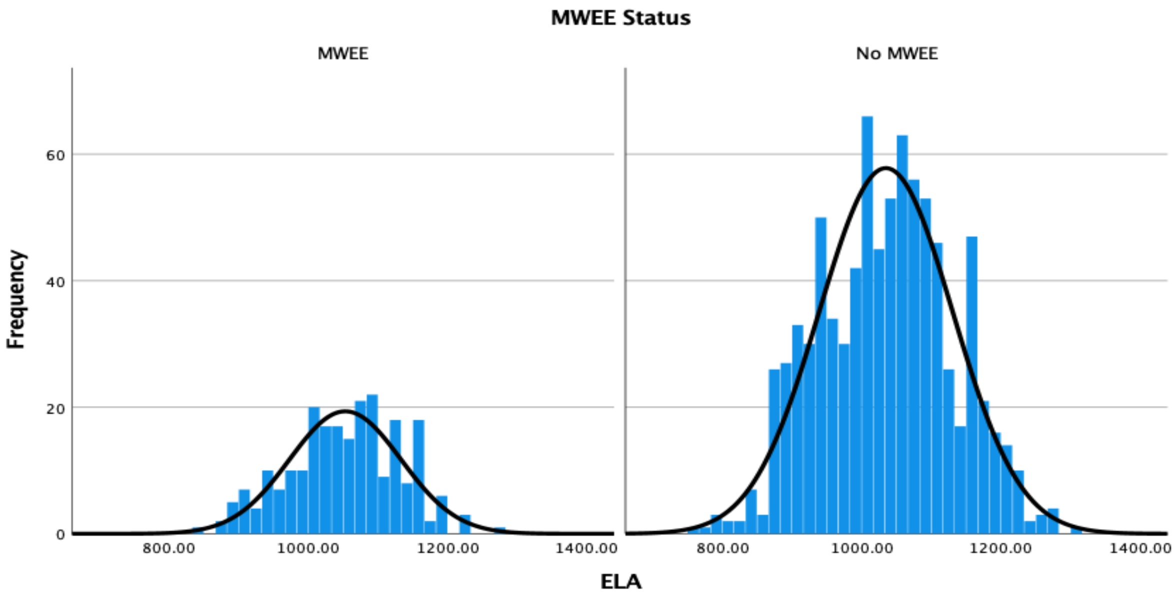


Figure 3

Histogram - Math PSSA Scores and MWEE Status

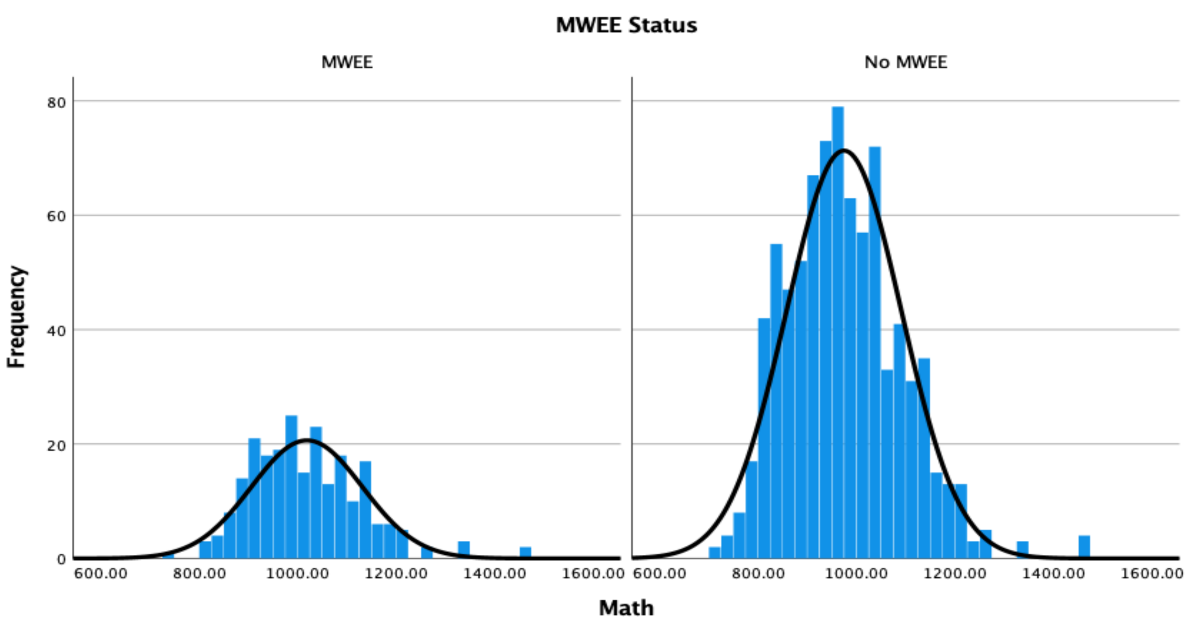
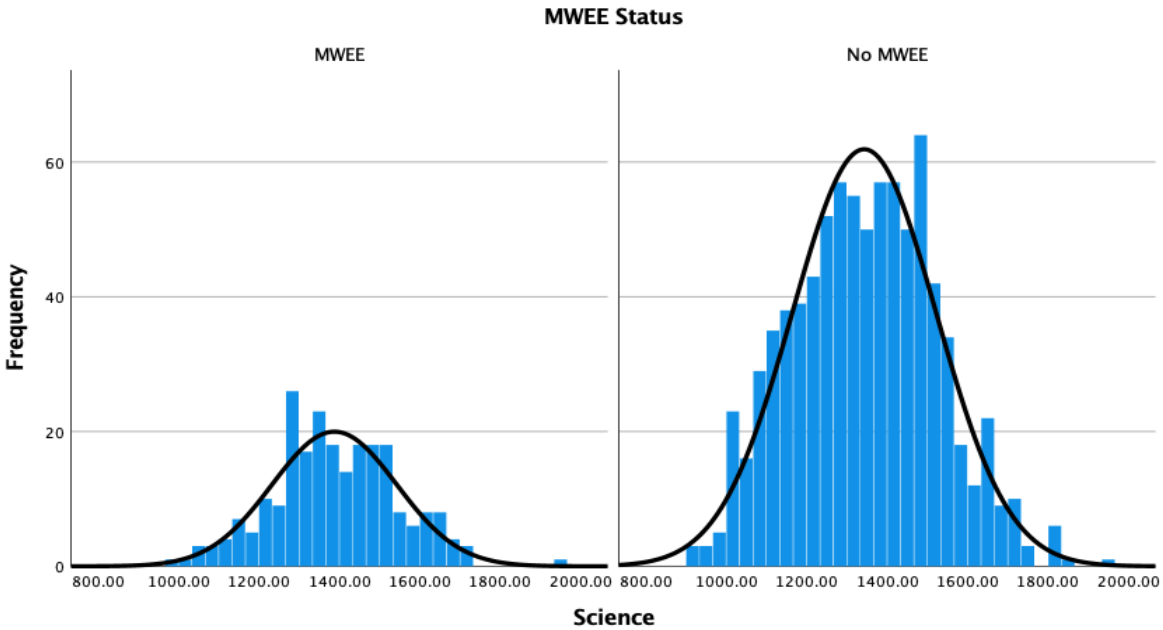


Figure 4

Histogram – Science PSSA Scores and MWEE Status



In addition to the histograms created, according to Warner (2013), the Kolmogorov-Smirnov test can also be conducted to test whether the shape of an empirical frequency distribution contrasts significantly from the normal. The result of the Kolmogorov-Smirnov test is shown in Table 7. This test was selected due to the sample size being >50.

Table 7

Kolmogorov-Smirnov Test

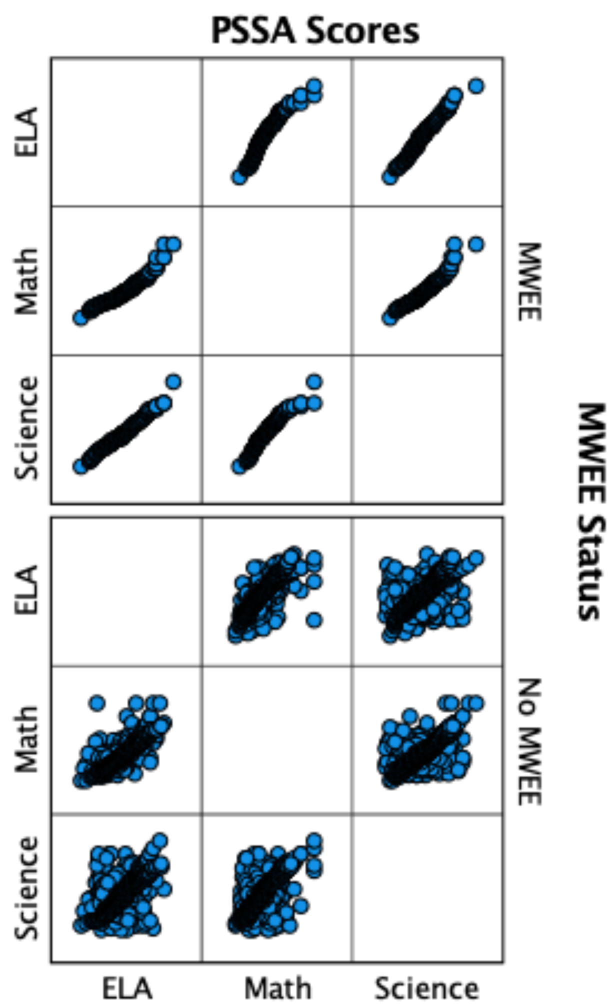
	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
ELA	.039	1067	<.001	.996	1067	.004
Math	.043	1067	<.001	.980	1067	<.001
Science	.040	1067	<.001	.995	1067	<.001

Assumption of Multivariate Normal Distribution

Using SPSS, the researcher created a scatterplot matrix on the dependent variables. The scatterplot's cigar shape provides evidence of linear relationships (Warner, 2013); therefore, the assumption of multivariate normal distribution was met. See Figure 5 for the Scatterplot matrix.

Figure 5

Scatterplot Matrix - PSSA Scores and MWEE Status



Assumption of Homogeneity of Variance – Covariance Matrixes

Warner (2013) stated that Box's *M* test examines the assumption of homogeneity of the variance/covariance matrices. Warner (2103) claimed the Box's *M* test can be problematic depending upon the test's sensitivity to nonnormality of distribution of scores as well as issues with the number of cases. When the number of cases is large or very small, the results of the Box's *M* test may be unreliable (Warner, 2013). A large number of cases were included in this study; thus, Warner (2013) recommended using a smaller alpha level such as (α = .01 or .001).

Another recommended method to remedy these violations is by using data management strategies such as application of log transformations, which reduces the impact of outliers and corrects for nonnormally of the distribution shape (Warner, 2013). Pillai's trace, which is more robust to violations of the homogeneity of variances and covariances, instead of Wilks's lambda (Λ) is also recommended by Warner (2013). Dropping cases with extreme scores may also be an option to address violations of assumptions but is not always recommended (Warner, 2013).

Green and Salkind (2017) stated caution should be used when interpreting the results of the Box's *M* due to violations of the multivariate normality assumption or lack of power. In addition, Foster (2017) recommended using Levene's test of homogeneity of variance if issues arise with Box's test. See Table 8 for the results of Box's Test of Equality Covariance Matrices and Table 9 for the results of Levene's Test of Equality of Error Variances. This assumption was not met; therefore, Pillai's trace was utilized.

Table 8

Box's Test of Equality of Covariance Matrices

Box's *M*	*F*	*df1*	*df2*	Sig
1018.547	168.916	6	1085934.622	<.001

Table 9

Levene's Test of Equality of Error Variances

		Levene Statistic	*df1*	*df2*	Sig.
ELA PSSA Score	Based on Mean	11.345	1	1065	.014
	Based on Median	11.103	1	1065	.021
Math PSSA Score	Based on Mean	.710	1	1065	.029
	Based on Median	.778	1	1065	.029
Science PSSA Score	Based on Mean	9.013	1	1065	.003
	Based on Median	9.090	1	1065	.004

Absence of Multicollinearity

Foster (2017) claimed that all dependent variables should be moderately related; however, correlations over .80 suggest the issue of multicollinearity. Foster recommended conducting the Pearson Product Moment test to evaluate this assumption. A Pearson correlation examined the relationship between the dependent variables of PSSA scores (ELA, math, and science). This test showed the relationships among all variables were strong, positive, and statistically significant.

ELA and science PSSA scores were found to be statistically significant, $r(1065) = .707$, $p < .001$. Math and science scores were $r(1065) = .742$, $p < .001$, and ELA and math were $r(1065) = .868$, $p < .001$. There is a high association between these variables, as shown in Table 10. Multicollinearity was not a concern for the variables of ELA and sciences or math and science as all were below the suggested .80 cutoff (Warner, 2013). While the variables of ELA and math were above that threshold with an .868, all variance inflation factors (VIF) calculated using SPSS were less than 5, thus, multicollinearity was not a concern, see Table 11 (Kim, 2019; O'brien, 2007).

Table 10

Pearson Correlation

		ELA PSSA Score	Math PSSA Score	Science PSSA Score
ELA	Pearson Correlation	1	.868	.707
	Sig. (2-tailed)		.000	<.001
Math	Pearson Correlation	.868	1	.742
	Sig. (2-tailed)	.000		<.001
Science	Pearson Correlation	.707	.742	1
	Sig. (2-tailed)	<.001	<.001	

Note. $N = 1067$

Table 11

Variance Inflation Factor

	Unst B	Coeff St Err	Stand Coeff B(	*T*	Sig.	Collinearity Tolerance	Statistics VIF
(Constant)	313.336	14.412		21.742	<.001		
Math	.613	.018	.772	34.540	<.001	.443	2.256
Science	.074	.012	.140	6.317	<.001	.449	2.226
MWEE Status	12.192	3.388	.054	3.599	<.001	.976	1.025

Note: Dependent Variable: ELA

Analysis

The null hypothesis stated there is no difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status. The results of the MANOVA showed a statistically significant difference between students' MWEE status and PSSA scores. Pillai's Trace of .036, F (3, 1063) = 13.313, $p < .001$, partial $\eta^2 = .036$, observed power = 1.00, $\alpha = .0167$, resulting in the rejection of the null hypothesis.

Based upon these results students' standardized tests scores as measured by the PSSA significantly differed based upon their MWEE status. The effect size was medium. See Table 12 for multivariate test results and Table 8 for tests of between-subjects effects results.

Table 12

MANOVA Analysis

Effect		Value	*F*	*df*	Error *df*	Sig.
Group_id	Pillai's Trace	.036	13.313	3.000	1063.00	<.001
	Wilks's Lambda	.964	13.313	3.000	1063.00	<.001
	Hotelling's Trace	.038	13.313	3.000	1063.00	<.001
	Roy's Largest Root	.038	13.313	3.000	1063.00	<.001

Note. Computed using alpha = .0167

Table 13

Tests of Between-Subjects Effects Analysis

Source	Dependent Variable	Type III Sum of Squares	*Df*	*F*	Sig.	Partial Eta Squared	Observed Power
group_id	ELA	60047.113	1	6.989	.008	.007	.597
	Math	354503.305	1	26.456	<.001	.024	.997
	Science	362261.632	1	11.941	<.001	.011	.855

Note. Computed using alpha = .0167

CHAPTER FIVE: CONCLUSIONS

Overview

This study examined if the participation of a meaningful watershed educational experience (MWEE) impacted the standardized test scores of eighth grade students from four different school districts within the Chesapeake Bay Watershed and within the same intermediate unit. Archival data from the 2017-2018 school year was collected and examined utilizing descriptive and statistical analysis. Chapter Five provides the discussion of results, implications, limitations, and recommendations for future research.

Discussion

The purpose of this quantitative, causal-comparative, ex post facto study sought to examine the impact of MWEEs on the academic achievement of eighth grade students in Pennsylvania. The independent variable was the student's MWEE participation status. The independent variable has two levels: participation in MWEEs and non-participation in MWEEs. A MWEE occurs when students explore environmental issues within their watershed through hands-on, inquiry-based, problem-based learning and implement their solution via action projects. The dependent variables were the scores achieved on the ELA, math, and science on the eighth grade PSSA. The participants were students who were enrolled in the eighth grade in Pennsylvania middle schools in 2017-2018 where the students did (n = 233) or did not (n = 834) participate in a MWEE based upon the Chesapeake Bay's Environmental Literacy Indicator Tool (ELIT).

The study's research question asked was there a difference between eighth grade students' PSSA scores in ELA, math, or science based on their MWEE participation status. Standardized test score data was collected from 1067 eighth grade middle school students from four separate districts within the Chesapeake Bay Watershed, all within the same intermediate unit. A MANOVA was utilized to examine the differences between independent groups on more than one continuous dependent variable (Gall et al., 2007, p. 645). The MANOVA showed a statistically significant difference between students' MWEE status and PSSA scores. Pillai's Trace of .036, F (3, 1063) = 13.313, p < .001, partial η^2 = .036, observed power = 1.00, α = .0167, resulting in the rejection of the null hypothesis. Based upon these results, students' standardized PSSA scores significantly differed based upon their MWEE status.

Equipping students with the tools and skills required to be productive citizens is the goal of education. Today's news headlines display the impacts of climate change and other pressing environmental issues and depict the gravity of advancing environmental literacy through environmental education (EE). The pressing need for environmental literacy and sustainability is the conceptual grounding for the current study. Research indicates EE provides academic, economic, health, and various other benefits (Ardoin et al., 2018; Becker et al., 2017; Berman et al., 2008; Chawla, 2018; Kaplan & Kaplan, 2011; Kuo et al., 2019; Williams, 2017; Zint et al., 20140). Ardoin et al.'s (2018) review of 119 peer-reviewed, empirical EE studies focusing on K-12 students over a 20-year span found many positive outcomes including attitudes, dispositions, knowledge, and skills. Administrative support is crucial to implementing EE in schools (Smith et al., 2020). However, many educational stakeholders are hesitant to incorporate EE due to the pressures of mandated, standardized tests (Craig & Marshall, 2019; Diamond, 2007; Ernst & Erickson, 2018; Kopkin et al., 2018; Koretz, 2017; Ledwell & Oyler, 2016; McGuire Nuss et al., 2019; Redding & Nguyen, 2020). According to Gruenewald and Manteaw (2007), "Teachers and administrators, especially under the pressures of NCLB, often need to be convinced that whatever curricular approach they adopt will enhance student achievement" (p. 177). To encourage educational stakeholders to implement MWEEs thereby allowing students to develop environmental literacy and the skills vital to address environmental issues, there was a need to determine whether MWEEs impact state-mandated standardized test scores (Kuo et al., 2019). The current study supports this claim and addresses Gruenewald and Manteaw's (2007) recommendations that additional studies need to be conducted regarding the correlation of academic achievement with EE. Ardoin et al. (2018) found positive outcomes in academic achievement and civic engagement, but only 9% of the studies measured non-environmental related outcomes solely. The results of the current study aligned with Bartosh et al.'s (2006) claim that EE could contribute to students' academic achievement on standardized tests.

While many studies have been conducted on MWEEs (Ernst & Erickson, 2018; Haines, 2016; McConnell et al., 2020; McGuire, 2012; McGuire Nuss et al., 2019; Moyer & Miller, 2017; Reynolds et al., 2021; Zint et al., 2014), a lack of published research examining the impact MWEEs have on academic achievement as measured by standardized tests exists. Due to this lack of data and given the increased reliance on standardized test outcomes as the primary indicator of student success, educational stakeholders may be less likely to incorporate MWEEs into the curriculum. Thus, students may miss the opportunity to become environmentally literate, and they may not be equipped to address environmental issues. The results of this current study support the inclusion of MWEEs into a school's curriculum based upon the statistically significant results of the MANOVA.

Implications

Theoretical Implications

The results of this study implied meaningful watershed educational experiences (MWEE) may improve standardized test scores in ELA, math, and or science. Therefore, this study may encourage school districts to implement MWEEs which, in turn, may foster environmental literacy and provide students with the tools to address today's complex environmental issues. This research adds to the existing body of literature by showing the impacts MWEEs may have on state mandated standardized test scores. In doing so, this study strengthens the conceptual framework, addressing the gravity of advancing environmental literacy through EE (CBF, 2001; NAAEE, 2019; UN, 1973).

Implications for Practice

The pressure to improve standardized test scores is paramount in many school districts across the nation (Gruenewald & Manteaw, 2007). The incessant demand to raise test scores even led to multiple test cheating scandals nationwide (Martin et al., 2020). The results of this current study encourage the implementation of MWEEs as a way of addressing the push to enhance standardized test scores while also attending to multiple other critical needs, including environmental literacy. MWEEs are student-centered, project-based investigations on local environmental issues leading to informed action and civic engagement (Sprague et al., 2019). MWEEs connect standards-based instruction with outdoor field investigations fostering environmental literacy (CBP, n.d.). With the overall goal to promote student citizenry, this current study implies that the implementation of MWEEs also boosts academic achievement as measured by standardized tests scores.

Implications for Future Research

While there exists a plethora of research studies documenting the benefits of EE and specifically MWEE implementation, there was no previous study to suggest whether MWEEs may have an impact on standardized test scores (Ardoin et al., 2018; Becker et al., 2017; Berman et al., 2008; Chawla, 2018; Kaplan & Kaplan, 2011; Kuo et al., 2019; Williams, 2017; Zint et al., 2014). With additional research, the benefit of MWEEs could be further documented in both the standardized testing and environmental stewardship arenas. MWEEs may be the vehicle to address both vital areas. Educational stakeholders could then make informed, research-based decisions on whether to implement MWEEs.

Limitations

This study was limited by the low number of school districts who completed NOAA's Environmental Literacy Tool (ELIT) within Pennsylvania. In Pennsylvania, only 30 out of 193 (16%) of districts within the Chesapeake Bay Watershed responded to the ELIT compared to 96% of districts within Maryland and 74% of Virginia (Sickler, 2018). There was no response from 84% of school districts within Pennsylvania. Of those school districts who did respond, only 17% LEAs participated in a systemwide MWEE, whereas 47% of schools did not participate in a MWEE at all according to the Chesapeake Bay Watershed 2017 Environmental Literacy Report (Sickler, 2018). Due to the low response rate of the ELIT from Pennsylvania LEAs, future studies should use additional methods to determine study participants.

The uneven sample sizes between the two groups, students who have participated in a MWEE (n = 233) compared to students who did not participate in a MWEE (n = 874), made the results less predictable, which was partially mitigated by the large sample sizes (Warner, 2013). A limitation of an internal threat was whether an MWEE was fully implemented within the 17% of schools who responded that they did participate in a systemwide MWEE. Again, future studies should use additional methods to determine study participation beyond the ELIT.

In addition, the current study does not consider students who may have moved into the district after the MWEE or were absent during the MWEE. As such, the data received does not ensure every student who completed the PSSA also participated in the MWEE. The same is true for the reverse. In the current study, there is no method to gather data to determine whether students new to a district who claimed they did not participate in a MWEE may or may not have participated in a MWEE at their previous school district. Future studies should include procedures for determining whether a student was new to a district and whether they did or did not participate in a MWEE. The nature of this study and sampling procedures, a quantitative causal-comparative ex post facto versus an experimental study, limited the potential for generalizing the results and the ability to claim causality. Future studies could be experimental in nature, including random assignment of participants to groups and experimental control of variables to improve internal and external validity. An experimental design would improve generalization (Warner, 2013).

COVID-19 also served as a significant limitation on this study due to the massive academic disruptions it created. The pandemic caused school districts to transfer from in-person to virtual instruction during the 2020 school year, cancelling both meaningful watershed experiences as well as the 2019-2020 PSSA. Thus, historic data was required to be utilized to complete the study.

In addition, the current study was limited due to the reliance solely on the ELIT to gather information on schools' MWEEs. While the ELIT did provide information on the MWEE participation status of students, it did not provide detailed information about the MWEE or corresponding curriculum (see Appendix 3 for the ELIT survey). Future studies should utilize a method for determining how MWEEs were implemented including instructional methods, curriculum, and demographics on participating teachers. This would address treatment fidelity. Findings in this study are limited to the population examined and may not be generalized to all students.

Recommendations for Future Research

As noted in the preceding section, several recommendations for future research are presented. Further research on the impact MWEEs may or may not have on academic achievement regarding standardized testing should include student demographics. Researchers should evaluate whether subgroups of students may or may not benefit more than others from MWEE participation academically. Ideally, experimental methods should be incorporated to improve the potential for generalization of the results. Another area to incorporate into additional research on the impact of MWEEs would be educators' related experiences, professional development, and attitudes pertaining to MWEEs and whether these may or may not contribute to both the implementation as well as the success of conducting a MWEE.

Lastly, the impact of the academic disruption due to COVID-19 is an area of recommended future study. In addition to significant academic consequences (Goldhaber et al., 2022), the likelihood of disparity of environmental experiences may have also increased. The participation in MWEEs may provide students the academic, social, health, and other benefits to negate the COVID learning gap.

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APPENDICES

APPENDIX A: IRB Approval Letter

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

December 3, 2021

Gina Mason
Jillian Wendt

Re: IRB Exemption - IRB-FY21-22-364 A Causal-comparative Study of the Impact of Meaningful Watershed Environmental Experiences on Academic Achievement of Middle School Students

Dear Gina Mason, Jillian Wendt,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

(4) Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:

(ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

APPENDIX B: ELIT Request

October 27, 2021

XXXXXXXXXXX
XXXXXXXXXXX
XXXXXXXXXXX
XXXXXXXXXXX
XXXXXXX
XXXXX

Dear XXXXXXXXX,

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate degree. The title of my research project is A Causal-comparative Study of the Impact of Meaningful Watershed Environmental Experiences on the Academic Achievement of Middle School Students, and the purpose of my research is to examine the impact of MWEEs on the academic achievement of 8th grade students in Pennsylvania. The research question for my study is: Is there a difference between 8th grade students' PSSA scores in ELA, math, or science based on their MWEE participation status.

I am writing to request your permission to access and utilize your Environmental Literacy Tool data that relates to Pennsylvania. All data will be kept on a password protected secure computer with only myself and possibly my dissertation committee having access. Individual school district data will not be released publicly. Any information released will be aggregate data. All Identifiable information will be removed from data and pseudonyms will be utilized.

The data will be used to assist in selecting cases for my study based upon their MWEE participation status. The data sets and cases for the study will be drawn from a purposeful convenience sample of Pennsylvania middle schools located within the Chesapeake Bay Watershed.

Thank you for considering my request. If you choose to grant permission, please respond by email to XXXXXXXXXX.

Sincerely,

Gina R. Mason
Doctoral Candidate

As per your previous email APPENDIX C: Environmental Literacy Indicator Tool (ELIT)

OMB Control Number: 0648-xxxx
Expiration Date: xx/xx/2020

Attachment 2: Environmental Literacy Indicator Tool Survey

This is a voluntary survey.

Paperwork Reduction Act Statement
Public reporting burden for this collection of information is estimated to average 90 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other suggestions for reducing this burden to [redacted]

Responses are voluntary, but are not confidential. Information will be treated in accordance with the Freedom of Information Act (5 USC 552).

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.

Important Tips before You Begin the ELIT

- We recommend that you preview the Environmental Literacy Indicator Tool (ELIT) before completing it online. Download a Word version of the survey at this link: Environmental Literacy Indicator Tool.
- We recommend you first make note of your responses within this "offline" document, including consulting with colleagues, as needed, to answer the questions accurately.
- Use this online survey to enter and submit your responses. If you've typed answers into Word, you can copy-and-paste into the online survey.
- We recommend that you enter the answers online during one sitting. Due to security settings on some computers, your system may not retain previously entered responses between two different sessions.

Introduction

The purpose of the Chesapeake Bay Program's Environmental Literacy Indicator Tool (ELIT) is to help local and state schools systems collect important information that will help advance the implementation of environmental education efforts in schools in the mid-Atlantic region.

This tool, the data collected, and related efforts supporting environmental education in the region are in direct support of the Environmental Literacy Goal and Outcomes of the new Chesapeake Bay Watershed Agreement (signed 6/19/14).

> **Environmental Literacy Goal:** Enable every student in the region to graduate with the knowledge and skills to act responsibly to protect and restore their local watershed.
> **Environmental Literacy Planning Outcome:** Each participating Bay jurisdiction should develop a comprehensive and systemic approach to environmental literacy for all students in the region that includes policies, practices and voluntary metrics that support the environmental literacy Goals and Outcomes of this Agreement.
> **Student Outcome:** Continually increase students' age-appropriate understanding of the watershed through participation in teacher-supported, meaningful watershed educational experiences and rigorous, inquiry-based instruction, with a target of at least one meaningful watershed educational experience in elementary, middle and high school depending on available resources.
> **Sustainable Schools Outcome:** Continually increase the number of schools in the region that reduce the impact of their buildings and grounds on their local watershed, environment and human health through best practices, including student-led protection and restoration projects.

The underlying principles of the outcomes and the resulting elements of this tool are founded on research-based best practices in the field of environmental education. The results from these data collection efforts will provide valuable information to states and the Chesapeake Bay Program Education Workgroup about how best to support local efforts to create and implement comprehensive strategies to support student environmental literacy. It will also be used by major funding partners, including the NOAA Bay Watershed Education and Training (B-WET) Program and the Chesapeake Bay Trust, to inform funding priorities and decisions. Therefore, accurate reports of both accomplishments and gaps are important.

Please complete the five sections of the Environmental Literacy Indicator Tool:

Section I:	Environmental Literacy Planning
Section II:	Student Participation in Meaningful Watershed Educational Experiences (MWEEs)
Section III:	Sustainable Schools
Section IV:	Environmental Education Improvement Efforts
Section V:	Feedback on ELIT

If you have questions about this tool, please contact:

Please complete this contact information before you begin completing the Environmental Literacy Survey.

**required question*

Please select your state from the drop-down list below:

- Delaware
- District of Columbia
- Maryland
- Pennsylvania
- Virginia
- West Virginia

**required question*

Please select your school district or local education agency (LEA) from the dropdown list.

[pre-populated drop-down list with LEA names]

**required question*

What is your primary job title/responsibility? (please select the title that most closely matches your job)

- District-level superintendent
- District-level assistant superintendent
- District-level director of curriculum/instruction/education
- District-level curriculum supervisor/coordinator
- District-level STEM supervisor/coordinator
- District-level business administrator

- o School principal
- o School assistant principal
- o Classroom teacher
- o Other, please describe: ___________________________

Section I: Environmental Literacy Planning

Environmental Literacy Planning Outcome: *Each participating Bay jurisdiction should develop a comprehensive and systemic approach to environmental literacy for all students in the region that includes policies, practices and voluntary metrics that support the environmental literacy Goals and Outcomes of this Agreement.*

State departments of education and local education agencies play an important role in establishing expectations and guidelines, and providing support for the development and implementation of environmental education programs within their schools. To ensure that every student in the region graduates with the knowledge and skills to act responsibly to protect and restore their local watershed as called for in the Chesapeake Watershed Agreement, environmental education should be embedded into the local curriculum and Meaningful Watershed Educational Experiences (MWEE Definition 2014.pdf) should occur at least once during each level of instruction (elementary, middle, and high school).

In the development of plans and the delivery of programs, local education agencies can also benefit from partnerships with environmental education organizations, natural resource agencies, universities, businesses, and other organizations that have a wealth of applicable products and services as well as a cadre of scientific and professional experts that can complement the classroom teacher's strengths and heighten the impact of environmental instruction both in the classroom and in the field.

The following questions are intended to help assess the current capacity of your school division/local education agency (LEA) to implement a comprehensive and systemic approach to environmental education. **Please review the following elements (a-f) and, using the scale below, make a determination about your LEA's capacity to address them.**

a. An established program leader for environmental education (providing effective, sustained and system leadership)

- Not in Place
- Fully in Place: Program leader is in place to design, implement, and/or monitor EE program

Comments

b. An integrated program infusing environmental concepts into appropriate curricular areas

- Not in Place
- Partially in Place: EE is represented in some LEA curricula (science, social studies, math, reading, etc.) or initiatives (STEM, Service Learning, etc.)
- Fully in Place: EE is fully embedded in the curriculum across all relevant PK-12 LEA curricula and initiatives

Comments

c. Regular communication among staff responsible for environmental education curriculum and program implementation.

- Not in Place
- Partially in Place: Appropriate staff meet periodically and/or share information about environmental education curriculum and programs
- Fully in Place: Appropriate staff meet regularly to design, implement, and/or monitor environmental education curriculum and programming for students

Comments

d. A support system in place that enables teachers and administrators to engage in high quality professional development in content knowledge, instructional materials, and methodology related to environmental education.

- Not in Place
- Partially in Place: PD in environmental education is offered periodically to teachers and/or administrators
- Fully in Place: PD in environmental education is provided regularly for all relevant teachers and administrators

Comments

e. A plan to ensure opportunities for all students to engage in meaningful watershed educational experiences (MWEEs) at the elementary, middle and high school levels

- Not in Place
- Partially in Place: LEA has a plan to provide MWEEs in one or two grade bands (elementary, middle, and high)
- Fully in Place: LEA has a plan to provide MWEEs at least once in each grade band (elementary, middle, and high)

Comments

f. Established community partnerships for delivery of environmental education, including implementation of MWEEs

- Not in Place
- Partially in Place: Partners are offering environmental education programs in schools, but these are not coordinated with the LEA
- Fully in Place: Partners are working with LEA to coordinate delivery of environmental education programs in support of a LEA environmental education plan or priorities

Comments

Section II: Student Participation in Meaningful Watershed Educational Experiences

Environmental Literacy Student Outcome*: Continually increase students' age-appropriate understanding of the watershed through participation in teacher-supported, meaningful watershed educational experiences and rigorous inquiry-based instruction, with a target of at least one meaningful watershed educational experience in elementary, middle and high school depending on available resources.*

All four of these components are required for the experience to qualify as a Meaningful Watershed Educational Experience (MWEE) (for a more detailed definition, see MWEE Definition 2014.pdf):

> ***Issue Definition:*** *Students identify an environmental question, problem, or issue and explore through background research and investigation.*
> ***Outdoor field experiences:*** *Students participate in one or more outdoor field experience sufficient to collect the data required for answering the research questions and informing student actions.*
> ***Action projects:*** *Students participate in an action project during which students take action to address environmental issues at the personal or societal level.*
> ***Synthesis and conclusions:*** *Students analyze and evaluate the results of their investigation of the issue and synthesize and communicate results and conclusions.*

On the following pages, please describe the participation of your school district's elementary, middle, and high school students in MWEEs in the 2016-2017 school year.

Elementary School

For each grade level, please indicate student participation in MWEE programs during the 2016-2017 school year.

A complete MWEE program includes: 1) Issue Definition, 2) Outdoor Field Experience, 3) Action Project, and 4) Synthesis and Conclusions.

	A system-wide MWEE is in place for students in this grade	Some schools or classes in this grade participate in MWEEs	No evidence that students in this grade participate in a MWEE
Kindergarten	❍	❍	❍
1st grade	❍	❍	❍
2nd grade	❍	❍	❍
3rd grade	❍	❍	❍
4th grade	❍	❍	❍
5th grade	❍	❍	❍

[If selected column 1 for any item above]

Please describe the system-wide MWEE programs that are in place to reach all elementary school students (i.e., grade, description of unit, partnerships, etc.).

[If selected column 2 for any item above]

Please provide examples of MWEE programs in which students participate that are currently not offered to all elementary school students (i.e., grade, description of unit, partnerships, school(s), etc.).

Do you have any other system-wide outdoor education experiences that do NOT meet the full criteria of a MWEE at any elementary grade level(s)?

- O Yes
- O No

[If at yes is selected above.]

In which grade level(s) do you have a system-wide outdoor education experience that does NOT meet the full criteria of a MWEE? (select all that apply)

- ☐ K
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

[If yes is selected above.]
Please describe the system-wide outdoor education experiences for the grade(s) selected above. (i.e., location, partnerships, description, etc.)

Middle School
For each grade level, please indicate student participation in MWEEs during the 2016-2017 school year.
A complete MWEE program includes: 1) Issue Definition, 2) Outdoor Field Experience, 3) Action Project, and 4) Synthesis and Conclusions.

	A system-wide MWEE is in place for students in this grade	Some schools or classes in this grade participate in MWEEs	No evidence that students in this grade participate in a MWEE
6th grade	❍	❍	❍
7th grade	❍	❍	❍
8th grade	❍	❍	❍

[If column 1 is selected for any items above.]
Please describe the system-wide MWEE programs that are in place to reach all middle school students (i.e., grade, description of unit, partnerships, etc.).

[If column 2 is selected for any items above.]
Please provide examples of MWEE programs in which students participate that are currently not offered to all middle school students (i.e., grade, description of unit, partnerships, school(s), etc.).

Do you have any other system-wide outdoor education experiences that do NOT meet the full criteria of a MWEE at any middle school grade level? (select all that apply)

- O Yes
- O No

[If at yes is selected above.]
In which grade level(s) do you have a system-wide outdoor education experience that does NOT meet the full criteria of a MWEE? (select all that apply)

- ☐ 6
- ☐ 7
- ☐ 8

[If a yes is selected above.]
Please describe the system-wide outdoor education experiences for the grade(s) selected above. (i.e., location, partnerships, description, etc.)

High School
For each **REQUIRED** high school course (i.e., every student takes the course), please indicate student participation in MWEEs during the 2016-2017 school year.
A complete MWEE program includes: 1) Issue Definition, 2) Outdoor Field Experience, 3) Action Project, and 4) Synthesis and Conclusions.

Just answer for required courses. We'll ask about elective courses next.

	System-wide, a MWEE is included in this course	Some schools or classes include a MWEE in this course	No evidence that students in this course participate in a MWEE
Biology (required course)	❍	❍	❍
Chemistry (required course)	❍	❍	❍
Physics (required course)	❍	❍	❍
Earth Science (required course only)	❍	❍	❍
History and Social studies	❍	❍	❍
English	❍	❍	❍
Mathematics	❍	❍	❍
Other Required Science Course (indicate course) ________	❍	❍	❍
Other Required Course (indicate course) ________	❍	❍	❍

For each high school **ELECTIVE course**, please indicate student participation in MWEEs during the 2016-2017 school year.

	System-wide, a MWEE is included in this elective	Some schools or classes include a MWEE in this elective	No evidence that students in this elective participate in a MWEE
Environmental Science/Ecology	❍	❍	❍
AP Environmental Science	❍	❍	❍
Career and Technical Education	❍	❍	❍
Health and Physical Education	❍	❍	❍
Other Science Electives (indicate course) ____________	❍	❍	❍
Other History or Social Studies Electives (indicate course) ____________	❍	❍	❍
Other elective (indicate course) ____________	❍	❍	❍
Other elective (indicate course) ____________	❍	❍	❍

[If column 1 is selected for any items in the above two tables.]

Please describe the system-wide MWEE programs that are in place to reach all high school students (i.e., grade, description of unit, partnerships, etc.).

[If column 2 is selected for any items in the above two tables.]

Please provide examples of MWEE programs in which students participate that are currently not offered to all high school students (i.e., grade, description of unit, partnerships, school(s), etc.).

Do you have any other system-wide outdoor education experiences that do NOT meet the full criteria of a MWEE, at any high school grade level?

- O Yes
- O No

[If yes is selected above.]

In which grade level(s) do you have a system-wide outdoor education experience that does NOT meet the full criteria of a MWEE? (select all that apply)

- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12

[If yes is selected above.]
Please describe the system-wide outdoor education experiences for the grade(s) selected above. (i.e., location, partnerships, description, etc.)

Section III: Sustainable Schools

Environmental Literacy Sustainable Schools Outcome*: Continually increase the number of schools in the region that reduce the impact of their buildings and grounds on their local watershed, environment and human health through best practices, including student-led protection and restoration projects.*

Sustainable Schools Pillars (as defined by the U.S. Department of Education Green Ribbon Schools):

- Reduce environmental impact and costs,
- Improve the health and wellness of schools, students and staff, and
- Provide effective environment and sustainability literacy, incorporating STEM, civic skills and green career pathways

Separate from this survey, we will receive data about which schools in your LEA are recognized as Sustainable Schools by several certifying organizations that are recognized by the Chesapeake Bay Program Education Workgroup, including:

- U.S. Department of Education Green Ribbon Schools
- Eco Schools (National Wildlife Federation)
- Project Learning Tree Green Schools
- Maryland Green Schools (MAEOE)
- Virginia Naturally Schools
- West Virginia Sustainable Schools

Other than the sustainable schools programs above, what best practices are schools implementing and/or in what environmental certification programs do schools in your LEA participate (e.g. LEED)?

Please select one answer per question.

	Yes	No	I don't know
Does your LEA have a staff lead or team responsible for coordinating sustainable schools efforts?	❍	❍	❍
Does your LEA have a sustainability plan or formal environmental sustainability objectives?	❍	❍	❍
Are sustainable school efforts, which may be overseen by facilities departments, incorporated in district curriculum?	❍	❍	❍
Do you encourage your schools to seek sustainable school certification? If yes, which certification program(s) do you encourage: ____________________	❍	❍	❍
Has your school district received district-level sustainable school certification?	❍	❍	❍

Please provide the contact information for the person in charge of facilities for your LEA:
Name (First and Last)
Email
Phone

Section IV: Continuous Environmental Education Improvement Efforts

What are the strongest elements of your environmental education program for <u>students</u>? What data or subjective assessments support this?

What are the strongest elements of your environmental education program for <u>teachers</u>? What data or subjective assessments support this?

Please share any success stories as exemplars and models of best practice that are not detailed above. (Please provide links to websites, articles, etc. if possible.)

What are the greatest challenges related to establishing/implementing your environmental education program?

What are opportunities to grow your environmental education program?

What are your highest priority needs for improving your environmental education programs? Please rate how much of a need each of the items below is for your LEA.

	1 No need	2	3	4	5	6	7 High Need
Outdoor Classrooms	❍	❍	❍	❍	❍	❍	❍
Increased Alignment with Curriculum	❍	❍	❍	❍	❍	❍	❍
Support from Board of Education	❍	❍	❍	❍	❍	❍	❍
Teacher Professional Development	❍	❍	❍	❍	❍	❍	❍
Sustainable Schools Technical Assistance	❍	❍	❍	❍	❍	❍	❍
Curriculum Planning/Integration Support	❍	❍	❍	❍	❍	❍	❍
Funding	❍	❍	❍	❍	❍	❍	❍
Community Partnerships	❍	❍	❍	❍	❍	❍	❍
Other (please describe)	❍	❍	❍	❍	❍	❍	❍

Section VI: Feedback on ELIT

On a scale from 1 to 10, how difficult was it to provide the data for the ELIT survey overall?

	1	2	3	4	5	6	7	8	9	10	
Very difficult	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	Very easy

Do you have any suggestions for improving the design and/or functionality of the ELIT survey?

THANK YOU for completing this survey! Please click on the SUBMIT button below to complete the survey. After you submit the survey, you will see a summary of your entered responses. Click on the Adobe symbol to download a PDF and save a copy of your data.

APPENDIX D: LEA PSSA Data Request

January 4, 2022

Dr. XXXXXXXXXXX
Superintendent
XXXXXXXXX School District
XXXXXXXXX
XXXXXXXXX, PA
XXXXXX

Dear Dr. XXXXXXXX,

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate degree. The title of my research project is A Causal-comparative Study of the Impact of Meaningful Watershed Environmental Experiences on the Academic Achievement of Middle School Students, and the purpose of my research is to examine the impact of Meaningful Watershed Environmental Experiences (MWEEs) on the academic achievement of 8^{th} grade students in Pennsylvania.

I am writing to request access to your district's student-level 8th grade PSSA data (ELA, math, and science) with identifiers removed for the 2017-2018 and 2018-2019 school years.

The data will be used to determine the impact, if any, of the participation in MWEEs upon PSSA scores in ELA, math, and science. The data sets and cases for the study will be drawn from a purposeful convenience sample of Pennsylvania middle schools located within the Chesapeake Bay Watershed based upon National Oceanic and Atmospheric Administration's (NOAA) Environmental Literacy Indicator Tool (ELIT) data. All data will be kept on a password protected secure computer with only myself and my dissertation committee having access. Individual school district data will not be released publicly. Any information released will be aggregate data. All identifiable information will be removed from data and pseudonyms will be utilized.

Thank you for considering my request. If you choose to grant permission or if you have any questions, please contact me at XXXXXXXXXXXX.

Sincerely,

Gina R. Mason
Doctoral Candidate