

INCLUSION OF ENVIRONMENTAL EDUCATION INTO PUBLIC SCHOOL
CURRICULA

by

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Doctor of Philosophy at George Mason University

by

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Master of Science
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DEDICATION

This is dedicated to my mother, Elizabeth. You still inspire to me be creative and inquisitive.

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I would like to thank the many friends, relatives, and supporters who have made this happen. My wife Stephanie Monschein tolerated close to a decade of my fretting over coursework and sample sizes. My parents Gerald Tracy and Dr. Patricia Behre helped me realize just how big I could dream. Dr. Chris Parsons, Dr. Dann Sklarew, Dr. Erin Peters Burton, and Dr. Betty Sanders continuously supported my work over the past several years. Your ongoing dedication to the environment and to education has been truly inspirational.

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LIST OF ABBREVIATIONS

Adequate Yearly Progress.....	AYP
Advanced Placement.....	AP
Compulsory Education Act.....	CEA
Department of Education.....	DOE
Elementary and Secondary Education Act	ESEA
Environmental Education.....	EE
Environmental Protection Agency.....	EPA
Global Learning and Observations to Benefit the Environment.....	GLOBE
Individuals with Disabilities Education Act	IDEA
International Baccalaureate.....	IB
Meaningful Watershed Educational Experience.....	MWEE
National Aeronautics and Space Administration.....	NASA
National Education Association	NEA
National Environmental Education Advisory Council	NEEAC
National Environmental Education Association.....	NEEA
National Oceanic and Atmospheric Administration	NOAA
National Research Council	NRC
National Science Foundation	NSF
National Science Teachers Association	NSTA
New Environmental Paradigm.....	NEP
Next Generation Science Standard	NGSS
No Child Left Behind.....	NCLB
No Child Left Inside	NCLI
Office of Environmental Education.....	OEE
Outdoor Education.....	OE
Programme for International Student Assessment.....	PISA
Science Education.....	SE
Virginia Department of Environmental Quality	VADEQ
Virginia Department of Education.....	VDOE
United Nations	UN

ABSTRACT

INCLUSION OF ENVIRONMENTAL EDUCATION INTO PUBLIC SCHOOL CURRICULA

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In recent years there have been growing proenvironmental trends in the United States, as well as internationally (Bekoff, 2014). Environmental education (EE) in U.S. public curricula can be a driving force for these trends (Andrews, 2006). However, there are major barriers to inclusion of EE into public school curricula; lack funding, the multi-curricular nature of EE, and the controversy surrounding some environmental issues. National and global socioeconomic and political changes affect public attitude and attitude, in turn, affects these changes. Shifts in environmental attitudes have been assessed using multiple different scales, but most prominently with the New Environmental Paradigm scale (Dunlap, 2008; Sutton and Gyuris, 2015). Findings over the past decades have shown differences in proenvironmental behavior between genders, but studies have found limited differences in attitude using the NEP scale. For this reason, several studies have begun linking value scales to the NEP in order to gain insight

into the underlying causes of change in environmental attitudes (Sutton & Gyuris, 2015). Findings in this study indicated that the differences may be in individual aspects of the attitude and value scales rather than in the total score. Regardless, increased exposure to outdoor experiences has been shown to positively impact student attitudes towards the environment (Kellert, 1984, 1997; Louv, 2005, 2007, 2012; Mainella et al., 2011). If the ultimate goal of environmental education is to produce environmental stewards, comprehensive learning experiences in outdoor spaces can help to solidify pro-environmental behaviors in students, giving them a sense of place in the natural world.

CHAPTER ONE – A HISTORICAL CONTEXT

INTRODUCTION

National and international attitudes have been shifting slowly to address concerns of environmental degradation. Educational programs have changed to reflect this concern, but generally as a novel experience for students rather than an integrated part of a holistic curriculum. This is due to paradigm shifts in public policy that have led to lack of funding, lack of teacher training, and therefore lack of student engagement. Legislative efforts have been made to spur the growth of environmental education programs, such as the National Environmental Education Act of 1990 that provides grants for education. However, this funding is limited. A review of grants awarded to date shows that only about \$2.30 was awarded annually per public and private schools. The majority of funding went to non-profit organization. This chapter attempts to illuminate a complex history of changes in U.S. politics and the effects they have had on science education, particularly environmental and outdoor education programs in public schools.

Environmental education defined

Since the late 20th century, national and international attitudes have been shifting slowly pro-environment, meaning that increased focus is being put on human influence on the natural world (Bekoff, 2014; Caldwell, 1996; Dunlap, 2008; Louv, 2005). Andrews (2006) wrote, “Three and a half decades after the dawn of the ‘environmental era’ in 1970, in short, environmental concerns have become an enduring, resilient, and

important domain of American public policy, and of the international agenda as well” (p. 395). Saylan and Blumstein (2011) suggested that American schools can foster this agenda through environmental education (EE) and help drive a national attitude change. Such paradigm shifts have caused, but may also be in part due to, a renewed focus on EE.

EE is not solely education about ecological and environmental science, but encompasses all disciplines and essential skills such as critical thinking, analysis of environmental issues, and understanding how human behavior impacts surroundings (Bearden, 2002; Athman and Monroe, 2001). Because of this attitudinal and behavioral component, EE is not always included in science education (SE) programs. Stapp et al. (1969) established the first widely accepted definition of EE, stating: “Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution” (p. 34). EE’s focus on attitudes and behaviors means that it does not always fit into the more rote fact-based SE curricula. EE bridges multiple subjects, drawing from many fields of study including economics, sociology, and all fields of science.

In order to understand the natural environment, and one’s role within it, students must also consider the social, cultural, political, and economic environments. All of these environmental streams coalesce to embody the collective human *environment*. This is what must be addressed by EE programs. Issues of natural environmental degradation are not solely issues of environmental science, but have broad implications in socio-economic environments and cultural impact. Wilson (1998) referred to this bridging of

disciplines as “consilience”. EE must be consilient if it is to produce a knowledgeable citizenry, as Stapp et al. (1969) posed. This means bridging educational curricula so that students have a comprehensive understanding of the world around them, rather than the current system which trains students in isolated categories of curricula. Two ways to achieve this are: (1) to address issues of literacy in science classes; and (2) to teach critical thinking and logic in all classes rather than rely on the scientific method and science classes to address these skills

Saylan and Blumstein (2011) generally defined this overarching, consilient knowledge as “scientific and environmental literacy”. They wrote that “Environmental education *must* foster functional literacy if it is to accomplish any measurable impact on environmental problems” (p. 35). It is understood that effective education will produce literate, knowledgeable students. Such thinking must be considered for every program, especially those focused on environmental, or outdoor, education. Consilient education will foster growth of engaged citizens through a well-balanced understanding of one’s place in the natural world (Bekoff, 2014; Wattchow & Brown, 2011)

A historical context

The history of EE closely follows that of public education in general, but also teeters on the border with the development of environmental policy. The most notable events have been compiled and are expressed in Figure 1. McCrea (2006) credited Jean-Jacques Rousseau’s 1762 publication of *Emile* as the first mention of environmentally-focused education, but that may be a stretch as it was not for at least another century that

EE would be directly addressed within the U.S. For the purposes of this study, EE began with the push for better public education.

In 1857, the National Education Association (NEA) formed to advocate for more uniform public education, however, the NEA would not take a leadership role in conservation education until the 1930s (McCrea, 2006; Stohr, 2013). Prior to this the focus was on literacy, with little focus on the sciences. During the mid-1800s, science education advocates, such as Thomas Henry Huxley, called into question the traditional education system's focus on reading and writing only. In 1854 Huxley wrote: "Science is, I believe, nothing but *trained and organized common sense*" (p. 27, Huxley, 2008). It would be another hundred years before core curricula included science, but even at this time, educators understood that science can be taught as a way of observing the world; such training in logic and deduction can be used in other core subjects. As a nation, we have moved away from the study of scientific method to the memorization of facts and it has likely harmed scientific learning and critical thought. This will be addressed further in a later section.



Figure 1: Historical timeline of environmental education leading up to the National Environmental Education Act of 1990 (compiled from various sources to be discussed in this chapter)

By the late 1800s, there was a rise in environmental awareness within the general public. This was partly due to prominent writers at the turn of the century, such as John Muir, and due to the Roosevelt administration’s focus on resource management (Andrews, 2006; Athman and Monroe, 2001; Stohr, 2013). In 1891, Wilbur Jackson published *Nature of Study for the Common School*, a book promoting natural studies, but this was not widely used (McCrea, 2006). However, Jackson wrote, “The most serious obstacle in the way of science work is the teacher’s own lack of faith in his ability to do anything useful or credible” (p. 12). This holds true today as many elementary school

teachers may not have a science background. Later sections of this chapter will address ways that elementary teachers can improve science education without much training. In the last decade of the 19th Century, university leaders recognized a need to create uniform secondary instruction (McCrea, 2006). This would have resounding impacts on scientific instruction to this day.

Despite the lack of a direct role in EE, the National Education Association hosted a series of conferences in 1892-1893, some of which placed increased focus on scientific literacy (DeBoer, 1991). In July 1892, ten college leaders met at the annual NEA conference to discuss college entrance practices. This committee set out a series of conferences, each to develop best practices in instruction, time allotment, and assessment (NEA, 1893). Some of the reports from these conferences still guide tracking and course selection in American public schools.

The Conference on Physics, Chemistry, and Astronomy reported several resolutions, including that chemistry should be taught prior to physics to allow students a proper background in mathematics; also that half of the course work in high school should be laboratory work (DeBoer, 1991). *The Conference on Natural History* proposed a focus on hygiene and personal health. This is still reflected in the modern biology classes through the teaching of sex education and nutrition. According to DeBoer (1991), in 1893, *The Conference of Geography* proposed renewed focus on scientific method, in general. The conference report echoed Huxley's proposal that science course should teach a way of thinking rather than just facts; recommending several specialized science courses (which we would now call electives), the goal of which would improve

observation skills and reasoning; something sorely needed in current times with the limitless access to information available to students through social media newsfeeds. Students, more than ever, need to know how to critically filter information.

In the early 1900s, there was growing concern over the American public education system and a call for curriculum that was appropriate for college-bound students, as well as those that were not. The Commission on the Reorganization of Secondary Education addressed this: “the commission argued that education should be aimed toward democratic life for all” (p. 67, DeBoer, 1991). Even today, we see this dichotomy in public schools. It is important to educate the whole student, but one has to also understand that in a universal system, like that in the United States, adding new curricula means removing others, or overburdening teachers. Some systems, such as those in the United Kingdom, funnel secondary students into tracks that allow for more intense focus in one field, e.g., science, but the U.S. system does not. That makes it great in theory, but sometimes unwieldy in practice.

In 1907, the Boy Scouts of America formed. This group increased focus on natural studies through outdoor education. The Boy Scouts represent an early acknowledgement to the idea that there is more to education than just reading and writing. Though some may view the group as paramilitary, from an environmental point of view, this is an important shift in national attitude. This was complimented by the 1911 publication of Anna Comstock’s *Handbook of Nature Study*; a compilation of journals published through Cornell University, to be used in public classrooms (Athman and Monroe, 2001). By the 1930’s, the ‘dust bowl’, along with writings for a new,

progressive education movement - led by John Dewey - increased public awareness of human impact on the environment (McCrea, 2006). This was an important turning point in EE. The general public started to see that human activities had profound impacts on the environment (Fraser et al., 2015). Years of 'to-the-fence' farming and disregard of soil health compounded with extended drought lead to one of the greatest environmental disasters in U.S. history.

Throughout the late 1930's and 1940's, U.S. focus on the Second World War left little room for further development of education policy, but did have long term effects on environmental policy. This instilled a public mentality of resource use and technological advancement, despite the environmental impacts they caused (Andrews, 2006). Industry grew and the economy boomed, but it would not be for another two decades that environmental impacts of such growth would be addressed. As far as education policy is concerned, it was during the 1940s that education specialists began to focus on gifted and talented students (DeBoer, 1991). This lead to a further push for literacy during cold war. Curricula changes set the stage for the later part of the century when the focus of education would shift entirely to student achievement, school accountability and, therefore, more test assessment based culture rather than hands-on, experiential learning.

The 1950s did see increased attention on outdoor education programs (Athman and Monroe, 2001) than previous decades. For example, the Conservation Education Association formed in 1953 and advocated for better EE through conferences and publications (Stohr, 2013). These education developments ran parallel to increased environmental awareness amongst the U.S. public. Rachel Carson's 1962 publication,

Silent Spring, was a climax event in EE (Athman and Monroe, 2001). This text is viewed as a great work of literature as well as science. EE strives to cross curricular boundaries and Carson's works were some of the first to do this in the modern age. Her publications brought issues of environmental degradation to the forefront of the public mind.

The Elementary and Secondary Education Act (ESEA) of 1965 established better funding for education programs and strengthened the individual state departments of education. The Act normalized public education by mandating core curricula in science, math, history, and English classes; and included funding for teacher education at at-risk schools (Ravitch, 2010). This would later open states to develop their own environmental education plans under the National Environmental Education Act (NEEA). The ESEA of 1965, along with the Compulsory Education Act (CEA) of 1969, which required all children between the ages of 6-12 years to receive an education, both strengthened public education in the United States (Stohr, 2013). This would pave the way for better science education, and eventually EE.

The NEEA of 1970 (P.L. 91-516) "called for the creation of an Office of Environmental Education (OEE) within the then existing U.S. Department of Health, Education and Welfare" (p. 28, Stohr, 2013) and later the Department of Education (DOE). It also established a grants program and a National Advisory Council for environmental education, but the 1970 law was defunded in 1975 and repealed in 1981 (McCrea, 2006). Despite this, it established the framework for EE that would be reaffirmed in the 1990 iteration (to be addressed further in the next section). In response to growing EE efforts, the National Association for Environmental Education was formed

in 1971. The group would later become the North American Association for Environmental Education (NAAEE). The NAAEE was an author of the 1990 NEEA draft and is a manager of NEEA grants.

In 1972, the United Nations held the Conference on the Human Environment in Stockholm. Not only did this conference break ground in international environmental policy with the creation of the U.N. Environmental Programme (UNEP), the conference also reestablished the need for the U.N. Educational, Scientific, and Cultural Organization (UNESCO) to be an international leader in scientific outreach. Recommendation 96 of the 1972 conference specifically “called for the development of environmental education as one of the most critical elements of an all-out attack on the world’s environmental crisis” (p. 2, UNESCO, 1975). In 1975, UNESCO met in Belgrade, Yugoslavia for a workshop that, according to science education specialist W. F. McCormas (2002), “featured the drafting of position papers about the teaching of ecological topics” (p. 667). The conference yielded what would be called the Belgrade Charter and established a definition of environmental education that would later be used by most agencies and governments (NEEAC, 1996).

The Belgrade Charter “established a framework for an international consensus which without a doubt has been the seminal influence on the development of environmental education policies around the globe” (p. 8, Palmer, 1998). It focused education as a primary component of economic development and environmental management. With this in mind, the Charter set six EE objectives: (1) Awareness, (2) Knowledge, (3) Attitude, (4) Skills, (5) Evaluation ability, and (6) Participation

(UNESCO, 1975). The objective was to aid both individuals and societies in attaining, and spreading, awareness of human impact on the environment. Then these groups could have the know-how, drive, and evaluative skills to actually mitigate impact. Such evaluative skill is the literacy defined by Saylan and Blumstein (2011). Further, UNSECO (1975) established eight guiding principles for program development. Figure 2 shows these objectives in their entirety as presented by UNESCO (1975). In general, these closely align with the original definition of EE established by Stapp et al. in 1969 mentioned previously.

1. Environmental education should consider the environment in its totality – natural and man-made, ecological, political, economic, technological, social, legislative, cultural and esthetic.
2. Environmental education should be a continuous life-long process, both in-school and out-of-school.
3. Environmental education should be interdisciplinary in its approach.
4. Environmental education should emphasize active participation in preventing and solving environmental problems.
5. Environmental education should examine major environmental issues from a world point of view, while paying due regard to regional differences.
6. Environmental education should focus on current and future environmental situations.
7. Environmental education should examine all development and growth from an environmental perspective.
8. Environmental education should promote the value and necessity of local, national and international cooperation in the solution of environmental problems.

Figure 2: Guiding principles of environmental education programmes (p. 4, UNESCO, 1975)

Under the Belgrade Charter, ratifying nations would develop consilient outreach programs to encompass the holistic human environment, encourage life-long learning by bridging curricula. The Belgrade Charter also encouraged a global mind-set in establishing EE programs. Environmental issues cross national boundaries, and so must education. One of the most important objectives was that programs would prepare students to anticipate and respond to future environmental problems through a compassionate, literate citizenry that would act in a precautionary manner.

In 1977, the first intergovernmental conference on environmental education was held in Tbilisi, USSR, currently known as Georgia (Athman and Monroe, 2001; McCrea, 2006). According to Athman and Monroe (2001), there were 66 U.N. member nations (and 2 non-member nations) in attendance. The conference reiterated the goals of the Belgrade Charter and recommended that nations adopt these criteria in order to develop individual, national and localized EE programs that would focus not just on the human environment as a whole. This would create international attitude shifts with the hope that it would change social behavior and reduce human impact on the natural environment. In order to assess these changing attitudes, Dunlap and Van Liere (1978) developed a tool that would quantify shifts in the dominant social paradigm.

In the 1980s, there was increased focus on education for all students by bridging achievement gaps to compete on a national stage. The 1983 publication of *Nation at Risk* saw a flip in focus of public education from inputs to outputs (Ravitch, 2010). The Department of Education (DOE) report called attention to international rankings and the fact that the United States performed poorly on national assessments; primarily in reading

and writing. This sparked the movement for better education for at-risk students (Ravitch, 2010). The Individuals with Disabilities Education Act (IDEA), which mandated individual education plans for identified students, was passed in 1990 alongside the NEEA. Environmental education cannot be viewed within a bubble. Any change in general public education would have resounding effects on science education as well.

In 1989, a draft of the revised 1970 NEEA was prepared by the Committee on Environment and Public Works Alliance (CEPWA) and the NAAEE (Marcinkowski, 1991). Representative George Miller (CA) and Senator Quentin Burdick (ND) both introduced the bill to the House and Senate respectively. In February of 1990, both the CEPWA and the NAAEE were called to testify and a joint committee was formed to revise the draft (Marcinkowski, 1991). The NEEA was approved on October 26th, 1990 and sent to President Bush, who signed it into law on November 16th (Marcinkowski, 1991).

The National Environmental Education Act of 1990

First and foremost, the NEEA of 1990 established a U.S. policy on environmental education: *P.L. 101-619*, Section 2b states that it is not only the policy of the U.S. to establish EE programs, but to support them through all education related fields and to encourage students to pursue environmental careers (NEEA, 1990). This would set the stage for state developed EE programs and non-profits to provide informal education as well. Though limited funding would actually go to institutions of formal education, funds given to providers of informal education do impact formal education as well.

Section 4 of the NEEA of 1990 also reestablished the Office of Environmental Education, but, as a change from the abandoned 1970 version of the bill, relocated control of the office to the Environmental Protection Agency (EPA) from the Department of Education (Bearden, 2002). Though the Office of Environmental Education was moved, an Interagency Committee on Education was established to work with the Department of Education (Marcinkowski, 1991). The National Environmental Education Advisory Council (NEEAC) was set as a federal task force, which according to the NEEAC Charter, available on the NEEAC website, would advise and consult with the administrator. Section 5 of the 1990 NEEA mandated an environmental education training program (Bearden, 2002). Under this the National Environmental Education and Training Foundation (NEETF) was established to improve communication between public and private partnerships in order to improve EE programs (NEETF website). The NEEA of 1990 set aside grants for providers of EE to provide for teacher training, international exchange programs, and curriculum development (Marcinkowski, 1991). Under section 6, the EPA was required to reserve a minimum of 38% of its environmental education funding for this grants program (Bearden, 2002). Grants were capped at \$250,000 and at least 25% of the grants must be less than \$5,000 meaning that the limited funds can be well distributed (Bearden, 2002). The Act also established six awards to be given by the EPA. These include the *Roosevelt award* for an outstanding career in EE, the *Thoreau award* for contribution to literature, the *Carson award* for contribution to print or broadcast media, the *Pinchot award* for education and training in forestry or resource management, the *President's Environmental Youth Award* for K-12

students who work in raising local awareness, and an awards program to give recognition to teachers who demonstrate excellence in promotion of EE (Marcinkowski, 1991).

Success and failures of NEEA 1990

The greatest success of the NEEA of 1990 was to establish a national environmental education policy. The set into public law the importance of environmental education. The move of the OEE from the DOE to the EPA was an interesting choice. It may have freed the NEEA of 1990 to avoid much of the struggle in education currently happening since the 2001 No Child Left Behind Act (NCLB) and the new move for a *Common Core*, a set of mathematics and English standards created by a coalition of municipal and national lawmakers in coordination with private education agencies, and the *Next Generation Standards* in science (which will be discussed further in chapter 2 of this dissertation), but it also weakened the ability of the NEEA to appeal to public and private school teachers. Data provided on the EPA website indicated that between 1992 and 2015, 55% of all grants were awarded to non-profits and only 10% awarded to pre-secondary schools (Figure 3). In the 23 years of provided data, the EPA indicated that non-profits, generally providers of informal education, received 1,961 grants totaling \$37,529,241; whereas all other sectors combined received \$31,227,243.

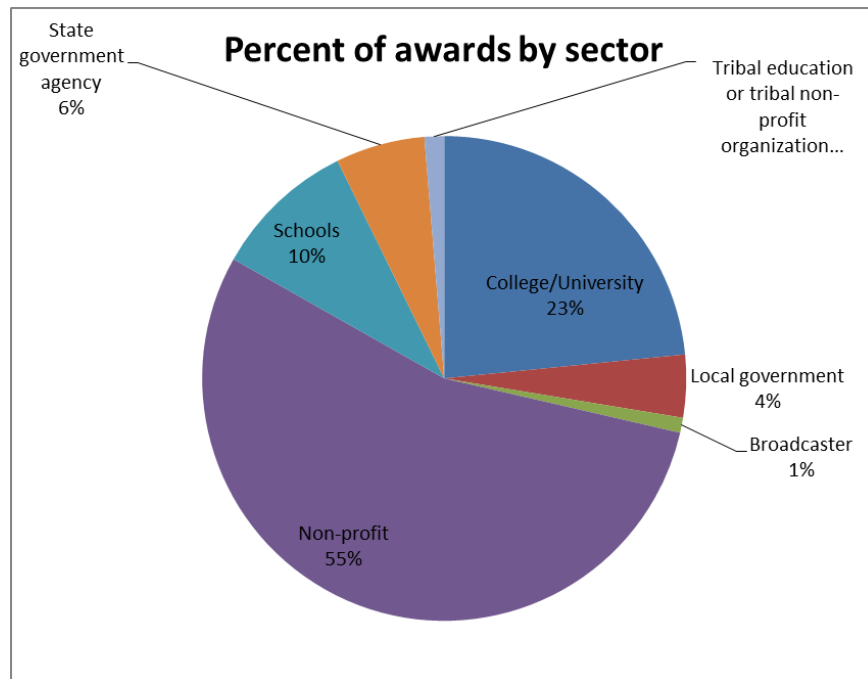


Figure 3: Percent of EE awards by organization from 1992-2015 (EPA).

According to the National Center for Education Statistics (NCES) webpage, between the years 1990 and 2013 (most recent data available) there were, on average, approximately 128,660 public and private, K-12 schools in the U.S. During this time, the EPA reported spending an average of about \$2,959,204.29 per year on environmental education programs. As schools have received only about 10% of grants, as shown in Figure 3, then that represents an average of approximately \$295,920.43 per year. As stated previously, the NEEA of 1990 had several goals for EE programs including teacher training and curriculum development. This amount of money would barely cover the cost of a single, moderately-sized (i.e. 1,000-2,000 participants), conference. If individual grants were equally distributed amongst all public and private schools, the EPA awarded

approximately \$2.30 of EE funding per school, per year, since 1992. This is a surprisingly small amount of money to be put towards EE programs. In fact, \$2.30 is not even enough money to provide each school with one dozen number 2 pencils - a pack of which currently costs \$2.69.

That being said, the large amount of money funneled towards informal education, in combination with the U.S. policy for EE established by the NEEA could lead to future partnerships between schools and non-profits. According to the EPA website, EE grants were distributed to programs addressing different environmental issues. These issues included: air quality/climate; biodiversity conservation; human health; pesticides; soil and agricultural impacts; solid domestic waste; management of toxic substances; water quality and science literacy. Figure 4 shows the total dollar amount of awards given by environmental issue, between 1992 and 2015, as reported in publically available data on the EPA website.

Programs addressing issues of biodiversity received 1,048 total grants (21% of all grants awarded) for a total of \$18,699,330; water quality received 1,242 grants (25% of all grants awarded) for a total of \$24,817,940. Air, human health, pesticides, agriculture, solid waste, and toxic substances only received a combined \$26,312,002. Interestingly though, awards given for air quality and toxic substances were both the largest amount awarded per grant at \$33,508 and \$26,134 respectively. However, both of these fields only comprised a combined 5% of awards given.

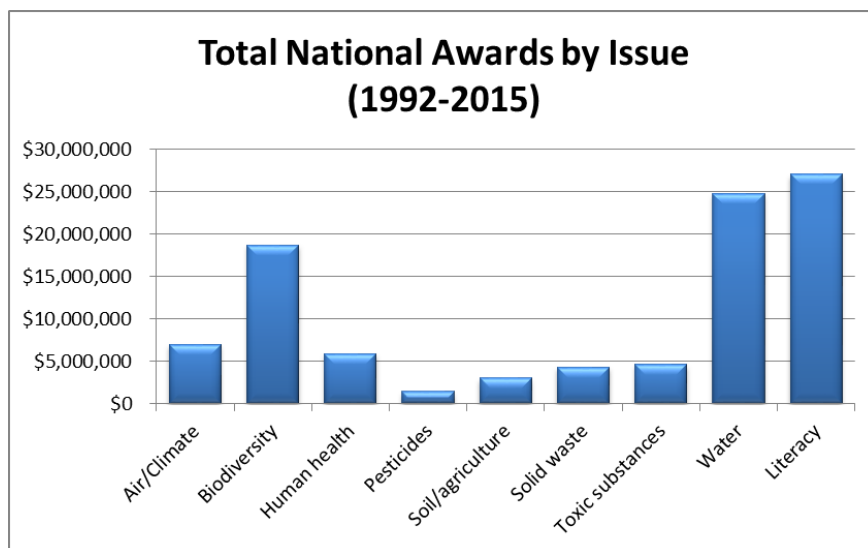


Figure 4: Total national awards given by the EPA to EE programs by environmental issue (EPA).

By far the most awarded area of environmental concern was scientific literacy. Literacy programs received 1,353 awards for a total of \$27,080,649 (of the \$96.9 million total awarded to EE programs between 1992 and 2015). This comprised 28% of all awards given, and also 28% of total money awarded. This represents a success in the delivery of NEEA funds. Increased literacy in science will impact all other realms of environmental education. If the goal of EE is to encourage proenvironmental behaviors, then the citizenry must be literate in order to understand these issues.

According to Bearden, in 2002 Congress appropriated \$77.9 million for the EPA's EE Program. At the time, the United States was about to enter the second Iraq War and federal funding for education programs became scarce, such was one of many issues with the 2002 No Child Left Behind (NCLB) Act. Regardless of insufficient funding, the

NEEA of 1990 established policy that would open the door to public-private partnerships, and state and municipal initiatives in EE. This national policy can be the pathway to inclusion of EE into all curricula and, eventually, to a better informed citizenry.

Timeline continued

In 2002, the *No Child Left Behind Act* (NCLB) shifted the focus of public education (Manna, 2011; Ravitch, 2010). The goal of NCLB was to increase accountability for student achievement, especially in reading and writing. There was a national push to make U.S. public schools the best in the world. This push was a failed endeavor from the start. The U.S. has a universal education system, in part due to the ESEA of 1965 and the CEA of 1969, along with other legislation such as IDEA (1990). The US requires *all* students to participate in schools and to take tests. Because of this, the U.S. will never outscore nations that have less inclusive education systems. Countries such as Finland and Ireland are often held as gold standards in education, but the each entire country has fewer public schools than New York City alone and include far more homogenized populations. The systems also have funneling mechanisms that exclude the poorer testing students at different check points. The U.S. system is good because it is all inclusive, but this will ultimately drive U.S. test scores down.

Regardless, the NCLB was established to hold schools accountable for making gains in education by meeting Adequate Yearly Progress (AYP) (Manna, 2011). Whether or not schools achieved yearly progress would impact federal and state funding (Ravitch, 2010). This set up failing schools for further failure because schools with more transient, lower-income populations, regularly scored the lowest on assessments and struggle to

improve. These at-risk schools would then be deprived funding for vital programs, supplies, and staff. Despite funding issues, success or failure of a school was placed on the individual teachers and departments within each school to show progress every year. Lipman (2013) discussed how the economic recession further exacerbated these funding short-falls. Increased financial constraints meant more teacher turnover and therefore more difficulty in achieving AYP (Lipman, 2013), thus amplifying the problem.

Through the last decade, financial and political struggles in education have put increased strain on programs outside the core curricula such as the arts and technology. The sciences may also be left by the wayside for more focus on reading and writing skills, even though reading and writing can be taught in all subjects. The Obama Administration instituted a renewed focus on developing a *Common Core* curriculum for reading, writing and mathematics; also further development of science, technology, engineering, and mathematics (STEM) courses (Ravitch, 2010). Though stalemates in funding social programs continue, this focus could further open the door to new public-private partnerships in EE.

Despite insufficient federal funding for all necessary programs, EE has gained national and international focus in the 2000s (Louv, 2005), including 2005-2014 having been declared the Decade of Education for Sustainable Development (DESD) by the UN General Assembly in 2002 (UNESCO, 2016). That being said, Huckle and Wals (2015) wrote a scathing review of the DESD, finding that the “Decade represents ‘business as usual’ in the end... [Education programs] failed through inadequate guidance, misplaced idealism or the censoring of more critical ideas and content...” (p.492). Hursh et al.

(2015) expanded on this censoring, recognizing that EE programs can be political in nature. Issues such as climate change, development, and resource management can be polarizing, making curricula difficult to create and implement. Though these should not be divisive issues, the U.S. political climate has been uniquely cold on teaching these so-called “controversial” scientific topics.

Sauvé et al. (2007) called the early 2000s a “new phase of institutionalism” (p. 34) for science education. Outdoor programs have been a gateway to introducing more comprehensive EE programs and are a great way to introduce EE without being controversial. Educators recognize the benefit of removing students from the classroom for experiential learning. This could be a great bridge to introducing EE into other curricula. The Chesapeake Bay Foundation (CBF) is one group that has continually pushed for more outdoor education, primarily in elementary schools (CBF, 2012). That being said, in an effort to be more politically correct, many programs have shifted focus from environmental issues to simple nature study.

Outdoor education is an important aspect of EE. Advocates claim that teaching children (any subject, not just science) in the natural environment greatly impacts both cognitive and social development (Louv, 2005). Richard Louv (2005), an outdoor education advocate, coined the term “Nature Deficit Disorder”, and has subsequently spearheaded a national movement to get children away from computer and TV screens, and back playing outdoors. The CBF has taken up Louv’s mantle and has twice pushed for a No Child Left Inside (NCLI) amendment to the 1965 ESEA. The 2011 NCLI Act was sent to the senate subcommittee on Early Childhood, Elementary, and Secondary

Education, but was not passed. The bill was designed to authorize grant money through the ESEA for states to develop independent EE programs (CBF, 2011).

NCLI of 2011 did not pass for two main reasons: (1) at the time, it was thought that there were sufficient funds already authorized through the NEEA of 1990. Though, as previously mentioned, these funds are not *entirely* sufficient. (2) The name NCLI was created as a play on words during rewrites of the NCLB. At the time, the *No Child Left Behind* Act (NCLB) was so unpopular that aligning the bill to NCLB, even in jest, would be the nail in the coffin for the bill. NCLI was designed to provide funding for voluntary reform. It actually would give some control back to the states for certain programs, but the title of the document did not convey this and opponents used the unfavorable mandates from NCLB to kill NCLI.

Several states such as Connecticut, Maryland, and Wisconsin have already successfully implemented NCLI state education plans and would be eligible for NCLI funds. States that choose not to participate would not be mandated to. Despite this, in a statement to the House Committee on Labor and Education (June 18, 2008), Representative Howard ‘Buck’ McKeon (CA) said, “We need to proceed carefully with any bill that expands federal intrusion into our schools, whether it’s environmental education or school construction.” This shows that he, and other law makers, did not understand the nature of the bill, nor what environmental education really is. McKeon went on to discuss how NCLI forces a liberal agenda into public curricula, again citing the teaching of “controversial” issues such as climate change. This bill was not a federal

mandate, but a funding opportunity, but the politicization of science blocked teachers and school systems from critically needed funding.

Though there are no national mandates in STEM, groups have been working on national benchmarks in achievement. The National Science Teacher Association (NSTA), along with the National Academies (Science, Engineering and the Institute of Medicine, The National Research Council, and the American Association for the Advancement of Science) have all partnered with State representatives to write and publish “Next Generation Science Standards” (NGSS) (Pratt, 2013). NGSS are not mandated curricula, but are a series of standards, or expectations, for American science students (NRC, 2012). The initial framework for the NGSS was released in July 2011 (Pratt, 2013), but the entire NGSS was not released until 2013. The standards were written to compliment *Common Core State Standards* mathematics and English language arts standards.

The *Common Core* was produced by the National Governor’s Association and subsequently adopted in 46 states and the District of Columbia to date. The *Common Core* and NGSS both represent a push towards national uniformity in education. The ultimate goal of NGSS is to ensure that students are informed and scientifically literate. “By the end of 12th grade, students should have gained sufficient knowledge of the practices, crosscutting concepts, and core ideas of science and engineering to engage in public discussions on science-related issues, to be critical consumers of scientific information related to their everyday lives, and to continue to learn about science throughout their lives” (p. 9, NRC, 2012). To date there is little quantitative evidence that core standards such as the *Common Core* or the NGSS have had serious impact on

student achievement of on EE. Most states only adopted these programs within the last two years and have not yet fully implemented them. Some groups, such as Nadelson et al. (2015), are establishing baseline data for future use.

A growing problem

Comprehensive change in EE is going to take a total societal paradigm shift.

There has been a growing trend to keep students indoors. This may be due, at least in part, to increased media attention on shootings, crime, and kidnappings. Mainella et al. (2011) reported that, in a study of 830 mothers, 70% of the women played outside when they were young, but only 31% allowed their own children to do so. Louv (2007) reported that, that only 6% of children, ages 9-13, play outdoors in a given week; and a study by the National Sporting Goods Association showed that bicycle riding had gone down by 31% since 1995. According to Louv (2005) and Ravitch (2010), the No Child Left Behind (NCLB) Act of 2001 provided justification for the wholly indoor lifestyle that students live today. Social media and internet access have exacerbated the problem, but also the current testing mentality of our school system.

Springs are silent again - though not from a lack of birds as Rachel Carson wrote, but silent from lack of children playing outdoors. Standardized, high stakes testing at the end of the school year, fear of the outdoors, and modern technology have all led to a generation of indoor dwellers. In 2005, Louv coined the term Nature-Deficit Disorder (NDD). NDD results from decreased outdoor play among children. Children need regular interactions with nature for proper social and cognitive development (Louv, 2005). This is not a novel concept. Education psychologist Lev Vygotsky (1930) published on the

importance of a child's surroundings in cognitive development. Vygotsky (2004 translation) wrote that children in adolescence incorporate their surroundings into their cognitive development. He presented the use of mimicry as a crucial creative and developmental outlet for students of all ages.

With regards to nature and environmental education, Wilson (1984) expanded on this concept of outdoor play coining the term *biophilia* to refer to humans' innate need to be a part of nature. In 1997, Kellert explained that "every person – rich or poor, educated or uneducated, city or country dweller – possesses this aesthetic connection to nature" (p. 39). Tracy (2012) showed that Kellert's (1997), Wilson's (1984), and Vygotsky's (1930) works all interplay in childhood development and need to be addressed in public education. Students must learn from their physical, natural, and social environment. Peer education fits hand in hand with outdoor or environmental education. The healthy social relationships that sprout from these interactions will help develop awareness and understanding of the complex environmental webs that surround all individuals. As early as the 1800s, Huxley (1854) critiqued that formal education had too much focus on reading/writing and 150 years later, modern education has still placed experiencing nature secondary to book-work. Because of this student development, emotional and physical, has suffered (Louv, 2005 & 2007).

Funding deficiencies have forced educators to be cleverer in how to incorporate issues of environmental concern into the classroom and into their students' lives. This will be addressed further in Chapter 2 of this dissertation. EE must be integrated among all curricula to stretch the limited funding and aid multiple content areas. As mentioned

previously, the NEEA of 1990 moved the OEE to the EPA, expanded grants established by the NEEA of 1990 to include teacher training and student fellowships, and established the National Environmental Education and Training Foundation (NEETF) (McCrea, 2006; Potter, 2009). These changes shifted responsibility of EE and literacy to the EPA, making them seemingly less accessible to public school teachers. Despite legislation and acquisition of funds, according to Potter (2009), only about \$6 million per year is actually used directly to fund EE programs in schools. Potter (2009) stated: “At this rate, we will never be able to achieve environmentally literate citizens who embrace the concept of stewardship and demonstrate environmentally aware behaviors and attitudes in their daily lives and their consumption patterns” (p. 24-25).

Conclusion

Issues of environmental degradation are not just issues of ecological science, but have broader implications in socio-economic environments. E. O. Wilson (1998) referred to this bridging of disciplines as *consilience*. Just as environmental issues span fields of study, so should EE. Working together, educators can combine concepts across core subjects. For example, freshman biology classes can share vocabulary with English classes so that students learn the same words in multiple contexts rather than study each subject in isolation. Literature classes should teach Rachel Carson, government classes should teach the Stockholm conference or sulfur trading, and math classes can work with data on sea level rise or biodiversity changes.

Students benefit from bridging curricula and through access to nature (Kellert, 1997; Louv, 2005; Wilson, 1984; and Vygotsky, 2004). Such experiences must not be

limited solely to science courses. EE has separated from SE because it focuses on behaviors and values rather than on rote facts (Wals *et al.*, 2014) and this natural separation can be used as an advantage by incorporating the concepts of EE across other disciplines. Just as literacy and mathematics are taught in the science classroom, EE should be taught in literature and math classrooms. Environmental education can tie together all core subjects to produce a balanced, consistent education that presents environmental issues to students on multiple fronts.

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CHAPTER TWO – BARRIERS TO INCLUSION

Introduction

In 1990, environmental education (EE) would be written into United States public law - *P.L. 101-619* specifically states, “It is the policy of the United States to establish and support a program of education on the environment” (Section 2b). By the original definition of EE, established by Stapp et al. (1969), programs should motivate the citizenry to action (p. 34). This means a focus on changing attitudes and behaviors rather than on scientific content knowledge, as is the focus is in more traditional science education (SE) curricula (Wals et al., 2014). As shown in Chapter 1, EE is not SE and due to modern testing based school culture, has been growing further and further from integration into SE curricula. It has proven difficult to include EE into K-12 public schools in the US for three specific reasons: (1) EE is interdisciplinary by nature making it difficult to teach, and assess, in an introductory science course; (2) EE topics can be controversial in the minds of some; and because of these reasons (3) EE programs are not well funded.

Barrier 1: Environmental education is multi-curricular

Environmental science itself bridges many fields of study so, therefore, EE does not lend itself to just one realm of science. Environmental science is typically included in biology curricula when ecology is addressed, but these are two different topics. In 1998, ecologist E.O. Wilson coined the term “*consilience*” to refer to the interdisciplinary

nature of issues of environmental studies (Wilson, 1998), specifically in reference to the politics of the issues of environmental concern. Wilson addressed established boundaries between realms of study: he focused on environmental policy, ethics, social science, and biology. He wrote that in traditional studies, there are defined boundaries between these fields, but issues of environmental degradation cross these boundaries. Wilson (1998) described environmental issues as a moving target, seen in Figure 5.

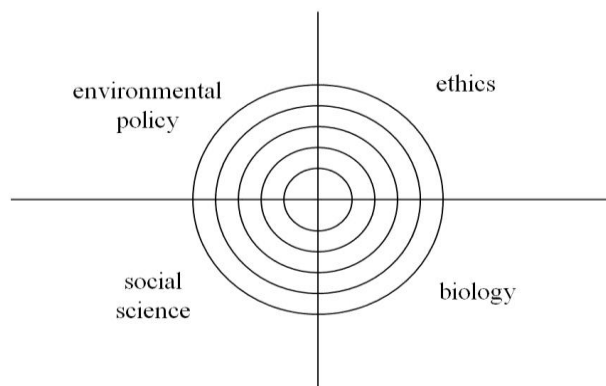


Figure 5: This Figure shows interrelated topics that are needed to address issues of environmental policy. From Wilson (1998, p. 10).

Issues of environmental policy border on issues of ethics and social science (Wilson, 1998). For example, forestry is regulated by the U.S. government, making it a resource management, policy issue. Deforestation and habitat destruction are ethical issues, but also potentially a social science issue if the resulting land is to be used for agriculture, providing food and job opportunities for local people. Wilson (1998) created a target around the boundaries between these fields of study showing that the closer to the

center of the target one focuses, the better issues of environmental degradation can be addressed in a political arena. The same must be true of EE.

When teaching about issues of environmental concern educators must address the ethical, biological, and social impact of those issues. However, current public school curricula silo each of these disciplines and has locked EE into the natural sciences, segregating it from both the physical and social sciences (or humanities – how frequently are environmental issues and society changes discussed in history or civics classes?). As discussed in Chapter 1, in the late 1800s, the National Education Association (NEA) held a series of conferences designed to assess methods of instruction and testing of science education (NEA, 1893). Our public schools systems still largely follow this antiquated line of thinking. “Schools today, more than any other institution, are remarkably similar to how they were organized and how they looked 150 years ago” (Nelson & Cassell, 2016, p, 50). At the time of the NEA conferences state run, public schooling was not compulsory in the United States so the NEA worked with college admission boards to create some semblance of a standard, national curriculum. It is time to update these suggestions and take a broader approach to education in general.

Bowers (2016) wrote that “ecological intelligence requires the broadest form of relational rather than compartmentalized thinking” (p. 65). Here Bowers speaks specifically about ecological issues, such as how the warming of the oceans will impact coral, but this itself is compartmentalized thinking because the loss of coral will impact fish nurseries and, therefore, have an economic impact on global fisheries, let alone the major impacts coral loss will have on tourism. These are the broader implications of

issues of ecological crisis that are too often pigeon-holed, by being taught only in introductory biology courses. The misconception that issues of the environment are solely issues of ecology and, therefore, should be taught as natural sciences and not the physical sciences, means that citizens of the U.S. have no larger frame of reference for issues such as climate change. In fact, over the past decade more and more U.S. citizens question the human impact on a warming climate (Dunlap et al., 2016; Boggs, 2013). Though this may have more to do with political polarization due to a lack of understanding of the issues by both the public and the legislators they elect (Dunlap et al., 2016). This lack of education creates a positive feedback loop promoting further misunderstandings.

At the time of the NEA conferences, biology courses focused on Natural History, but now these courses have grown and today consist primarily of cellular biology and genetics; fields that did not even really begin in the scientific realm until the early 1980s, when Polymerase Chain Reaction (PCR) was invented. The focus on microbiology leaves little room for larger issues of the natural world, such as those included in the greatly stunted ecology unit. In Virginia, the state that this researcher works as a public high school science teacher, the word “ecosystem” only appears on objectives 8b-e, 4 of the 53 total objective listed for high school biology (VDOE, 2010). Only 1 objective (8d) specifically addresses human impact. Conversely, 33 of the 53 indicators address scientific investigation or cellular biology.

Environmental topics are so far removed, and each contain so much content, that even the most prestigious public education programs, such as Advanced Placement (AP) and International Baccalaureate (IB) programs have removed environmental science from

their biology courses and offer it as a stand-alone course. The state of VA has not adopted the Next Generation Science Standards (NGSS). The NGSS Core Idea 2 for Life Sciences (LS2) does specifically address issues of human impact on the environment. NGSS sets knowledge objectives for different time points in a child's education, called Grade Band Endpoints; meaning that students are expected to know certain material at the end of a given grade point. Core Idea LS2 focuses on Ecosystems. This is 1 of 4 Core Ideas, meaning that there is a greater amount of time recommended for ecosystems, but, again, only one subgroup, LS2.D specifically mentions human interaction with other organisms (NRC, 2012). That being said, the NGSS does address human impact in other ways and even states explicitly that issues of the "environment, energy, and health – require social, political, and economic solutions that must be informed deeply by knowledge of the underlying science and engineering" (NRC, 2012, p.7),

Environmental science does lend itself to inclusion into all of the other sciences, especially higher level courses. For example, the IB Physics curriculum contains an optional unit on nuclear energy. Alternative energies are an international issue of environmental concern. The study of these energies is one aspect of EE that would lend itself well to inclusion in a chemistry or a physics curriculum. In 2016, about 65% of the power in the United States was generated by fossil fuels (EIA, 2016). Such power sources are generated by combustion reactions, a topic taught in introductory chemistry courses. In fact, molecular collisions and the conversion of potential into kinetic energy is explicitly stated in the PS1.B (National Research Council, 2012).

Along the same lines, the conversion of thermal energy into electrical energy can be calculated using laws of conservation of energy, which are taught in introductory physics and chemistry courses. The concepts of nuclear fission, nuclear fusion, and beta decay are also explicitly listed as Grade Band Endpoints in the NGSS, PS1.C. Earth science courses do teach mineral mining and alternative energies, but as mentioned previously, these are not often considered standard courses in a K-12 public science track. As stated in Chapter 1, the NGSS are independently-created national standards for scientific learning in public K-12 schools. The National Research Council does not keep a formal record of how many states have adopted the NGSS, but according to the National Association of State Boards of Education, as of the 2016-2017 school year, 18 states and the District of Columbia have adopted the NGSS.

NGSS encourage cross-curricular collaboration of science teachers, but for teaching certification in all states, teachers of each of the core subject must pass a competency exam in that field for endorsement. Most states accept the Electronic Testing Service's PRAXIS exams (available at ets.org), but some states, such as Massachusetts and Texas, have their own endorsement examinations. This does ensure that teachers are knowledgeable in their specific content area, but also means that they are siloed into teaching only one of the sciences, and may not be comfortable teaching others. Physics teachers, by definition, are only endorsed to teach physics. EE is holistic in nature, but the teacher certification process is not. Physics teachers may have little to no background in environmental science due to the specificity of science programs and, therefore, not feel comfortable incorporating a unit on alternative energy resources into the curriculum.

As stated previously, biology is the most likely field to include EE into a program, due to the conflation of EE with ecology, but even biology teachers may have little background in environmental science, if they were trained in a university program designed to prepare students for the medical field, for example

Confounding this further is the modern testing culture. Teachers are constrained by testing standards which means they often have little room to incorporate new topics into their curricula (Saylan & Blumstein, 2011). Adding more content to already straining curricula, would increase teacher stress and overall dissatisfaction. The teachers have to want to incorporate this new learning. Teachers have a limited time to cover a wide breadth of state required content. As discussed in Chapter 1, in some school systems, student achievement on end of the year and summative assessments, impacts teacher employment, as well as school funding and even student enrollment. Adding new content to an overextended curricula, therefore, is not a good way to include EE into K-12 curricula. EE must be integrated into materials already taught, and be spread across multiple subjects to reduce the individual load.

Solution: Include EE in across multiple sciences and beyond

As discussed in Chapter 1, EE has fragmented from SE -particular biology- because of the focus on behavior and attitudes (Gough, 2013; Wals et al., 2014). This has made it difficult to include EE into any specific science curriculum. As discussed in the previous section, EE lends itself into inclusion across the sciences, reducing the load of natural science teachers. However, Wilson (1998) wrote, “In education, the search for consilience is the way to renew the crumbling structure of the liberal arts” (p. 12). This

means bridging curricula so that students have a comprehensive understanding of the world. The current system trains students to study each subject in isolation. But the separation of EE from SE may actually present a great opportunity to expand EE and use it as a unifying, integrating, bridging concept across courses.

The easiest of alternative subjects in which to incorporate environmental issues would be mathematics through statistics, probability, and logic. Math classes could examine real data from scientific reports, such as figures from the International Panel on Climate Change. Students could graph sea-level rise or calculate Simpson's biodiversity index to compare the diversity of biodiversity hotspots. Basic population calculations are taught in environmental science courses and require no more than a basic Algebra background. Using such real world examples of how to utilize mathematics would allow students to do applied mathematics and further increase their understanding of both math and the environment.

One typical case-study explored in environmental science courses is that of chlorofluorocarbons (CFC) and their effect on the hole in the ozone layer. In order to understand this complex atmospheric interaction, one must attain a high level of chemistry. But then to apply that to how increased ultraviolet radiation impacts oncogenes in the human melanocytes or basal cells to increase rates of skin cancer, one must understand genetics. This can be taught in an AP or IB course because students would have a requisite science background. However, this may be more difficult to explain in an introductory biology course. If limited science background is assumed, as is when teaching an introductory biology course with no prerequisites, then the story of the

development of the Montreal Protocol - the international agreement to ban the use of CFCs - and subsequent treaties on regulating ozone-depleting substances such as CFC, might be more easily taught through Government or history classes.

The Montreal Protocol is one good example in which all United Nations (UN) nations identified an environmental health concern, agreed to do something about it, and then actually did it (Andrews, 2006). As of October 25, 2016, Bryan Johnson, Project leader of the NASA-NOAA joint collaboration to monitor polar ozone, stated that “the rate of ozone loss a bit slower than we’ve typically seen...This is what we would expect to see in years to come as a result of the Montreal Protocol and international efforts to control ozone depleting chemicals” (NASA, 2016). This makes the Montreal Protocol great fodder for a “model UN” type lesson in a social science course. The UN website provides many of the original documents and discussions in the decade of preparation leading up to the Montreal Protocol and subsequent treaties. These could be included in a lesson about the use of primary versus secondary documents in research, to connect to writing classes as well.

Environmental scientists do occasionally write great works of literature that could be studied in reading/writing courses. For example, Rachel Carson’s 1952 book *The Sea Around Us* won the National Book Award for Nonfiction and could be a great way to bridge environmental science into a reading or literature course. Along the same lines, many U.S. students may be able to recognize Disney’s iconic Epcot geodesic dome, but many may not know that the ride inside is actually called Spaceship Earth, in recognition of R. Buckminster Fuller. Fuller actually held the U.S. patent for the geodesic dome in

the 1950s and his essay, *Operating Manual for Spaceship Earth* views the Earth through an engineering lens, explaining how each of the operating systems on our planet are interrelated. Not only is his essay fairly short (a little over 100 pages), it is available for free online and, therefore, would not cost teachers anything to attain a class copy.

Garrett Hardin's 1968 essay *The Tragedy of the Commons* is also available for free online through the Garrett Hardin Society's website (<http://www.garretthardinsociety.org/>) and could create interesting discussion in an economics or government class. Hardin wrote on the concept that there are common resources available to all, but the tragedy is that they can be used up by individuals in the absence of mutual agreements. This reading fits easily into any subject studying capitalism, resource use, or other issues of governance. *The Tragedy of the Commons* could also be used to teach "the prisoner's dilemma". The prisoner's dilemma is an introductory example of game theory: explaining how individuals may act in one's own interest even if working together would be more successful. This could be addressed in psychology or in upper level math courses.

Thinking outside of the box in other subjects can help teachers invent creative ways to teach EE in all subjects. AP environmental science courses often take part in trash collections. Some schools use collected trash for competitions repurposing the waste into boats, houses, or even visual art. This should be extended to other curricula. Engineering courses could look into innovations in developing countries that use recycled plastics to build homes - such as the Conceptos Plasticos company in Columbia that compresses waste plastic and rubber into building blocks for housing. According to the

Conceptos Plasticos website, the construction of such recycled homes is 30% less expensive than other rural methods of construction. This company also claims that in 2015, they built homes for 42 families that reused 120 tons of plastic. Visual art classes could further explore waste in the students' own homes and repurpose waste into art. This would increase student awareness of just how much discarded material they generate, a major issue of environmental concern, through the lens of a subject outside of the sciences.

History classes in the US often study “the Dust Bowl”, an ecological nightmare of the early 1930s in which mismanagement of cropland combined with a drought to cause massive dust storms (Botkin & Keller, 2007). Students learn how this environmental disaster added to the stressors of “the Great Depression” of 1929-1939. In music classes, folk music is studied, but particular focus could be put on artists such as Woody Guthrie who spoke directly about the environmental impact of the dust in songs such as “The Great Dust Storm”. The U.S. Library of Congress actually has an online collection of “Voices from the Dust Bowl” (<https://www.loc.gov/collections/todd-and-sonkin-migrant-workers-from-1940-to-1941/about-this-collection/>) with articles and recordings. This is a resource for cross-curricular projects between history, music, and science classes. The Library of Congress also includes photographs from this time period. These could be studied within a photography or film course.

There is an emerging field of photography in environmental science called conservation photography. When studying film or photography students should be encouraged to capture the natural world. James Balog is a photographer that started a

project called the *Extreme Ice Survey* (<http://extremeicesurvey.org/>) whose goal is to bridge art with science through the photography of glaciers and changing ice flows around the world (EIS, 2014). Studying Balog's work capturing time-lapse and even his work with night footage, as arctic regions have extended times in darkness, would be beneficial for photography students. The same production team also recently released a documentary called "Chasing Coral" (<https://www.chasingcoral.com/>) in which photographers captured real-time coral bleaching events. Underwater photography could be an interesting way to blend physics of light with the visual arts and EE. The National Geographic (NatGeo) *Photo Ark* is another interesting project (<https://www.nationalgeographic.org/projects/photo-ark/>). This is an international effort between National Geographic and photographer Joel Sartore, who seeks to "create intimate portraits of the estimated 12,000 species of birds, fish, mammals, reptiles, amphibians and invertebrates" (National Geographic, 2017) that are currently in zoos and similar facilities around the world. Such projects are clearly issues of environmental science, but lend themselves neatly to achieving the goals and standards of curricula outside of science.

The AP language exams contain a speaking portion in which students must discuss current events. Even introductory foreign language classes could use such a model to study issues of environmental degradation and response. For example, the 2015 Paris Agreements could easily be taught in a French class. Many South American - Spanish-speaking - countries have been successful in international carbon trading and the 2018 G20 conference, during which climate change will come up again, will be held in

Buenos Aires. Inclusion of the international nature of issues of environmental concern into global studies courses will help students experience these issues across fields of study, to further understand them.

Wilson (1998) wrote: “There is only one way to unite the great branches of learning and end the culture wars. It is to view the boundary between the scientific and literacy cultures not as a territorial line but as a broad and mostly unexplored terrain awaiting cooperative entry from both sides” (p. 126). Many public K-12 courses are separated by content area with little cross collaboration. Professional Learning Communities (PLC) focus on sharing ideas within content area using a constructivist approach to collaboration (Hord, 2009), but these rarely branch out to multiple subject areas. Administrators and managers of public education programs should facilitate professional development opportunities across academic boundaries. This would benefit teachers in that they would have a more rounded understanding of what was being taught in their own schools. This would also benefit students, in that they would have a more consistent educational experience, by studying the same issues from multiple angles.

As stated in the previous section, testing based culture is a barrier to inclusion of EE. There are few definitive studies linking EE programs directly to increased performance on standardized exams. One recent study did find a direct improvement in reading, writing, and math scores of students who participated in an extensive outdoor education (OE) program as compared to the students’ peers who did not participate (Quibell et al., 2017). However, there were likely other interventions and differences in curriculum design, between the OE program and standard educational program that could

account for these changes. One could also argue that this could be a ‘chicken and egg’ situation, meaning that those students driven enough to participate in a strenuous OE program may already perform better in school and have a level of interest in the natural world. Either the students score better because of the program or the students in the program will score better regardless of intervention.

Other studies have linked the amount of time that students pay attention to a given task with OE programs (Ulst et al., 2017) and positive effects on mental health (Becker et al., 2017; Bowen et al., 2016). OE programs are an important part of EE and will be addressed further in Chapter 3. It is important to understand that improving the social, mental, and cognitive well-being of a student is essential to overall student growth, and likely impacts student achievement. It is not beyond the stretch of the imagination to assume that increased focus and psychological stability are both important factors in academic success. There are many ways to incorporate EE into all aspects of education to the benefit of the student, without overburdening individual content teachers.

Barrier 2: EE topics can be controversial

Emerging issues in science, and especially the environment, can be politically polarizing because environmental issues cross multiple boundaries, they often cross into economics and, therefore, politics. Miller (2012) wrote: “Although few adults could have studied stem cells, climate change, or nanotechnology during their formal schooling, all of these issues have become a part of the current political discourse in the United States” (p. 224). These are all hot-button issues requiring government discourse, but also because these are new issues that the individuals on regulating bodies, and their constituents, may

have no educational background in. Mitch McConnell, the current Senate Majority Leader, was born in 1942, meaning that he was in high school classes prior to James Watson and Francis Crick's winning of the Nobel Prize for the discovery of the DNA double helix in 1962. The Senate Majority leader likely has not formally studied science since the 1960s. Tectonic plate theory was not even accepted until 1968 (Chang, 2011), when Mitch McConnell was 26 years old. This is not only true of our political leaders, but of educators themselves. Educators have mandatory continuing education requirements for licensure, government officials, and the general public, do not have such requirements and may have little background on emerging issues.

To address issues that cross boundaries of study, educators and students alike need to have reasonable background knowledge in multiple fields. This may explain why some of these issues can be glossed over in classes. Over 10 years of experience of teaching high school environmental science in public schools has demonstrated that many students, and teachers, confuse the issues of the hole in the ozone layer with climate change. One study done in 2004 found that 69.76% of 172 primary education majors in their first year of the university program, believed that the hole in the ozone layer was the cause of climate change, while only 51.16% listed the "greenhouse effect", and 16.27% listed car emissions (Papadimitiou, 2004). Ten years later, Mun et al. (2014) found similar results, stating that high school students confused climate change with global warming and depletion of the ozone layer. This is because the two topics are usually clumped together as "atmospheric issues", and the educators may not be fully understand the differences themselves. If the general public does not understand these complex

issues, and they have a high impact on economics, as climate change does, these issues become controversial to teach in public schools.

Some argue that students should not be asked to make judgments, or take stands on science that they do not understand (Hungerford, 2010). They believe it is the educators' role to present the facts and facilitate learning about the issues at hand, not to promote debate over topics. Supporters of this mode of pedagogy believe that the environmental educator should not also be an environmentalist: that EE should focus only on learning about the environment (Hungerford, 2010). Opponents believe that it is the science educators' duty to promote responsible behavior (Hungerford, 2010).

Environmental educators should also be environmentalists, proponents for a clean and healthy ecosystem. Though historically not entirely accurate, in the current political climate no rational person would accuse an oncologist of bias if they told a patient to quit cigarettes, but environmentalists are called "alarmist" when they suggest that citizens make an attempt to reduce consumption of fossil fuels. Myron Ebell, one of President Trump's first picks for the head of the US Environmental Protection Agency, publically called the UK Chief Scientist, David King, "an alarmist" for his views on climate change (Griffin, 2017).

There are many factors that may make issues politicized, for example, there are strong predictors between religion and views on homosexuality and same-sex marriage or on evolution (Keeter et al., 2007). However, this is not the case for climate change. Keeter et al. (2007) and Dunlap et al. (2016) both found much stronger indicators between political association and attitudes towards climate change than religious beliefs.

Political affiliation may be a hard indicator to overcome, but Shi et al. (2016) found perceptions on climate change may change with education level; “knowledge about the causes of climate change was correlated with higher levels of concern about climate change in all countries” (p. 761). This is one issue in which better education, increasing the overall public knowledge, can make an issue less divisive.

Climate change is one of the largest environmental issue facing humanity, but it is certainly not the only environmental concern that can be polarizing. Resource management and use of public land use are also hotly contested issues that could cause controversy when taught in a public school. As this is being written, there is national news focus on the Clive Bundy trial. Bundy is a Nevada rancher who had an armed standoff with law enforcement in 2014 over cattle grazing fees (Ralston, 2014). Bundy’s two sons were also recently in the public eye when they joined with several members of local militia groups to occupy the Malheur Wildlife Refuge in Oregon (Berry, 2016). They did this to “raise awareness” of federal control over public lands and the struggles that ranchers have over land-use permitting.

Because of the polarization and controversy related to this case, teachers in Nevada or Oregon may currently be reticent to discuss issues of land management in class for fear of parent retaliation. However, if students cannot freely discuss issues in class, they will never learn how to have rational, public conversations about these issues. If students studied *the Tragedy of the Commons* in other classes, as suggested previously, they would have a firm background in discussing the consequences of individual claims

to public lands. Students must learn how to debate controversial issues in order to become active participants in modern democracy.

Solution: Teach engagement

Public education should inspire citizens to be active in their communities, be it local, national or global. “Public schools exist to serve public goals... U.S. public schools were established to reduce the political and social unrest by teaching future citizens a common set of political values” (Spring, 2004, p. 7). If the true goal of public education is to produce well informed citizens who can contribute to society, then promoting environmentalism is an imperative aspect of that (Hungerford, 2010). It is important to note that EE is a civics education and not propaganda. EE serves public goals by increasing awareness of students’ personal impact on the world around them. EE includes ecological health, but also issues of human health, international economics, and political history (Bowers, 2016). This allows students to view themselves as part of a greater whole rather than as individuals.

Bowers (2016) suggests that it is the individualistic view of the world that is currently promoted in education that drives students to view themselves as separate from the environment, writing; “The tragedy of mindless environmental degradation can in part be traced to how public schools and universities perpetuate the myth of the autonomous individual who has certain proclivities but still exempt from being held responsible for the decline in democratic decision-making and in the viability of natural systems” (p. 18). Bowers (2016) blames the roots of the word “individualism” for the perpetuation of a Western, Christian paradigm that the individual is responsible for

his/her own morality. This is good conceptually, but does not necessarily fit into the more modern ideal of being an active, global citizen who must work across borders and cultures. Nelson & Cassell (2016) suggest that this multiculturalism is essential to addressing international issues. Students must understand that they are part of the greater web of life through exposure to it (Louv, 2005; Wilson, 1984).

Both Wilson (1984, 1998, 2002) and education psychologist Lev Vygotsky (1987, 2004a, 2004b) wrote extensively on how scientific reasoning and the logic of the scientific method can be used to solve problems in any discipline. Jackson (1857) advocated for the teaching of scientific investigation as a standard of learning for all students. Such lessons encourage students to think critically about their surroundings and to search for knowledge independently through rational thought (Dickinson & Bonney, 2012). Such learning is paramount for modern students who are constantly bombarded with information from newsfeeds and sources real and false. Bowers (2016) suggested that such unfettered access to technology is not only a security risk, but a detriment to the natural environment. Until pedagogy and practices can be utilized in a successful manner, efficacy of EE programs will continue to falter. Kim (2012) wrote; “Scientific communication will be more successful when it talks about problems and issues... Science needs to understand the public if the public is to understand science” (p. 377). One way to engage the public in their local environment, and incorporate a novel use of technology is through “citizen science” projects.

Citizen science

Citizen science is a relatively new term, but not a new concept. It is the “public participation in organized research effort” (Dickinson & Bonney, 2012, p. 1). Citizen scientific data collection has been occurring since prehistory. Ancient astronomers, herbalists, and other naturalists were the earliest contributors to the scientific body of knowledge. Benjamin Franklin was not a professional scientist, but was a pioneer in the discovery of electricity. Gregor Mendel was a monk when he studied heredity. The concept of citizen science is that groups of citizens can work together to collect large bodies of data. In the US, lighthouse keepers began collecting bird data as early as 1880 and the National Audubon Society launched annual Christmas bird count in 1900 (Dickinson & Bonney, 2012). Current programs are efficient ways to engage the public in the scientific process and introduce people to the world around them in a new way while working within the time and funding constraints of a public education system. Whether identifying invasive species or monitoring water quality data, these public projects are an excellent ways to give people a sense of ownership in the scientific research happening around them; for the individual to be a part of a greater whole.

One very successful example of a citizen science project is the Great Backyard Bird Count (Chu et al., 2012). In 2011 more than 65,000 amateur bird watchers across North America identified nearly 11.5 million birds and 596 different species (Chu et al., 2012). This data is used to catalogue species around the continent. There is no way that an individual science team could collect such large amounts of data and it actively engages the public in the scientific process. This specific project was successful for multiple reasons. First, there was a lot of media interest in the event. Chu et al. (2012)

reported that there were more than 1400 articles about it in mainstream media in 2010. The event organizers, the Cornell Lab of Ornithology, also made use of ambassadors to go talk to different school communities, nature centers, and birding organizations. Lastly, Chu et al. (2012) credit the ease of access to the website for the event with helping collect the extensive amount of data. Programs such as this would be a great way to engage students in larger scientific projects and bring citizen science into the classroom.

Citizen science projects are good ways to kill two birds with one stone. Some states and municipalities have curricular requirements that would lend themselves well to participation in such projects. For example, in Virginia, the Department of Environmental Quality has authorized the 2014 Chesapeake Bay Agreement with the goal to “Enable every student in the region to graduate with the knowledge and skills to act responsibly to protect and restore their local watershed” (VADEQ, 2017). This will be achieved by providing every VA student with a Meaningful Watershed Educational Experience (MWEE). What each MWEE looks like is left up to individual school districts, but these could easily involve cross-curricular, citizen science projects. For example, the National Science Foundation (NSF) has joined with a non-profit group called the Biological Sciences Curriculum Study (BSCS) to create a free online resource called *fieldscope* (<http://www.fieldscope.org/>).

Fieldscope is a citizen science program that hosts multiple national projects including, *BudBurst* (<http://budburst.org/>), which tracks budding and leafing events nationally, *FrogWatch* (<http://frogwatch.fieldscope.org/>), which teaches students about amphibian conservation through frog and toad calls, and maintains multiple projects

relating to watersheds including the Chesapeake. To address MWEE, VA students could use the free online Chesapeake Bay software hosted on the *fieldscope* website. This project allows participating members to access public data from the Chesapeake Bay Foundation and the NOAA Chesapeake Bay Office. NOAA collects data from multiple locations around the Chesapeake waterways and much of this data is uploaded to *fieldscope*, or can be accessed directly through NOAA's free smartphone application, *Smart Buoy* (<https://buoybay.noaa.gov/>). *Smart Buoy* allows users free access to data from 10 active buoys around the Chesapeake area.

Students can use archived data in *fieldscope* to investigate their own watershed. They could work with a writing or history class to investigate how changes in temperature and pH of the bay, or its tributaries, has affected oyster and crab catches. They could also use the data to investigate how major flooding events has impacted the industries by cross referencing with weather data. This would be a great way to incorporate EE into multiple subjects while allowing students the opportunity to explore their own geographic area through relevant, real-life data. *Fieldscope* also allows members to input their own data into the geographic information system (GIS) mapping software. This aspect is not a free service, but is inexpensive and one account would do for the entire class. Students could, for example, conduct a stream study in their neighborhood and collectively input data to compare to the remote, downstream sensors in *Smart Buoy*. This is a great way to get students out of the classroom while integrating EE and technology.

It is important that students understand how their actions can have global effects. Ferreira (1998) suggested that hikers do not like trails that show signs of human impact. This is because people, as a whole, realize that human involvement in nature causes damage. Using outdoor based curriculum like Ferreira's trail-based learning, or a "gardening pedagogy" such as that described by Howes et al. (2009), and further discussed in Chapter 3, introduces nature back into the lives of a generation of students who have been locked to smartphone and computer screens. Even in the early 1900s, psychologist Lev Vygotsky (2004b) wrote that student cognitive development is linked to play, mimicry, and observation of nature. Louv (2007) linked the amount of time students spend in front of screens to increased rates of Attention Deficit Disorder (ADD). This may be a controversial conjecture, but there is something to be said for student engagement into the world around them rather than the screen in front of them.

That being said, harnessing students' interest in computer technology can link the students to real-world, global science. *Fieldscope's* use of GIS to map watersheds is one example. Science and technology education can go hand-in-hand if the technology is used for course enrichment rather than a crutch for educators who do not understand the content they teach. Both Moore and Huber (2001) and Moseley et al. (2010) studied an online citizen science program similar to fieldscope called *The Global Learning and Observation to Benefit the Environment* (GLOBE) run by NASA and supported by NOAA and NSF (<https://www.globe.gov/>). Studies indicated that some educators may rely on programs like GLOBE to teach students the subject matter that the teachers, themselves, are unfamiliar with (Moore & Huber, 2001; Moseley, 2010).

GLOBE is intended as a tool to help students apply their knowledge of the environment and to connect them with scientists in the field. This makes the curriculum relevant and exciting. Using citizen science software such as this, students have the chance to contribute to actual research and to real publications. It is noted - with a touch of irony - that such programs intend for students to experience their world around them are accessed indoors, through a computer screen. Internet based curriculum can be beneficial to an environmental lesson as long as it is not the crutch of the lesson and is part of a greater project, otherwise it may detract from the learning experience. Such internet based projects must be accompanied by some meaningful outdoor experience, which will be addressed further in Chapter 3. Citizen science is a great way for students to be involved in large scientific missions and to learn data collection techniques through large scale projects that often require little to no funding from the school.

Barrier 3: EE is underfunded

Funding is the most important, barrier to implementation of EE, or of *any* new educational program. The majority of funding for public education comes from state and local governments as per the 10th amendment of the U.S. Constitution. Figure 6: Governance of secondary and elementary (K-12) education shows the hierarchical structure of governance for elementary and secondary education.

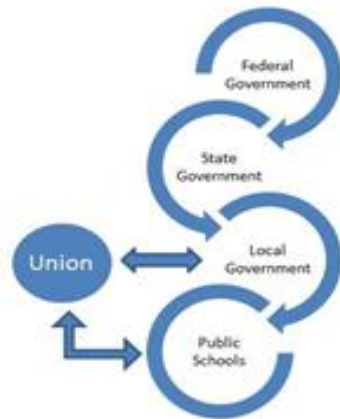


Figure 6: Governance of secondary and elementary (K-12) education

In K-12 education, federal mandates from legislation such as the 1965 Elementary and Secondary Education Act (ESEA), No Child Left Behind (NCLB) of 2001, or the Individuals with Disabilities Education Act (IDEA) of 2004 set federal guidelines and funding that trickle down through the system. As shown in Figure 6, state legislation works within Federal mandates to create standards. The local government then works with unions and/or directly with public schools to implement programs that address these mandates or standards. NCLB has put increased pressure on teachers because of this accumulation of Federal standards down the chain of governance, without adequate funding for implementation (Manna, 2011; Ravitch, 2010). Ravitch (2010) wrote, “What was once the standards movement was replaced by the accountability movement. What was once an effort to improve the quality of education turned into an accounting strategy: Measure, then punish or reward” (p. 16). This is indicative of the evolving federal role in

K-12 education. It is difficult to advocate for increased federal funding without school accountability, but that is what is necessary in the current system.

In following through the timeline of K-12 education, traditionally, U.S. schools were locally managed and taught within each community. In 1791, the 10th Amendment (to the US Constitution) delegated governance and funding of public education to the states. Locally enforced governance would not change for more than 150 years. In 1840, Horace Mann wrote on the role of public education (Spring, 2004). Mann disagreed with the Jeffersonian ideal that the goal of public education should provide the basic skills for citizens, as was discussed in the previous section of this paper. Mann believed that education should include ethics and morals (primarily religious in the case of Mann) (Spring, 2004).

In 1868, the 14th Amendment added the legal concept of equal treatment under the law and it was because of this that, in 1895, we saw the first major Federal involvement in public K-12 education. The court case of Plessy v. Ferguson instituted the federal mandate of separate, but equal schools for students of color (Spring, 2004). This ended up having major ramifications in education and would not be overturned in the 1954 Brown v. Board of Education case when it was found that separate is not equal (Spring, 2004).

The Elementary and Secondary Education Act (ESEA) of 1965 not only introduced core curricula, but included Title I funding for equity and resources, marking the first and most comprehensive federal involvement in public education (Ravitch, 2010). Title I is the portion of the ESEA that defines schools with a high percentage of

students from low-income families, making them more at-risk for drop-outs and failing academically. The ESEA is an allocation process. The legislation was designed to redistribute funds to at-risk schools, but first authorizing the spending, appropriating the money and then allocating funds on a needs-based basis. The ESEA was a major attempt to involve Federal standards in education. Of the six Titles (sections) of the ESEA, Title I is generally regarded as the most important, but Title V relegates more control back to the States, with grant funding for state run programs. This is an important aspect in keeping federal mandates to a minimum. It allows state to manage their own programs through grant funds rather than direct federal finance.

In 1983, things changed in K-12 education. As discussed in Chapter 1, the *Nation at Risk* report indicated that the United States was behind in literacy and math scores (Ravitch, 2010). This data may not have been presently entirely fairly, but regardless, the impact is still resounding. In 1983, we saw a flip in education from a focus on inputs, to a focus on outputs – via test scores. Standards and assessment became the ‘name of the game’ and this mentality peaked with the 2001 No Child Left Behind (NCLB) Act. As previously discussed, NCLB mandates annual yearly progress (AYP). If schools do not attain AYP then they can be put on probation, taken over by the State, lose Federal funding, or be shut down (Manna, 2011).

This mandate places an inordinate amount of stress on the schools themselves. AYP is assessed by performance on summative, ‘autopsy-like’ assessments. No regard is given for levels of transience at the schools. Students that arrive to schools at the end of the year, and fail the State exams, are still counted against that school’s AYP. Such high

stakes testing and federal involvement, in standards and mandates, has reduced focus on learning skills and increased focus on rote memorization and practice answering test questions. Teachers teach the exam material and ‘nothing more, nothing less’ (Ravitch, 2010). This has arguably drained the creativity out of public school educators for the past 12 years and has had vast effects on student motivation and global understanding; “when we use the results of tests, with all their limitations, as a routine means to fire educators, hand out bonuses, and close schools, then we distort the purpose of schooling all together” (Ravitch, 2010, p. 167). The increase in Federal involvement has been primarily due to an increase in need for equitable funding. NCLB increased stress on schools in transient, low-income areas. As Federal funding increases, so will Federal mandates. This has been a slow shift in governance. It is in the Nation’s best interest to produce a literate and marketable work force. However, moves in the past few months under the newest Administration may indicate that the pendulum may swing back the other direction, away from federal involvement. On April 26, 2017 during the signing of an executive order on Federalism Education, Education Secretary Betsy DeVos remarked that the administration would work to remove federal control of education stating, “That means empowering parents, teachers, state and local leaders -- not the federal government” (The White House, 2017).

Schools across the nation see unequitable discrepancies in funding making it difficult to incorporate EE programs. During the 2013-2014 school year, with the most recent data available from NCES, only about 9% of total funding was Federal with about 46% from the State and 45% Local Governments. Currently EE is siloed into SE for this

evaluation. According to NCES table 235.40, only about \$1.5 million of federal funding went to “Math, science, and professional development” (NCES, Table 235.40). This is very limited funding for a rather broad purpose. It is difficult to say how much of this federal funding went to EE, if any. As shown in Chapter 1, federal funding specifically for EE programs is negligible. This leaves the funding of such programs to more localized sources of revenue.

In 2016, Turner et al. published an interactive map on the National Public Radio (NPR) website (<http://www.npr.org/>) showing how spending per student varies from school district to district across the nation. They found, according to census data, that 27 States saw decreases in local funding between 2008 and 2014. At the same time, national State spending per student dropped by about \$600. According to Turner et al. (2016) “13 states are defending themselves in school-funding lawsuits: Arizona, California, Connecticut, Florida, Kansas, New Jersey, New Mexico, New York, Pennsylvania, South Carolina, Tennessee, Texas and Washington.” The years 2008 to 2014 also saw a loss of 220,000 education positions (Turner et al., 2016).

The lack of federal backing in our public education system has led to alarming variability in education spending. Turner et al. (2016) found that, though the national average of total spending per pupil is \$11,841, there are 80 districts (local school administrations) that spend more than \$40,000 per student, and several counties that spend less than \$10,000 per student. In the nation’s capital, Washington, DC spends about \$19,911 per student. As we move west across the map, Arlington County, Virginia spends \$16,089, Fairfax County, Virginia \$11,912, and this downward trend continues

into western Virginia where Warren County spends about \$7,764 per student (Turner et al., 2016). These disparities lead to unacceptable variation support of programs. The 1965 ESEA and 2002 NCLB - both discussed in Chapter 1 - attempted to provide more federal backing, but still fall short. This leaves local property taxes as the single primary source of revenue for public education. The decline in funding has led to removal of non-core programs (Manna, 2011), which may include novel EE programs.

EE programs may lack funding because they spark controversy as previously mentioned, or because they are multi-curricular making them difficult to assess, but (as was discussed in Chapter 1), most federal funding for EE programs goes to informal settings rather than directly to K-12 schools. Figure 3 of Chapter 1 showed that, according to EPA data, 55% of EE money allocated under the NEEA - between 1992 and 2015 - went to non-profit organizations and only 10% went directly to K-12 education programs. Non-profits do provide EE to the general public, and do participate in on-site teaching experiences, as well as teacher training programs. In fact, as discussed in the previous section, it is a non-profit, BSCS (<https://bscs.org/>), that developed the fieldscope citizen science program. That being said, it is far more difficult to track the direct affect these programs have on public K-12 education.

Teachers and students would be better served by receiving direct funding for the in-school programs rather than going through a secondary source. This puts the impetus on already overextended teachers to seek these individual programs and funding sources individually, rather than having a funding stream available. There are Federal grants available through the National Park Service (<https://www.nps.gov/teachers/index.htm>)

and U.S. Fish and Wildlife has grants for invasive species removal (<https://www.fws.gov/invasives/programs.html>). However, again, these may not be the most obvious of funding sources for a public educator, especially one with little training in a scientific field, such as an elementary education teacher.

Solution: Crossing curricula, utilizing informal education, and thinking locally

Though focus of this chapter has been primarily on federal regulations, states play the largest roll in development of educational curricula. Education programs must have the freedom to be addressed locally and modified to fit the needs and resources available by each individual state or municipality. As discussed, VA student studies of the Chesapeake watershed is a very specialized program that would make little sense in a place such as, Utah, where watershed study may be very interesting, but should focus on the Great Salt Lake and inland seas rather than estuaries. Each state would need to be taken into consideration independently, and thought that is not the purpose of this study it is important to recognize other sources of government funding for EE programs.

As far as other sources of federal funding goes, the National Science Foundation does have funding for educational programs. NASA and NOAA each have their own funding and provide outreach services, grants, and teacher awards. The National Park Service has funding for field trips, but there are National Parks in only 27 States, so this may be less helpful. Public-private partnerships are great sources for meaningful EE experiences. Local businesses and advocacy groups may be willing to provide grants for guest speakers, field trips, equipment, or teacher training, but this leaves the development of these partnerships entirely on the teachers or the local school district, with zero

centralized support. This breeds a self-feeding cycle in which schools with limited funds may be stressed and have less time for building such relationships.

Working within a tight budget, teachers must make any acquired funding go a long way. The multi-curricular nature of EE could actually save money. Coyle (2005) wrote in the National Environmental Education Foundations Literacy report that EE experiences are both practical and successful in crossing curricula, but providers of these experiences need to think outside of the box. For example, if one grant is aimed at providing students with a meaningful watershed experience, then that funding should not be limited solely to use in a biology classroom, but could be a resource for the school as a whole. Generally, public school teachers are separated during professional development by content area. In order to save money on teacher training, rather than hiring external guest speakers in EE, in-service workshops could be utilized for teachers with an EE background to work with teachers in other content areas. In the case of the MWEE in VA schools, the science teachers who have worked to incorporate watersheds into their classrooms could lead information sessions to teachers in other content areas. This would save money and help produce a cross-curricular experience while building local community.

Conclusions

The role of U.S. public education is to provide citizens with the information needed to be well-informed and active participants in a global society. An informed member of society can use rational scientific logic to research any question or to engage in political discourse, but such rational lines of thinking must be learned. As debate

around issues of environmental degradation flares in the political arena teachers must have the confidence to teach relevant content, have access to current data, and be creative in acquiring funding from multiple sources. Hungerford (2010) suggested that alternative approaches to teaching EE could be successful, including outdoor education programs, which will be addressed further in the subsequent chapters.

There is no single, ‘silver-bullet’, method to effectively incorporate EE into every classroom. To make EE programs meaningful they must be tailored to address students at local level, but these new programs require outside funding and creativity in working within limited budget. EE lessons can be easily tied between science to technology and to math and reading/writing skills saving money by using resources across multiple disciplines. Debate over conservation, waste management, and climate change should concern every person so students need practice in discussing controversial topics so they can participate in political discourse as future voters. “All children deserve an education that allows them to make these kinds of connections, and every community deserves to have its citizens engaged in this way” (Boggs, 2013, p. 114). A better understanding of the factors that affect each of them, and knowledge of how to utilize technology as a resource, rather than a toy, will help students to become well informed contributors of today’s global society. The next chapter will discuss the benefits of outdoor education and how public schools can use outdoor space to connect students with their environment in an effective, educational way.

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CHAPTER THREE – OUTDOOR EDUCATION

Introduction

Environmental education (EE) has not been effectively worked into general education because of its multi-curricular nature and because of periodic paradigm shifts in national policy, that have led to controversy and funding issues (see Chapter 1). Historically, educators unfamiliar with EE have attempted to incorporate it solely as a portion of the science education (SE) curriculum (Saylan & Blumstein, 2011), but as the definition of EE states, it encompasses more than just one field of science (Stapp et al., 1969) and, therefore, becomes cumbersome to force into one class. This is why environmental science is often taught as an upper level, stand-alone course, as in the Advanced Placement (AP) or International Baccalaureate (IB) programs. However, when taught as an individual class, environmental science gets reduced to a set of academic standards, as do other core curricula (Sobel, 2013). The point of EE is that it bridges, not just science, but also other fields such as sociology, economics, and politics (Stapp et al., 1969; Wilson, 1998).

EE should be a unifying concept taught across all disciplines, as it focuses more on attitude and behavior than standardized, rote SE does (Gough, 2013; Wals et al., 2014). This may afford a great opportunity to blend EE into less science-focused classes. This would allow teachers the opportunity to engage one another outside their own fields

of study creating an academic learning community amongst faculty (Monroe & Allred, 2013). One way to bridge curricula is through the use of outdoor space in educational settings. Outdoor programs can be inexpensive, if done on, or near, school grounds. Such programs also, usually have a specific focus, such as gardening, and may be less controversial than more direct EE programs.

Outdoor education (OE) is a broad term used to refer to any educational experience that utilizes nature to teach curriculum (Nicol, 2002a, 2002b, 2003). OE actively engages students in their surroundings, be it urban, rural, or a nonhuman-created environment, so that lessons do not require a solely science focus. For example, the use of gardens in non-science classes - as will be discussed further in this chapter - could have a nutrition focus, a historic focus, or a community focus. A good, enriching lesson would include all three. OE builds self-confidence, communication, and community engagement (Redmond et al., 2010; Wattchow & Brown, 2011) and has a positive physiological and developmental effect on students (Hanscom, 2016; Louv, 2005 & 2007). Working on a specific outdoor task, like gardening, allows students to interact with nature and with one another in a unique way (Louv, 2005; Wattchow & Brown, 2011).

It should be noted that OE does not specifically mean EE, but OE can be used to implement EE programs to achieve many of the same goals. The United Kingdom's National Association of Outdoor Education simply defined OE as meeting educational objectives through use of outdoor space (Nicol, 2002a). The outdoor space itself can be local, as in on school grounds or a nearby park, or it can be as far afield – such as

traveling to a biodiversity hotspot in another country, as in the case-study described in Chapter 5. In their guide to creating effective outdoor lessons, Redmond et al. (2010) wrote: “The outdoors is a place where participants have the opportunity to actualize and expand their understanding of content and abstract curriculum” (p. 1). OE, especially local OE, can save money and teach student civic engagement in their community while building upon other skills such as observation, cooperation, and even cognitive development (Hanscom, 2016; Louv, 2005; Wattchow & Brown, 2011).

OE is conflated with a subset of OE called Outdoor Adventure Education (OAE), or sometimes “*Wilderness Education*”. These programs include travel to a new location and some assumed risk (Ewert & Sibthorp, 2014). Whether it is rock climbing, canoeing, or camping these are novel experiences that are less accessible for the general population of students because of this assumed risk, and therefore liability, and due to the cost of travel and equipment. OAE poses a level of physical hardship (Nicol, 2002b & 2003), but this can be beneficial for student development (Ewert & Sibthorp, 2014) - Chapter 5 of this dissertation will further examine one such OAE trip. Adventure and wilderness education will be discussed further later in this chapter, as they are an important mode of disseminating EE, but they are difficult to incorporate into the standard public K-12 curriculum due to the physical requirements and the travel aspect. This chapter will also investigate a few different types of OE with particular focus on programs that can be readily used in a public K-12 school setting, and why such programs are essential for student growth.

Human development outdoors

As mentioned briefly in Chapter 1, Louv (2005) coined the term “*nature-deficit disorder*”. This is the concept that many people in the modern society have become disconnected from nature and lack the essential dose of, what Louv (2007) calls, “Vitamin N” (the “N” standing for nature). Our need for Louv’s “Vitamin N” is what Wilson (1984) called “biophilia”. This is humans’ instinctive need to be connected to nature (Kellert, 1997; Wilson, 1984). Wilson (1984) wrote that all humans have an innate drive to be a part of the natural world. Kellert (1997) suggested that our need for house plants, or placing a painting of a landscape in a poorly lit office, are examples of our collective *biophilia*. The natural world calms us in stressful situations and we have an internal drive to connect with the greater natural world (Kellert, 1998). Hanscom (2016) wrote that this is why children find comfort in holding stuffed animals. These are all examples of people, unknowingly taking their dose of *Vitamin N* in attempt to reconnect with the nonhuman world.

Martusewicz et al. (2015) explained how it has been through our self-created, societal systems that we have all learned to separate ourselves from the natural world. They cited tool use, religion, and the food chain as viable reasons for Western society’s learned anthropocentrism (Martusewicz et al., 2015). The term “anthropocentrism” specifically refers to the view that the natural world exists for human use (Dunlap, 2008). Nelson & Cassell (2016) proposed a complete overhaul of the U.S. educational system in order to address such deeply embedded thinking. This may be, idealistically, necessary in the long-run, but is not a feasible solution to address issues of environmental attitudes and the lack of civic engagement now. There is a high level of urgency in incorporating

natural studies into student learning, so that the public can ‘unlearn’ anthropocentrism. Replacing the entire U.S. education system to undo 150 years of institutionalized learning is not going to happen this year, nor next, but planting a school garden to be used as an outdoor classroom could. Nelson & Cassell (2016) suggest global intervention, but that is not fast enough. Local intervention can happen now. Programs such as gardening curricula have been shown to have a positive effect on children attitude, behavior, and cognitive development (Hanscom, 2016; Howes et al., 2009; Louv, 2005, 2007, & 2012).

Behavioral psychologist Lev Vygotsky (2004a & 2004b) studied how children interact through peer-education. Peer to peer learning is when students work together to share knowledge. He wrote that students need to work together in order to learn content and to develop other essential skills, such as communication and cooperation; all necessary for proper cognitive development (Vygotsky, 2004a). Through the development of social constructivist theory, Vygotsky (2004a) showed that such peer-to-peer interaction and creativity through play drives inquiry-based learning. Furthermore, Vygotsky (2004b) wrote that the physical environment is essential in shaping how adolescents synthesize understanding of one’s self. The physical environment in which one learns may be just as important as the topics learned (Stedman & Ardoin, 2013), i.e., the educational space and the content are linked: “The socially mediated nature of learning, coupled with the influence of physical settings often leads to a setting and message that are inseparable” (Stedman & Ardoin, 2013, p. 213).

It is important to note the difference between the terms *place* and *space* when examining the physical setting in education. In OE we refer to outdoor *space* because, as

noted by Wattchow & Brown (2011), the term *place* has a personal, human connotation to it. In OE, the purpose is to explore nonhuman, natural space in order to find one's place within it: "In nature, children learn to take risks, overcome fears, make new friends, regulate emotions, and create imaginary worlds" (Hanscom, 2016, p. 3). Louv (2005, 2007, & 2012) wrote extensively on the psychological, social, emotional, and physical benefits of students who are allowed to learn in nature. Both Louv (2005, 2007) and Hanscom (2016) built upon earlier writings by Kellert (1997, 1998) and Wilson (1984), focused primarily on early childhood. This is important for the primary years of K-12 education, but studies also show that it is never too late to experience physiological and psychological benefits of experience in nature (Tsunetsugu et al., 2010). Louv (2012) wrote: "young, old, or in between, we can reap the extraordinary benefits by connecting of reconnecting with nature" (p. 5). Outdoor activity has been linked to reduced obesity, reduced myopia, increased focus, and increased empathy (Louv, 2007 & 2012). Bekoff (2014) referred to reclaiming one's place in nature as *rewilding*": reconnecting with the natural world to fulfill our *biophilia*. OE is one way to 'rewild' EE, and education in general.

Rewilding must be "proactive, positive, persistent, patient, peaceful, practical, powerful, and passionate" (Bekoff, 2014, p. 72). To achieve this, educators must be creative in their use of space. The *Reggio Emilia* approach to education uses the environment as inspiration for learning (Hanscom, 2016). This approach to education allows students time to reflect on their surroundings to draw from natural space and one another (Gandini, 2003). While working at a *Reggio Emilia* summer day-care center as a

science teacher and general handy-man, I was asked to remove a large shrub that was blocking some of the outdoor space. Rather than kill the plant, I pruned it extensively to make space for the children at the base, but left the upper limbs alive. I cut the lower limbs in a pattern that the children could climb on. This made the shrub into a living jungle-gym, creating usable outdoor space and allowing the students to interact with nature in a unique way. One student told me that the resulting shape of the pruning made the plant look like a “truffula” tree from Dr. Seuss’ The Lorax (Seuss, 1971). She had made a connection between her environment and the reading she had done in day-care. Inspired by her connection with the shrub, I used the limbs that had been removed to make a dome structure for the children to play with. After leaving the summer program to teach during the regular school year I learned that the older children used my dome structure to build a wigwam after learning about Native American culture. It is this kind of cross-curricular associations that outdoor time and student interaction can spark.

Working with technology

Several online citizen science programs that can effective ways of integrating EE into the standard classroom were addressed in Chapter 2. However, technology can be limiting, and even detrimental if not used properly: “I don’t think modern technology necessarily alienates us from the world it mediates. But a lot depends on our recognizing how it *can* do so” (Talbot, 2013, p. 3). There is an ongoing battle between educators and the growing prevalence of ‘pocket-sized’ technology in the classroom. The county that I teach in distributes a MacBook to every in-coming 9th grade student. This means that every child has access to the internet, often on more than one device, at all times. This is

great for research projects and is an integral tool in the science classroom, however, it must be managed constantly.

In coming years, technology will continue to be more and more available. Students must learn how to use it as an effective academic tool rather than as a distraction. Some examples of effective technological integration into classrooms were discussed in the previous chapter, such as the GLOBE program (<https://www.globe.gov/>) or fieldscope (<http://www.fieldscope.org/>). Both are great examples of ways in which students can collect data outside, experience nature, but still use technology as an effective educational tool. However, it is important that students learn when it is appropriate to use their devices and when it is not.

In 2012, I chaperoned a group of U.S. high school students in Costa Rica. As part of the trip, we shared a boat tour down the Rio Frio in the Caño Negro Wildlife Refuge, on the border between Costa Rica and Nicaragua. Most of the high school students were engaged in the tour, observing the world around them, however, there happened to be another U.S. family on the boat with us. The son, about 12 years old, was entirely disengaged. He was on his father's smartphone for the entire trip, playing the game *Angry Birds*. I sat down next to him and asked him why he was playing the game rather than looking at the jungle around him. He replied "nature is boring" (pers. obs.). The irony that he was tied up in a game, on a small screen, that was entirely based around knowing which types of birds have which special abilities, while the rest of us were identifying and discussing *actual* birds, was entirely lost on him.

As the pilot of the boat cut the engine to point out a group of birds that the Costa Ricans called *anhinga*, also called snakebird, drying their wings on a fallen log, I handed my binoculars to the young boy and described to him how the *anhinga* feed by swimming underwater. He was shocked by this and borrowed my binoculars for the rest of the boat ride. I showed him how to hold the binoculars over the phone's camera to create a telephoto lens for his smartphone and take better pictures. All it took was a nudge of engagement and he was using technology to experience nature rather than intentionally remove himself from it.

In an age of limitless information technology, we are more disconnected from nature than ever. We feel the need to experience the outdoors, but we are distracted. The flashing lights and rapid movement of our personal technology devices, such as those in games like *Angry Birds*, raise stress levels and potentially keeping the body in a constant state of low-level stress with no real release from this technologically induced, mild-fight or flight response (Hanscom, 2016). These low levels of stress can be a real danger to our physical and psychological wellbeing (Bowers, 2016).

On top of that, the screen itself can be used as a physical barrier between people disengaging us, not only from nature, but from one another (Talbot, 2013). The use of technology to communicate ignores nonverbal communication and denies people the ability for real face to face confrontation. This can have developmental effects, especially on younger children. Prolonged exposure to screens are positively associated with cognitive, verbal, and motor delays in children (Lin et al., 2015). There are also connections between online media use and problems with sleep, obesity, and executive

functioning – meaning the ability to organize oneself and work towards a goal (Radesky & Christakis, 2016).

The cure is to spend more time in nature. The more people stay indoors, the less they know how to connect with nature (Louv, 2005). OE is a way for young children to disconnect from digital world and reconnect with the natural world in their own community. Bekoff (2014) wrote that “our education system itself needs to be rewilded, since the cumulative effects of technology, media, and our culture alienation from nature negatively impact children just as much as nonhuman animals” (p. 120). There are a few simple ways that public K-12 educators can incorporate the use of the outdoors as a safe, educational space instead of regular classroom instruction; the simplest is through gardening.

Gardening pedagogy

The use of a school or community based garden as a space for outdoor learning can bridge curricula, increase communication skills, and build community (Monroe & Allred, 2013). Garden pedagogy, as opposed to other types of OE, is an efficient use of outdoor time and space because the garden can be placed in close proximity to schools or community centers. Williams & Dixon (2013) investigated the academic merits of school gardening pedagogy. The researchers examined 48 published gardening studies. Only 40 of the studies measured direct impact on academic learning objectives in science, language arts, math, writing, and social studies, but 83% (33/40) found positive effects of incorporating gardens into the school academic environment. Only one study found a negative impact, while the rest found a neutral impact on academic indicators (Williams

& Dixon, 2013). Through effective planning, gardening pedagogy can be used to teach academics other than solely science.

Howes et al. (2009) conducted an extensive study of gardening program in an elementary charter school in Florida. The goal of this program was to get students outside of the classroom in order to allow them free time to work with their hands, and to interact with one another in a new way. However, teachers complained that between the time that it took to walk to/from the garden and issues with classroom management, the garden curriculum cut into regular classroom time. It was striking that despite goals of the program, teachers found it difficult to view their classrooms outside of the regimented norm: orderly students and orderly conduct. Most of the complaints issued by teachers against the gardening pedagogy echoed ideals about what more traditional school classrooms should be, however, the point of such programs is that OE spaces are not classrooms. Gardening pedagogy is supposed to be an inquiry based, experiential curriculum (Herrington, 2001).

Students should be allowed to wander and be exposed to different aspects of garden life. Instead, teachers went to great lengths to control the outdoor setting and made “invisible classroom walls” to contain students into a common area (Howes et al., 2009). This makes sense for coordination purposes, but detracts from the goals of outdoor based pedagogy. It was clear in this study that teachers were not properly prepared for OE and required better training in out-of-classroom management techniques. This study was from 2009, but there are now many available programs to aid educators in establishing gardens for example, the Nature Conservancy’s *Nature Works Everywhere*

(<https://www.natureworkseverywhere.org/>) program has multiple online resources including grants and webinars for teacher training.

If teachers themselves are uncomfortable outdoors, they will not feel comfortable teaching there. Bowers (2016) wrote on the difference between an individualistic education and an ecologically oriented point of view. He wrote that it is a self-feeding cycle of educators who were raised in a Western, human-centered point of view. Traditional, ‘Jeffersonian’ U.S. education curricula, as discussed in Chapter 2, are designed to produce active participants in the American democratic system (Reece, 2013; Spring, 2004). This makes it difficult to incorporate more global issues such as those of environmental degradation. “Ecological intelligence requires the broadest form of relational rather than compartmentalized thinking” (Bowers, 2016, p. 65). As discussed previously, these outdoor spaces can bring members of the community together to teach civic engagement through content.

Outdoor educational settings, such as a community garden, can build capacity at the local level. These areas serve to engage participants in the local community and to teach evaluation of processes at the public school and community level (Monroe & Allred, 2013). By placing a school garden within an existing community garden teachers will have to do less coordination and maintenance of the physical garden space. Læssøe & Krasny (2013) referred to this as “nested civic participation”. Placing one civic program within another to combine resources and fully utilize space. This may mean that it is more difficult to actually get students to the site if it is off school property, it does increase student involvement in the community. It could also increase community

involvement in the school if other members of the garden association are recruited to help work with the students (Læssøe & Krasny, 2013).

In 2014, as a biology and environmental science teacher, I worked with one of the health teachers to build raised planting beds for our public high school. We put in two beds 4 foot by 16 foot beds; one a native pollinator garden and one a vegetable garden. I used the pollinator garden to teach students about local versus invasive species and the importance of pollinators while the health teacher used the vegetable garden to teach her students about nutrition. Her class grew salad greens, tomatoes, and peppers so that they could eat them together. Vegetable gardens actually do increase student consumption of vegetables, creating healthy habits in students through OE (Berezowitz et al., 2015; Ratcliffe et al., 2011). The gardens at our school happened to be outside the window of one of the literature teachers. She used them to discuss naturalism in poetry. As an educator, this was the first time in six years at the school that I interacted with these teachers to develop content. Butcher (2016) found that gardening pedagogy in Havana forced educators to collaborate in unexpected ways. Howes et al (2009) also found that the garden created its own community within the faculty. This is important at all levels of education, but is especially so in at-risk schools.

Urban gardening can be used as a way for students to reclaim some of their natural environment. Kelley & Williams (2013) found that the use of a school garden in an urban, high-poverty school forced teachers outside of their typical comfort zone, but were a good tool to provide a safe, collaborative atmosphere. Such collaboration can also be beneficial for school populations with diverse students, especially those that are

second language learners (Williams & Anderson, 2017). Gardening programs can increase academic performance through increased attendance, and engagement (Berezowitz et al., 2015; Williams & Dixon, 2013). Berezowitz et al. (2013) found that students were more actively engaged in their learning during gardening time than during other school time. This may negate the negative findings in Howe et al. (2009), though some time may be lost traveling to the outdoor setting, it may be made up in time on task. Williams & Dixon (2013) found that the largest academic influence for gardening pedagogy was in science classes. This makes intuitive sense, but again is not the point of OE, nor EE. It is important that teachers be allowed adequate training and time to make a collaborative effort so that the garden space works for everyone.

Trail-based education

Student experiences in nature can be academic as well as increase awareness of the issues of human impact on the environment (Palmer, 1998). There is no better way to experience this than to explore the local environment through walks around a local neighborhood, park, forest trail, or even city block to investigate signs of human impact on the environment. This is an important component of EE; helping students understand exactly the ways in which their lifestyle, or humanity in general, impacts the world around them. One way to achieve this is through “trail-based education”. Here we will use this concept loosely as not all public schools have access to safe hiking areas. Trail-based education could be any nature-based walk that includes understanding of the students’ place in the natural space; this includes urban hikes.

Ferreira (1998) looked into the use of hiking to get the general public involved with nature and spark interest in environmental concerns, building on an earlier study by Clacherty & Ballantyne (1990) it was concluded that hikers hike to enjoy nature and hikers prefer to hike in places that have limited human impact, such as trash on the trail or street noise (Ferreira, 1998). This last piece is the key and raises important discussions for EE. Students travel to and from school every day and likely do not consider their route to school as a part of the natural environment. Talbott (2013) referred to this as a “tour-bus syndrome”. The idea that most individuals may feel some internal drive to interact with nature, some *biophilia*-based desire that may be expressed through the need to take a photograph of a pretty sunset or leaf on the ground, but, people predominantly just wander through their natural environment as a passerby on a tour bus, without really experiencing the world around them. This is how trail-based education can further a student’s place within natural space; by allowing them to experience it in a new way. Several studies in the past 10 years have been exploring the physiological effects of green environments.

According to the Washington Post in May 2016, “Forest bathing is the latest fitness trend to hit the U.S.” (Kim, 2016). *Shinrin-yoku*, or “forest bathing”, was created by the Japanese Ministry of Agriculture, Forestry and Fisheries in the 1980s (Kim, 2016). It means taking time to absorb all of the stimuli, be it sounds, sights, smells, or even palpable, that one can experience from being in a forest. Ohe et al. (2017) found that forest bathing actually reduced blood pressure in participants, and that the reduction lasted for several days afterwards. Park et al. (2010) and Lee et al. (2017) found similar

results, suggesting that even viewing a forest scene can lower stress indicators - primarily through changes in blood pressure and cortisol levels. Li (2010) also found that forest bathing can have positive physiological changes to the immune system, lasting up to 30 days after the experience. Tsunetsugu et al. (2010) noted that different species of tree give off different phytoncides, chemicals that can trigger an olfactory response in humans, and this may play a role in the physiological effects of forest bathing, however since these chemicals are species and season dependent, they are difficult to study in a broad sense.

As more studies investigate the role of which specific chemicals have which physiological response, it is important to note that just taking time to be outdoors is a healthy habit. Even if the outdoors activity is for no other reason than to allow students to explore the natural surroundings of their own neighborhood. “But today most of us spend much of our life indoors, or at least tethered to devices. Perhaps the new forest bathing trend is a recognition that many of us need a little nudge to get back out there” (Aubrey, 2017, para. 27).

In 2013, I took my IB environmental science class into a small stand of trees in the park across the street from our high school. We were studying the impact of invasive species and I wanted to point out a few that they may have seen in passing. I led the class down a trail to show them how much English Ivy (*Hedera helix*) there was when one high school senior said to me: “I never knew there were trails back here”. That one statement opened my eyes, showing me that I had been teaching environmental science

incorrectly, too rapt in standard-based learning, teaching to the IB exam, and not allowing my students to experience their own world.

There may be physical concerns to actual trail-based education. Physical fitness and mental preparedness allow the individual to enjoy the surroundings more often than those not comfortable with the demands of hiking (Ferreira, 1998). Not all students in typical classroom would be so willing, or prepared, to spend significant time walking in the woods; nor do all schools have access to a forest. The school system discussed in the next chapter does have an outdoor facility for the public K-12 schools. All students participate in an overnight, outdoor adventure in elementary school. The AP and IB environmental science classes also use the facility. One AP study will be addressed in further detail in Chapter 4. Even if schools do not have access to such facilities, they could take advantage of outdoor space through outdoor walks, or even visualization of outdoor spaces to produce positive psychological (Hanscom, 2016) and physiological effects on students (Lee et al., 2017; Park et al., 2010; Tsunetsugu et al., 2010). Chapter 4 will investigate specific attitude changes in students who participate in a trail-based program.

Site-based learning and adventure pedagogy

In moving from localized spaces for OE, as in garden pedagogy on school property or within the local community, through trail-based OE off of school property, the opposite end of the spectrum is “site-based learning” and “adventure pedagogy”. Site-based learning is OE in a specific space for experiential education; for example, the stream study discussed in Chapter 4. This type of OE focuses on study of a specific

outdoor area to enhance the content of an academic lesson. This may be close to the school facility, but does not have to be. In the case of the outdoor facility in Chapter 4, the facility is about an hour bus ride from the school of study. Adventure education is a little more difficult to define, but involves a level of *risk* (Ewert & Sibthorp, 2014). The risk described is generally in learning some new outdoor task, whether it be canoeing, mountaineering, camping, etc. Outdoor Adventure Education (OAE) adds an extra element of physical fitness; for example, elements of the Program of Study described in Chapter 5. This program blends elements of EE through study of biodiversity hotspots by incorporating adventure skills such as SCUBA diving.

The purpose of imposing such risk is twofold: (1) to engage in active learning through the use of multiple senses (Redmond et al., 2010); and (2) to encourage growth of self-esteem and self-advocacy (Wattchow & Brown, 2011). The ultimate goal is to provide an unforgettable experience that connects the student with the natural world, though: “Oftentimes skills taught are forgotten, but the experience is the catalyst for lifelong personal growth and pleasure by interacting with the natural world through outdoor activities” (Redmond et al., 2010, p. 2). As discussed previously, students are regularly overstimulated by rapidly moving images, loud noises, and a constant flow of information provided in the digital arena. This induces a continual release of stress hormones, but does not provide any release for the sympathetic nervous system (Bowers, 2016; Hanscom, 2016). In a usual fight or flight stimulation, there would be some climax event and then the stress hormones could be flushed from the system. This does not

happen with digitally-induced stress. Adding an element of risk to OE can provide this release; which may have physiological benefits (Wattchow & Brown, 2011).

Site-based and adventure programs may not be feasible options for the average public K-12 program due to the amount of money needed to travel to the site of study, and because of the physical requirements for activities such as swimming or rigorous hiking. Also, as Wattchow & Brown (2011) pointed out, OAE may involve so much risk that the activities must be highly regulated. This may actually undermine the benefits of unregulated, inquiry-based OE. That being said, gaining the skills needed to spend more time in nature may also encourage students to actively seek more outdoor opportunities (D'Amato & Krasny, 2011; Sheard & Golby, 2006). OAE may also encourage students to travel more (Redmond et al., 2010). It removes students from their local community, but may allow them to explore communities beyond their comfort zone.

Teachers who wish to implement such programs must be sensitive to student disabilities when selecting OAE options. Also, it is my personal experience that public school systems will not always be supportive of travel programs because of the *risk* element and liability issues. While recruiting for my two trips to Costa Rica, I was not allowed to advertise in school, only by word of mouth. That being said, it is also my experience that providing such opportunities for students has life-long implications. Of the students who traveled with me to Costa Rica, one student, who was previously not particularly invested in science studies, went on to earn a degree in biology so that he could go back to Costa Rica to study the effects of the chytrid fungus on tree frogs. A second student recently graduated with a degree in international affairs and intends to go

back to Central America to do development work. It is personal experiences such as this that were the impetus for the studies to be discussed in Chapters 4 and 5.

Conclusions

Responsible behavior includes respect for other people as well as the environment. “The daunting challenge facing the environmental movement is to pressure for the reform of science education in ways that help future scientists recognize that addressing the problem of moral ignorance of relationships, particularly human/nature relationships, may be more important and complex than understanding the chemistry that will enable them to engineer new forms of life” (Bowers, 1997, p. 47). The best way to achieve this is to help students build relationships with their surroundings early in life. Public interest in EE has fluctuated over the last century with serious focus on EE only beginning in the early 1970s (Louv, 2005; Hungerford, 2010). OE is a good way to incorporate EE into public education by connecting people directly with their environment.

The current public education system in the United States has removed students from the nonhuman world to the point that it has arguably caused physical harm (Bowers, 2016; Hanscom, 2016; Louv, 2005 & 2007; Radesky & Christakis, 2016). Students are so removed that they may even look down upon cultures that do value the environment (Bowers, 1997 & 2016). Bowers (1997) wrote that “One of the great ironies today is that the knowledge of relationships that ecologically centered culture have developed is considered by modern individuals to be ‘primitive,’ backward, and unworthy of advanced, progressive cultures” (p. 6). Students invest large sums of money into the latest

in technology in order to share culture through digital memes and short video clips; which may exacerbate the problem, especially for students that live their entire lives in an urban environment (Butcher, 2016; Kelley & Williams, 2013; Radesky & Christakis, 2016). As public educators, we have an important platform to engage students in their community through the investigation of the natural world. That could be through the use of gardens, trail/hiking based pedagogy, or even OAE. The act of simply being in a natural environment can, indeed, have positive psychological and physiological benefits (Lee et al., 2017).

Some educators feel that EE should focus exclusively on learning about the environment (Hungerford 2010). They believe it is the educators' role to present rote facts and facilitate learning about the issues at hand, but not to promote debate over topics; arguing that students should not be asked to make judgments or take stands on science that they do not understand (Hungerford, 2010). This, plays well into the test-based mentality of education, but does not generate healthy public discourse on important global issues. As evidence one only has to read the comments on any online news article about a scientific issue; for example, the Sept. 13th Fox News article "*Arctic expedition trapped by polar bears*". This article describes how a group of ten polar bears surrounded a group of scientists, trapping them in their workstation, but many of the comments suggest that this is proof that global warming is a hoax and polar bears are not endangered (Williams, 2016). Such flawed logic shows a lack of fundamental associative skills in scientific matters.

Students must learn in a safe space, where they can participate in human-to-human, as well as human-to-nature, interactions. Integrating the natural environmental into general curricula is beneficial on multiple fronts. OE facilitates cooperative learning through the use of natural space, with the added benefit of positive physical effects on participants. OE can be an inexpensive way to cross curricula, and effectively engage students. Chapters 4 and 5 will investigate two specific outdoor programs.

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CHAPTER FOUR – OUTDOOR LABORATORY LESSONS: A CASE STUDY

Introduction

Students can learn the academic content of multiple fields through active engagement in outdoor spaces (Hanscom, 2016; Louv, 2005 & 2007; Redmond et al., 2010; Wattchow & Brown, 2011). One of the goals of environmental education programs (EE), and specifically outdoor education (OE), is to change the way in which individuals view their surroundings (Martusewicz et al., 2015) in order to build community and belonging in a place (Monroe & Allred, 2013). This suggests that EE programs should induce some attitudinal and value change in participants. Chapter 3 introduced a range of outdoor education (OE) programs. This case study will specifically investigate an EE/OE program involving a two week long stream quality study with 11th and 12th grade students at a mid-Atlantic suburban, public high school.

The 1970s was, undoubtedly, a decade ripe with environmental reform. Increased public awareness of human impact on the environment and highly notable publications such Rachel Carson's *Silent Spring* and Buckminster Fuller's *Operating Manual for Spaceship Earth*; also, "the likes of Barry Commoner, Paul Ehrlich, and Garrett Hardin" (Dunlap, 2008, p. 6) brought environmental degradation to the public mind. In order to quantify these changes in social attitudes Dunlap and Van Liere (1978) created the New Ecologic Paradigm (NEP) scale. Individually, NEP scores mean very little, but if used

over time they can shine light into how collective attitudes change. This makes them a useful tool in assessing EE programs.

Over the past three and a half decades, the NEP scale has been modified as attitudes change. In 2000, Dunlap, Van Liere, and Mertig redubbed the NEP the *New Environmental Paradigm*. This change aimed to focus more directly on human impact rather than on ecological processes; Dunlap et al. (2000) wrote, “Besides achieving a better balance between pro- and anti-NEP statements, we also wanted to broaden the content of the scale” (p. 432). This was reiterated in personal communication with Dr. Dunlap (pers. comm.2011). The aim was to further investigate social attitudes towards human roles in the environment.

In a comprehensive meta-analysis of the NEP scale, Hawcroft and Milfont (2010) wrote that though there have been uses and misuses of the NEP scale, but all-in-all it was still found to be an effective tool for monitoring paradigm shifts. It is important to follow public view changes to understand how best to implement education programs. People cannot act proenvironmentally if they do not feel understand human impact.

Understanding attitudes is important for understanding, predicting, and even changing behaviors (Schultz & Zelezny, 1998). If the goal of EE programs is to create active, aware citizenry then social attitudes must be assessed often to track and monitor changes.

Proenvironmental behavior is altruistic in nature, meaning that the behavior is “motivated by an internal value and without expectation of anything in return” (Schultz & Zelezny, 1998, p. 541). This concept of altruism towards environmental issues is referred to as stewardship. In order to be considered stewards, students of EE programs

must take an active role to mitigate harm and do so without immediate reward. Figure 7 (Schultz & Zelezny, 1998) depicts a model for how an individual can move from values to action. Action begins with the individual's awareness of consequences so that responsibility can be assigned for said behavior. In order to predict behavior, one must assess each aspect along the line from value to behavior. The goal is to determine predictors of proenvironmental behaviors using the NEP scale to determine value systems (Schultz & Zelezny, 1998).

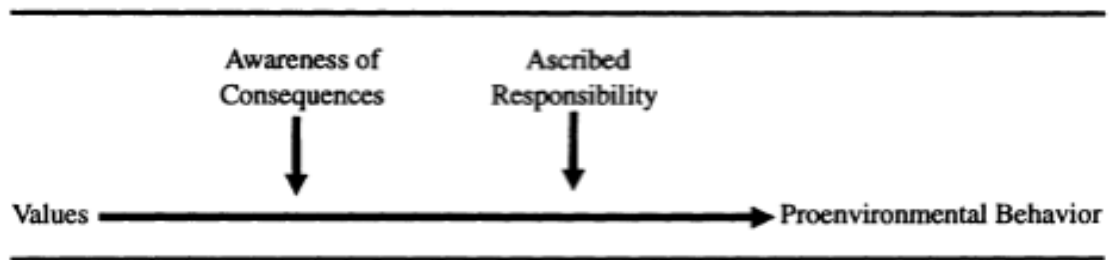


Figure 7: From Schultz & Zelezny (1998). Depicts a model for proenvironmental behavior.

Over the past two decades, links between the NEP attitude scales and general values have arisen making it clear that there are connections between individual levels of environmental concern and specific defined personal values, such as altruism (Kalof et al., 2002; Steg et al., 2014; Stern & Dietz, 1993, 1994; Stern et al. 1998, 1999). Kalof et al. (2002) developed a 15 item value scale utilizing a 1-5 scale Likert analysis to measure shifts in these values and links to pro-environmental attitudes. The 15 item scale is based

on a 56-item diagnostic that was developed by Schwartz (1992). The full, 56-item scale has proven statistically valid, but is cumbersome especially for the target respondents of this case study. In order to link Schwartz's values to the environmental paradigm, several groups have investigating shortening the value scale (Guagnano, 2015).

Kalof et al. (2002) focused on altruism, traditionalism, self-interest, and openness to change as values that could be linked to pro-environmental thinking. Altruism is an important value for the well-being of the common good. Those that have more concern for the environment would likely be more altruistic. Traditionalism, in the context of the value assessments, is defined by self-discipline, family security, and showing respect (Kalof et al., 2002; Schwartz, 1992). It is thought that greater scores in the self-interest category would correlate negatively with higher NEP scales, but openness to change would correlate positively.

Guagnano (1994, 1995) and Stern et al. (1998, 1999) investigated how Schwartz's (1992) value tool could be used to get to the root of pro-environmental behaviors and attitudes to find predictors of behavior. These studies showed links between NEP scores and value scores and suggested that these value systems may be a viable tool for investigating differences between population groups that may not be evident using the NEP scale alone. Value scales are comprised of a 12 question, 5 point Likert scale as developed and described by Kalof et al. (2002). This was received from Dr. G. Guagnano, a member of the Stern et al. team, through personal communication (February 6, 2015). These were described as "Short Scales" and were developed as a quicker, but still statistically viable version of the original 56-item value inventory.

The full, original inventory was impractical for this study as it would take too much time and likely reduce response rate. It covered 10 pre-defined values, but for the purpose of investigating which values impact environmental attitudes, Stern et al. (1998) narrowed the field to three: egoistic, biospheric, and altruistic. This was later adjusted by Kalof et al. (2002) into the version of the “Short Scale” used in this study. According to Stern et al. (1998), “We believe that the Short Scales are now developed well enough for preliminary use of the inventory internationally, especially in research on environmental attitudes and behavior” (p. 1000). This study also included some of the behavioral questions initially published by Stern et al. (1998).

Research Questions

- 1. How does the two week stream study program, with visit to the county owned outdoor facility, impact student views of the environment?**
- 2. Are there significant differences in environmental attitudes and values between the genders?**
- 3. Does change in environmental attitude – New Environmental Paradigm (NEP) – score, or values associate with change in self-reported behavior?**

The educational program

The program of focus for this case study included two sections of an Advanced Placement Environmental Science (APES) course in a mid-Atlantic suburban public high school. Each year, the APES students participate in a teacher created stream study investigating the local watershed. Teacher names, the school name, and the county will all be kept anonymous for the purpose of this study. According to teachers, the goal of

this program was to investigate the physical, biological, and chemical characteristics of different parts of a stream ecosystem, upstream and downstream from a man-made pond. The program contained two outdoor components. First students participated in a trial run of all stream quality assessments at a stream within walking distance of the school. Once students were comfortable with protocols, the classes conducted a more in-depth study at a stream located on a county facility – for the use of the public schools.

Students divided themselves into six groups of 5-8 students. Each group conducted the same four stream assessments, but were placed at different points along the bank. Within groups, individual students focused on one of the four tasks. The first stream analysis was to create a site-map using GPS coordinates and to make a sketch of the stream indicating curves, general shape, and position of obstructions, pools, and riffles. The second analysis was a biological study in which students identified local and invasive flora and fauna in their area; then conducted an aquatic macroinvertebrate study. The third investigated physical characteristics of the stream itself including turbidity, temperature, stream width, depth, velocity, and calculated discharge. Finally, students conducted chemical assays for pH, phosphates, nitrates, and dissolved oxygen.

In order to prepare for the trip to the outdoor facility, students first read through the protocols – provided by their own instructors – in class, and were allowed to pick jobs within their groups. Students practiced identifying macroinvertebrates using color pictures and learned about the importance of indicator species through class notes prior to the outdoor portions of the program. Groups then conducted the analysis at a stream in a community park within walking distance of the school. Students were assigned to

different points along the bank to practice their individual tasks. While visiting the park, teachers addressed the human impact on the area; specifically pointing out large amounts of plastic based litter. Teachers also discussed how each of the stream quality survey items may be affected by runoff pollution, or land-use changes such as new housing developments upstream. According to teachers of the class, the goal of this was to challenge students to think about how their community was affecting the stream and, eventually, the Chesapeake Bay further down the watershed.

Approximately one week after the practice investigation, students visited the county's outdoor facility. The facility, itself, is on land donated to the county public schools, but is located in a neighboring county within close proximity to a National Forest. It is also in the same watershed as the school of focus, the Chesapeake Bay, but is not directly connected to the stream studied prior. Student groups were given a map and supplies for assays, then sent to six locations: (1) as far upstream as convenience and safety would allow, (2) somewhat upstream, (3) upstream, near campsites – used by younger students in the county for overnight trips, (4) upstream near the pond, (5) downstream near the dam that created the pond, and (6) as far downstream as the property would allow.

Stream analysis was completed in a little over an hour while teachers and this researcher worked with groups to keep students on task. Facility staff was available for questions, but the students were largely self-sufficient. Once completed, students met back at the facility lodge for lunch. Students had previously been given the option to bring their own lunch or to cook hot dogs on an open campfire. The majority of students

chose the latter. After lunch students were given one hour to hike the trails, take a canoe or kayak out on the pond, or to visit the facility laboratory that contained a menagerie of native reptiles and fish. Despite their diligence in completing the stream quality analyses, from personal observation this seemed to be the part of the trip in which students seemed most engaged.

Data collection and analysis

Attitude scale

The NEP scale (2000 version) codifies responses into five distinct attitudinal categories that rotate through the 15 question survey: (1) Limits to growth – survey items 1, 6, & 11; (2) Anti-Anthropocentrism – survey items 2, 7, & 12; (3) Fragility of nature's balance – items 3, 8, & 13; (4) Rejection of exemptionalism – items 4, 9, & 14; and (5) Possibility of an ecocrisis – items 5, 10, & 15 (Dunlap et al., 2000, pg. 432). This version of the NEP contains 15 questions as follows:

1. We are approaching the limit of the number of people the earth can support.
2. Humans have the right to modify the natural environment to suit their needs.
3. When humans interfere with nature it often produces disastrous consequences.
4. Human ingenuity will insure that we do NOT make the earth unlivable.
5. Humans are severely abusing the environment.
6. The earth has plenty of natural resources if we just learn how to develop them.
7. Plants and animals have as much right as humans to exist.
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.

9. Despite our special abilities humans are still subject to the laws of nature.
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
11. The earth is like a spaceship with very limited room and resources.
12. Humans were meant to rule over the rest of nature.
13. The balance of nature is very delicate and easily upset.
14. Humans will eventually learn enough about how nature works to be able to control it.
15. If things continue on their present course, we will soon experience a major ecological catastrophe.

All NEP, attitudinal, responses were analyzed as described in Dunlap et al. (2000) and Manoli et al. (2007). For the purposes of this study, the 5 point Likert scale used by Dunlap et al. (2000) was adjusted back to the 4 point scale that as was used in the original 1978 version, with no "Unsure" middle ranking available to respondents. This is the way the questions were presented in the first iteration of the NEP and according to Dr. Dunlap (pers. comm., 2015) there was no statistical reason why researchers shifted from the 4 point to the 5 point scale in the 2000 study. The neutral ranking was removed in order to reduce the chance that student respondents simply mark the middle choice and force them to assign a pro- or con-stance on questionnaire items.

NEP questionnaire items alternate between positively worded statements, in which agreement indicates a pro-environmental view, and negatively worded statements,

in which disagreement indicates a pro-environmental view. The negatively stated questions – listed as the even numbers in the question set listed above, and as described in Dunlap et al. (2000), were reverse scored when total NEP value was calculated. Mean percent agreement was calculated for each question and then a total NEP rank for each of the five categories was calculated to compare view changes between pre and post responses. Respondents were analyzed as a group mean rather than calculating individual growth for each respondent.

Value and behavior scales

Value scores were reported for each value category as described by Kalof et al. (2002). Categories include altruism, traditionalism, and self-interest as were adjusted (Kalof et al., 2002). For this study, the openness to change category was removed due to the length of the questionnaire which also included the NEP scale, and behavioral questions. Within the value questions, six items addressed altruism with each question ranked up to 5 so that altruism as a whole could be scored 6-30 as a total per person. Mean score was found per study group. Traditionalism and Self-interest both only had 3 survey items, allowing for a score of 3-15 for each value and a total value score of up to 60.

APES students were asked to complete an online survey containing attitude, value, and behavior questions before and after their stream studies. All surveys were anonymous and voluntary. Students were asked to create a unique ID using the last four digits of their phone number and the day of their birth in order to compare pre and post assessments. Students under the age of 18 were given a second questionnaire in which

their parents used the same unique ID to give consent prior to participation.

Questionnaires were conducted through Google Forms and distributed to students through the individual teachers' Google Classroom accounts.

Analysis

Data was collected through Google Forms and saved in Excel spreadsheets. All data analysis will be done using IBM SPSS Statistics Version 24 software.

RQ1: How does the two week stream study program, with visit to the county owned outdoor facility, impact student views of the environment? It was hypothesized that students who participate in an outdoor experience such as the stream study described previously will rank higher on the NEP scale after the experience, indicating that their attitude has shifted more pro-environmentally due to the direct observation of human impact on the stream of interest. In order to address RQ1, mean NEP scores for each of five NEP subcategories ("limits to growth", "antanthropocentrism", "fragility of nature's balance", "rejection of exemptionalism", "ecocrisis") and total NEP score were calculated and compared between each of the questionnaires to look for growth in environmental view. Due to the low response rate (N = 8), assumptions were not met for parametric analysis. The Wilcoxon Sign-Rank Test for dependent samples was used to compare pre- and post- assessment scores.

RQ2: Are there significant differences in environmental attitudes and values between the genders? It was hypothesized that female respondents would exhibit more pro-environmental attitudes than their male classmates, but the male respondents would show greater changes between pre and post assessment. Though there have been few

studies on the difference in environmental attitudes between genders, some studies may indicate that women have a slightly more favorable view of the environment (Eagles & Demare, 1999; Kellert & Westervelt, 1984). The null hypothesis states that there is no relationship between gender and NEP score. Due to the low sample size ($N = 8$) the Mann-Whitney U test was used to investigate differences between pre and post Total NEP scores between genders. MANOVA testing was used to investigate significance of gender on differences in values and NEP scores as described by Kalof et al. (2002). Mean value scores were calculated within each value subcategory (altruism, self-interest, and traditionalism) and an average total value score found for each gender. Mann-Whitney U test was used to investigate differences in value scores between genders.

RQ3: Does change in environmental attitude – New Environmental Paradigm (NEP) – score, or values associate with change in self-reported behavior?

Responses to behavior questions were coded by type of behavior to produce a behavior score as was done with value scales (Kalof et al., 2002). Behaviors include: being a member of a conservation or environmental club, likelihood of joining a club, reading and sharing environmental information in person and online, making an effort to purchase fruits and vegetables without pesticides or chemicals, using reusable bags, making purchasing decisions based on the environmental impact of the producer, buying recycled products, willingness to pay higher prices to protect the environment, willingness to pay higher taxes to protect the environment and willingness to accept cuts in standard of living in order to protect the environment. These behaviors were edited

from the Kalof et al. (2002) study to include social media aspects of attaining and sharing of information rather than the print based media described in Kalof et al. (2002).

Each behavior was assigned a code: 1 meaning “Never”; 2 meaning “Not very often”; 3 meaning “Often” ; and 4 meaning “Always”. There were three questions that are presented as “yes”, or “no”. These items asked whether the respondent was willing to pay higher prices to protect the environment, willing to pay higher taxes to protect the environment, and willing to accept a lower standard of living in order to protect the environment. A “yes” was coded as a 4 and a “no” as a 1. Mean behavior score was calculated for each student; also mean score for the group so that behavior scores could be compared with change in NEP. A Pearson’s correlation and simple regression were used to investigate any correlation between total post assessment behavior score with total post value scores. Due to the low number of respondents, a Chi-square test for association was also run to investigate further association.

Results

Results of a Wilcoxon signed-rank test of pre- and post-assessment total NEP score showed that overall NEP score did not change significantly between the pre and post assessment ($p = .705$), with a total increase of only 2.57%. Table 1 shows that the greatest changes were in the limits to growth category with a 5.79% change ($p = .705$) and in the fragility of nature category with a mean increase of 4.79% ($p = .680$). Interestingly, the “Rejection of Exemptionalism” category showed a 1.17% decrease in environmental attitude ($p = 1.000$) and the “antanthropocentrism” category showed almost no change at all, increasing 0.29% ($p = .854$). Though not statistically significant

with such a small sample size, this does warrant further investigation into whether students may have gleaned some more understanding of issues directly affecting ecosystem functioning, but have not applied that to a greater view of how human activities interplay with degradation. They also may not ascribe personal responsibility for impact, as described by Schultz & Zelezny (1998).

Table 1: Results of Average Pre- and Post-assessment NEP Scores by Subcategory

NEP Category	Pre		Post		Percent Change
	Avg	SD	Avg	SD	
Limits to growth	2.89	0.50	3.13	0.35	5.79
Antianthropocentrism	3.28	0.49	3.29	0.63	0.29
Fragility of nature's balance	3.27	0.50	3.46	0.35	4.79
Rejection of exemptionalism	2.88	0.49	2.83	0.47	-1.17
Possibility of an ecocrisis	3.67	0.38	3.79	0.31	3.12
Total NEP	3.20	0.32	3.30	0.29	2.57

With regards to the investigation of how gender impacts changes in value, results of the MANOVA analysis indicated that there was no significant difference between female and male respondents between any of the value categories ($\Lambda = .667$, $p = 0.936$). Results of the Mann-Whitney U test showed that there was also no significant difference in total NEP between genders ($p = .464$) in change in behaviors between genders ($p = 0.464$). Curiously, some students even showed a decrease in values between the pre- and post-assessments. Table 2 shows the overall percent changes in the averages of those students that completed a valid pre- and post-assessment. The score for each category was found as a percent of total possible points and is shown as a percent change. The

most stark value changes were seen in the female change in “Traditionalism” and male change in “Self-Interest”. Both showed large percent decreases in value, but this may be a result of the fact that scores were limited in total number of points so each individual point change had a large percent value change. This is an effect of using a 12 point value scale rather than the original 56 point value scale described previously (Schwartz, 1992).

Table 2: Percent Change in Value Scores per Category and Total NEP by Gender

	Change in Altruism			Change in Traditionalism			Change in Self-Interest			Change in Behaviors			Difference in Total NEP		
	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
Mean	-0.21	-2.77	-1.81	-12.04	5.41	-1.13	-13.04	-16.19	-15.01	2.50	0.00	0.94	0.00	-0.03	-0.02
Std. Deviation	8.01	24.56	19.10	37.51	25.50	29.24	42.91	33.90	34.43	2.50	5.30	4.42	0.00	0.17	0.13

Results of the Pearson correlation between changes in Total NEP score and changes in reported behaviors showed weak, if any, negative correlation with $r(8) = -0.208$ that was not statistically significant ($p = 0.661$). The fact that the results were negative, though interesting, may merely be a result of the lack of response rate. Results of the Chi-square test for association between change in total NEP score and behavior score was not statistically significant ($\chi^2 = 18.00, p = .324$), nor were the association with change in value scores ($\chi^2 = 32.00, p = .275$).

Though this study showed no significant changes, there were several confounding issues. First, many of the students did not attain proper parental approval. This greatly

limited the number of potential respondents. Out of 43 program participants, only 25 completed usable pre-assessments. Second, due to scheduling conflicts with the outdoor facility, the only time to complete the study on-site was towards the end of the school year. This meant that post assessments were distributed during the AP examination testing window, greatly reducing the number of students willing to complete the post assessment (N = 8). Further study might investigate whether this increased level of stress actually impacted attitudes, values, or behaviors.

As this was a pre-established group of students enrolled in a higher level environmental science class, all students already had learned a large amount about issues of environmental concern prior to participation in this study. Future study should focus on a year-long impact of students enrolled in environmental science courses, such as APES. It would also be worth studying the effect of the overnight visit on the younger students who stay at the same facility. Many of the students interviewed in this study spoke fondly of their memories to the facility as an elementary student, but had not been back since 5th grade – 6 years prior. Such a study would require serious modification to the scales used here; with special consideration to reading level.

The NEP scale itself, and the length of the survey may have discourage some students from participating. Independent analysis of the NEP scale suggest that it may be a fairly high reading level – Frye score analysis is difficult with a survey as it is based on syllables of words per paragraph, but the NEP scale may be as high as a 13th grade reading level. It is possible that the 11th and 12th grade students in this study did not fully comprehend the questions. Future study may choose to focus on using the so called Child

NEP developed by Manoli et al. (2007). This version is likely closer to a 9th grade reading level – based on similar analysis – and would be more appropriate for students at an at-risk school, with a diverse student body, such as the one studied here. There may have been some bias in those students who were willing to complete both the pre and post assessment as they may already have had some level of interest in the environment.

As far as the lesson plan is concerned, the stream study could also be stretched across seasons to make it more engaging for students. Four total county high schools conduct similar studies with their APES classes at different times throughout the year – each of the county high schools get one yearly visit that are scheduled between the elementary school visits. These individual studies could become a more progressive countywide study by sharing data from one school to another in order to investigate changes in assay results throughout the school year. This data could also be entered into online citizen science programs, as described in Chapter 2, such as fieldscope (<http://www.fieldscope.org/>) or NASA’s GLOBE (<https://www.globe.gov/>) to compare to other data sources upstream or downstream. A more comprehensive program have greater impact on students, but would require little extra work for each individual school.

Conclusion

There is much debate, but limited studies over the differences in environmental attitude between genders. In 1980, Van Liere and Dunlap, developers of the NEP, stated that a “sex-environment concern relationship might exist, even though ignored by most researchers” (p. 191). Conflicted results have sporadically surfaced in the almost 40 years since. In 1996, Davidson and Freudenburg called for more attention on gender

differences in environmental concern. This was reiterated by Hawcroft and Milfont (2010). Though studies have found insignificant differences in NEP scores between genders there has been repeated call for further study as studies have shown that women are more likely to *act* in proenvironmental ways, which would indicate some value or attitudinal difference between genders (McStay & Dunlap, 1983). Further study, with a greater sample size, should investigate how the five aspects of the NEP scale correlate independently rather than as a total score as differences may actually be in the various categories of the NEP scale. As stated previously, there have been observed discrepancies between the Rejection of Exemptionalism portions of the NEP scale. In a larger study this may become more apparent. This will be further addressed in Chapter 5.

Serious deficiencies in scientific literacy in the United States must also be considered. As addressed in Chapter 3, U.S. students do not often learn *in* nature and are sequestered from experiencing the natural environment. In order to change behavior, societal attitude must shift. Goleman et al. (2012) established five practices of emotionally and socially engaged citizenry (p. 12): 1. Developing empathy for all forms of life; 2. Embracing sustainability as a community practice; 3. Making the invisible visible (linking decision and consequence); 4. Anticipating unintended consequences; and 5. Understanding how nature sustains life.

Providers of EE and OE can use these aims to further develop programs that address all aspects of the human environment. Throughout the outdoor trips, students were most engaged while cooking lunch, visiting the laboratory to touch a snake or turtle, or while paddling canoes around the lake. In discussion with students, this unfettered

time was by far the favorite part of the trip. As described in Chapter 3, though students learned course content during the stream study, the free time also likely had an important developmental effect on the students (Hanscom, 2016). Such changes are difficult to quantify over a two week period as was studied here, but a more comprehensive, longitudinal study might offer interesting insight.

Knowledge, understanding, skills, and attitudes are all important dimensions of cognition (Palmer, 2008). “However important ecological sensibility is today, the fact is that most of us do not truly grasp how our everyday actions... can threaten the health and well-being of the Earth” (Goleman et al., 2012, p. 4). The NEP scale separates various aspects of environmental attitude to track differences in social attitude; and although attitudes cannot always be used as a *predictor* of behavior, they are certainly an *indicator* (Guagnano, 1995). The key is for individuals to ascribe personal responsibility for the harm they see (Schultz & Zelezny, 1998). It is not enough to know that there is a problem, students must understand how they contribute to it in order to mitigate harm. The lesson in this case study was likely conducted over too short a time period to have any measurable on behavior. Continued study into differences in attitudes, and the effect that educational programs has on them, will provide valuable insight into how to inspire the public to prevent further environmental harm. Chapter 5 will investigate another such outdoor education program.

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CHAPTER FIVE – OUTDOOR ADVENTURE EDUCATION: A CASE STUDY

Introduction

The goal of environmental education (EE) programs are to inspire students to become environmental stewards, who are not only knowledgeable about human impact on the environment, but also take an active role in mitigating harm (Goleman et al., 2012; Stapp et al., 1969). Despite this it is difficult to ascribe the actual role of an EE program to a change in pro-environmental behaviors. Students who choose to participate in EE programs likely already have some level of understanding of environmental issues, and likely already show pro-environmental attitudes. This is important to note because, content knowledge and attitudes are both important dimensions of learning (Palmer, 1998). Providers of EE need indicators to track how programs experiences impacts student attitudes; with the hope of changing values and behaviors. This study focuses on addressing specific questions brought to this researcher by the director of an EE program (Research Questions 1-4, and 7 as listed in the next section), which for the purposes of this study will be referred to as the Program of Study. The Program of Study is a site-based outdoor education (OE) program that brings students to biodiversity hotspots to learn field techniques from researchers. This program directors were interested in learning more about how this experience influenced student attitudes.

The New Environmental Paradigm (NEP) scale separates various aspects of environmental attitude to track changes in social attitude (Dunlap et al., 2000). Although

attitudes cannot always be used as a *predictor* of behavior, they may be an *indicator* (Schultz & Zelezny, 1998). Through personal correspondence with the director of the Program of Study, he specifically wanted to know how gender, age group, and nationality affect attitude. Continued study into differences in attitudes between genders and nationalities provides valuable insight into how active the public is in preventing further environmental harm. Case studies such as this one further understanding of possible links between attitudes and behaviors. This study addressed these questions.

Nationality

In the U.S., there has been a growing trend to keep students indoors. Mainella et al. (2011) reported that, in a study of 830 mothers, 70% of the women played outside when they were young, but only 31% allowed their own children to do so. Louv (2007) reported that only 6% of children, ages 9-13, play outdoors in a given week. A study by the National Sporting Goods Association showed that bike riding had gone down by 31% since 1995 (Louv, 2007). According to Louv (2005) and Ravitch (2010), the No Child Left Behind (NCLB) Act of 2001 provides justification for the wholly indoor lifestyle that students live today. Testing focused education has drawn focus away from outdoor and play based learning. Springs are silent again, not from thinning egg shells, but lack of children outdoors.

Standardized, high stakes testing at the end of the school year, fear of the outdoors, and modern technology have all led to a generation of indoor dwellers. As discussed in previous chapters, in 2005, Louv coined the term Nature-Deficit Disorder (NDD). NDD results from decreased outdoor play among children. Children need regular

interactions with nature for proper social and cognitive development (Hanscom, 2016; Kellert, 1997; Louv, 2005). This was not a novel concept. Education psychologist, Lev Vygotsky published, in 1930, on the importance of a child's surroundings in cognitive development. Vygotsky (2004 translation) wrote that children in adolescence incorporate their surroundings into their cognitive development. He presented the use of mimicry as a crucial creative and developmental outlet for students of all ages.

With regards to nature and EE, Wilson (1984) expanded on this concept coining the term *biophilia* to refer to the innate need to be a part of nature. Kellert (1997) explained that “every person – rich or poor, educated or uneducated, city or country dweller – possesses this aesthetic connection to nature” (p. 39). Tracy (2012) showed that Kellert, Wilson, and Vygotsky's work all interplay in childhood development and need to be addressed in public education. Students must learn from their physical, natural, and social environment. Peer education fits hand-in-hand with outdoor or environmental education. The healthy social relationships that sprout from these interactions help develop awareness and understanding of the complex environmental webs that surround all individuals.

Over the past several decades, hundreds of researchers have measured social paradigm shifts and environmental attitudes (Dunlap, 2008). In personal communication (November 17, 2011), Dr. Dunlap described how social attitudes towards the environment have changed since the 1970s. In a study of 119 suburban public school students, Tracy (2012) showed that students were interested in the environment and *wanted* to act in pro-environmental ways, but their actions did not reflect this attitude.

Louv (2012), would say that this disconnect is due to their sedentary, passive lifestyle; that they have not experienced nature and, therefore, do not respect or understand it. This may not be the case in countries where there is greater focus on science education.

There is no international study of environmental content knowledge among school-aged children, but, as discussed in previous Chapters, environmental education is generally taught in the science courses, so we may be able to gain some insight in differences by looking at international science scores. The *Trends in International Mathematics and Science Study* (TIMSS) is an ongoing study that began in 1995 carried out by the International Association for the Evaluation of Educational Achievement (IEA), an independent research organization. TIMSS reports compare mathematics and science achievement of 4th and 8th grade students to peers in multiple nations. It has been conducted every 4 years since 1995. According to the 2011 study, though there has been an increase in U.S. average score points between 1995 and 2011, there were no measureable increases between 2007 and 2011 (Provasnik et al., 2012). This plateau is concerning. With the release of the most recent preliminary TIMSS data 2017, states that adopted the Next Generation Science Standards (NGSS), discussed in Chapter 2, had two years to implement the NGSS content by the 2015 testing; however, this recent study had limited participation from the United States making correlation of TIMSS data difficult on a state-by-state basis. For the purposes of this study, the 2011 data provides better insight.

Science assessment focuses on content driven, rote subject matter, and on cognition (Provasnik et al., 2012). Cognition is broken into three domains: knowing,

applying, and reasoning. In 2011, in Great Britain, percent of students who scored advanced or at least in the high range for TIMSS benchmarks were 14%, 44% respectively. 8th grade students in the United States scored only 10% for advanced and 40% in the high range. Both countries had 93% of 8th grade students studied score within or above the low range of scores (Provasnik et al., 2012). These students would be in the right age range for the Program of Study in 2015 and 2016. This suggests that both countries have achieved a similar baseline level of science education, but Great Britain has done a better job of pushing learners to understand content to fuller extent. The majority of students who participate in the Program of Study come from the U.S. and the United Kingdom. Differences in general understanding of science due to differences in national education systems may play a role in how students who participate in EE programs view the environment, showing as differences in pro-environmental attitudes or behaviors.

Gender

There is much debate, but limited study, of differences in environmental attitude between genders. Van Liere & Dunlap (1980), the developers of the NEP, stated that a “sex-environment concern relationship might exist, even though ignored by most researchers” (p. 191) and this has continued to hold true. Conflicted results have sporadically surfaced in the 30 years since. Davidson & Freudenburg (1996) called for more attention on gender differences in environmental concern. This was reiterated by Hawcroft & Milfont (2010). Though studies have found insignificant differences in NEP scores between genders there has been repeated call for further study. Studies have shown

that women are more likely to act in pro-environmental ways, which would indicate a value difference between genders.

According to the 2011 TIMSS, in grade 8, there were 17 nations that showed significant differences in the average science scores of males and females, with slightly higher values for males (Provasnik et al., 2012). The same study resulted scores that were slightly higher for males in 6 of the 9 participating U.S. states. The other three showed no significant difference. In grade 4, 20 of the 57 participating education systems, two of which were U.S. states, showed science achievement averages in favor of males while 12 were in favor of females. The other nations showed no significant difference. In grade 4, the United States showed a 10 point difference in achievement, in favor of males, while results in Great Britain showed no significant difference.

Figure 8 depicts data from Provasnik et al. (2012) arranged for differences in average 8th grade science scores, in favor of males, within regions of the United States and Canada. Data also includes national averages. Interestingly, in grade 8, the United States showed an average 10.4 point difference in favor of males while Great Britain showed actually showed a 2 point difference in favor of females. In grade 8, Canada showed an average 3.7 point difference in favor of males. Provasnik et al. (2012) showed that these differences are statistically significant differences in knowledge scores of tested scientific content. Because of this, the provider of the outdoor educational experience highlighted in this study was particularly interested in attitude differences between male and female students.

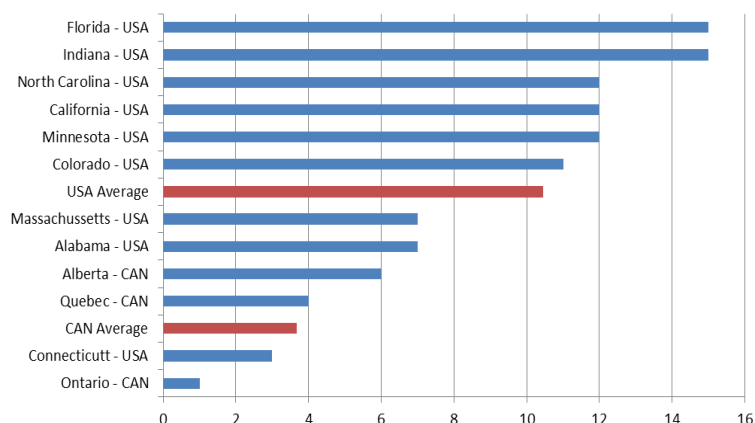


Figure 8: Differences between genders in average 8th grade science scores on the 2011 TIMSS assessment. Scores show point difference in favor of male students. Data from Provasnik et al. (2012) p. 57

Despite the contrast in scientific background, there has been little correlation between gender and general environmental attitudes (Eagles & Demare, 1999) though some studies have found attitudinal differences between genders when studying conservation of specific organisms such as cetaceans (Howard & Parsons, 2006) and coyotes (Draheim et al. 2011). Kellert (1984, 1993) found significant differences in environmental attitudes by race, ethnicity, and geographic location, but did not suggest any significant difference in gender. However, two studies: Kellert & Westervelt (1984), and Eagles & Demare (1999), suggested that females show a more moralistic point of view of the environment. In a controlled study of grade 6-8 Canadian students Eagles & Muffitt (1990) showed little to no significant difference in environmental attitude between genders, but suggested that women may develop these attitudes at a younger age than males. If women do, in fact, develop moralistic attitudes at a younger age than men, a study of older students may show an overall difference in environmental attitudes.

Especially if, in the U.S. and Canada at least, male students are learning slightly more about science as indicated by the TIMSS scores.

In a more broad study, conducted in Pennsylvania, Scott & Willits (1994) found that females were more likely to make purchase decisions based on environmental considerations than males. Despite showing difference in behaviors, Scott & Willits (1994) failed to show significant difference in environmental attitude; prompting researchers to call for more study on gender differences. According to Hawcroft & Milfont (2010), there were only 6 studies between 1988 and 1998 that used the NEP scale to focus specifically on gender. Hawcroft & Milfont (2010) wrote that there needs to be further comprehensive studies explicitly looking at gender and environmental attitude. Repeatedly gender is mentioned as a demographic, but not as the focus of the study.

In a 1983 study, McStay & Dunlap found that there was a behavioral difference between men and women. They found that women are more likely to act in environmentally friendly ways, while men are more likely to suggest that others act in environmentally friendly ways, even if they, themselves, do not. This would explain the findings by Scott & Willits (1994) mentioned previously. Stern & Dietz (1994) expanded on this phenomena, stating: “We found substantial gender differences in beliefs, with women seeing more negative consequences of environmental degradation for themselves, other human beings, and the biosphere, but no gender differences in values” (p.74). This suggested that it is the difference in belief systems and world view, *not* the valuation of the environment that leads to observed differences in behavior.

According to Stern & Dietz (1994), women have stronger beliefs than men that environmental degradation has serious consequences. Less than a year prior, Stern, Dietz, & Kalof (1993) showed that women were more aware of “consequences of events for others and are, therefore, more likely to develop beliefs about these consequences” (p. 330). Such discrepancies in attitude and behavior may be simply because men are more likely to take risks than women (Davidson & Freudenburg, 1996). Regardless, if there are measurable differences in the understanding of scientific content, in belief systems, and in environmental behaviors, further study should be conducted to understand possible links between gender and overall environmental attitudes. More recent studies have focused on specific aspects of environmental concern, such as two different studies (McCright, 2010; McCright & Xiao, 2014) that found correlations between gender and attitudes specifically towards, specifically, climate change.

Differences may actually be in the various categories of the NEP scale. As stated previously, there have been observed discrepancies between the “human exemptionalism” portion of the NEP scale and the other two categories defined by Dunlap and Van Liere (1978). If women do, in fact, have different value systems than men, and act more pro-environmentally, it may be that they have a different attitude of “human exemptionalism”. Differences in the overall NEP score may not be statistically significant between men and women when diluted by the “rights of nature” and “eco-crisis” data, but if taken individually, there may be statistically significant differences between genders within the categories. If, as the TIMSS suggested, men in the United States and Canada, do actually know more science than women, they may score higher on

the more knowledge based “eco-crisis” portion of the survey. This would inflate the overall male NEP score and may negate statistically significant differences in how the genders view the human role in the environment through the “human exemptionalism” category.

Host institution

The Program of Study is a provider of outdoor education and international conservation education (Program of Study website). According to personal communication with The Program founder (March 21, 2012), the Program of Study began by bringing students to do field research in a biodiversity hotspot in a region of Indonesia and has expanded steadily in the years since. They now host students, primarily from the United Kingdom, United States and Canada, for field courses in 12 countries. The Program also offers an array of courses, internships, and research opportunities on site.

This study focused on the study sites in Honduras because, according to the Program director (personal communication, 2012), it is the most popular site. Students participate in a series of lectures including: classification and taxonomy of birds; terrestrial and marine survey techniques; endemism and biodiversity hotspots; and also include site specific information. While visiting the Honduran basecamp at Cusuco National Park outside of San Pedro Sula, where most of the Honduran groups begin their excursion, all the lectures were visited and lecturer were spoken to, discussing pedagogy. Students rotated through lectures and field surveys such as, small mammal trapping, mist

netting (birds and bats), herpetology transects, nighttime insect light-trapping, foliage surveys, and an optional canopy course.

Students are assigned a rigorous schedule of about 4 different activities per day, including very challenging walks on the transects. For the terrestrial portion of the excursion students spent 3 days at base camp, and 3 days at a satellite camp. Satellite camps were very remote. The only electricity was a generator, run only for a few hours each evening, for charging essential battery powered equipment, such as radios, and to light equipment for moth and beetle traps. All bathing is done in natural water sources. Three meals per day and a late afternoon coffee/tea break were supplied by locals employed by the Program of Study. The group provides a portion of proceeds to help maintain the local national park and to support local shade grown coffee plantations. Much of the data collected by the Program is used in international studies to monitor biodiversity hotspots, such as the United Nations' REDD+ (reducing emissions from deforestation and forest degradation) program. Student participation costs and tuition help Program researchers in Cusuco monitor forest health, while supporting visiting researchers who provide the students with hands-on experience learning field techniques in an actual biodiversity hotspot.

Participants

Participants were high school (sixth form for students from the United Kingdom) and undergraduate students primarily from the United States, United Kingdom, and Canada. Participants in this study were volunteers from those enrolled in The Program of Study's Honduras, study abroad program during the summer of 2015 and 2016.

According to the Program organization, the Honduran sites hosted about 500 students between the ages of 16 and 22 per summer. Students varied in socio-economic status as The Program of Study offers fundraising option for lower income students. For the purposes of this study, and to maintain anonymity of students, that information was not collected.

The Program of Study offers several different courses at their Honduran sites, including terrestrial and marine studies. Most students participated in two to three of the offered experiences, but almost all participated in a *Forest Ecology and Jungle Training*, course. Some students, especially the older ones choose to stay longer and participate in more classes. All students have the option of purchasing university credit for these courses through the St. Andrews University, in Scotland.

Testing and test validity

Value scales and behaviors

Value scales are comprised of a 12 question, 5 point Likert scale as developed and described by Kalof et al. (2000). This was received on February 6, 2015 from Dr. Guagnano, a member of the Stern et al. (1998) team (who developed the Value instrument) through personal communication (February 6, 2015). These were described as “short scales” and were developed as a quicker, but still statistically viable, version of the 56 item value inventory published by Schwartz (1992). According to Stern et al. (1998): “Based on analyses reported here, we conclude that an inventory consisting of 3-item measures of the four value clusters defined in Schwartz’s (1992) value theory

provides scores that are both adequately reliable and useful as predictor of relevant attitudes and behavior in our samples” (p. 998).

The 56 item inventory was impractical for this study as it would take too much time and likely reduce response rate. The original inventory covered 10 pre-defined values, but the purpose of investigating which values impact environmental attitudes, Stern et al. (1998) narrowed the field to three values: *egoistic*, *bioshperic*, and *altruistic*. This was later adjusted by Kalof et al. (2000) into the version of the short scale that was used in this study. According to Stern et al. (1998), “We believe that the short scales are now developed well enough for preliminary use of the inventory internationally, especially in research on environmental attitudes and behavior” (p. 1000). This study also included behavioral questions initially published by Stern et al. (1998). Behavior questions were designed to investigate whether respondents actually act in pro-environmental ways.

The value systems short scale published by Kalof et al. (2000) was specifically used to study differences in values between gender and race. The original study focused on U.S. citizens over the age of 18. It did not account for socio-economic status nor education. In this study, it was used to focus on differences between students who participated in a similar field experience, provided by the Program. Value scores were be reported for each value category as described by Kalof et al. (2000). Value categories include *altruism*, *traditionalism*, and *self-interest*. For this study, the openness to change category was removed due to the length of the questionnaire. Six questions addressed altruism. Each question was ranked from 1-5 so altruism as a whole was ranked 6-30 as a

total score per person and mean score was found per study group. Traditionalism and self-interest both only had 3 questions, allowing for a score of 3-15. The total Value score was then calculated out of 60 possible point between all categories

New Environmental Paradigm scales

All New Environmental Paradigm (NEP) scale responses were analyzed as described in Dunlap et al. (2000) and Manoli et al. (2007). Mean NEP score was assessed for each subcategory and a total NEP score was calculated from the mean of those subcategories. This NEP score was then calculated for each demographic in each sitting of the questionnaire: pre -, post- and six months after. Demographics for this study included: gender; age (approximately 16-22 years); and last school year completed. Demographics did not include socio-economic data, but, as discussed later, should be included in further study.

For the purposes of this study, the 5 point Likert scale used by Dunlap et al. (2000) was adjusted to a 4 point scale, with no “unsure”, middle ranking available to respondents. This is the way the questions were presented in the original 1978 publication of the first iteration of the NEP. According to Dr. Dunlap (personal communication, 2015) there was no statistical reason why researchers shifted from the 4 point to the 5 point scale in the 2000 study. The “unsure” ranking was removed to reduce the chance that student respondents would simply mark the middle and forced them to decide a pro or con stance on questionnaire items.

NEP questions were broken into 5 categories: *limits to growth* - beliefs about factors affecting human populations; *antianthropocentrism* - whether or not humans are

believed to be the most important species; *fragility of nature's balance* - human impact on ecosystems; *rejection of exemptionalism* - investigate the idea that humans are exempt from the natural environment; and the *possibility of an ecocrisis* - belief in the likelihood of an environmental catastrophe (Dunlap et al., 2000). The last two subcategories were added to the NEP in the 2000 iteration. NEP questions alternate between positively stated questions, in which agreement indicates a pro-environmental view, and negatively stated questions, in which disagreement indicates a pro-environmental view. The negatively-stated questions were reverse scored when total NEP value was calculated. Mean percent “agree” was calculated for each question and then a total NEP rank for each of the five categories was calculated to compare view changes between Pre, Post, and the six month after “follow-up” responses.

Research Questions

RQ 1: How do the different trips offered at the Program of Study Honduras site impact student view of the environment? If the goal of EE programs is to inspire stewardship, it was hypothesized that students who have a field experience such as that offered by the Program, Honduras site would rank higher on the NEP scale after the experience, indicating that their attitude shifted more pro-environmentally. It was also hypothesized the attitudes would shift back slightly in the six months since the excursion, but still be more pro-environment than before the field experience.

In order to address RQ1, first a Chi-square test for goodness of fit was used to ensure that participants did not respond randomly. Mean NEP scores for each of five NEP subcategories were used to calculate a total NEP score as previously discussed.

Repeated Measures ANOVA testing was used to pre- and post- total NEP scores, and for the Post and Follow-up scores, to investigate growth in environmental attitudes. This was done only for those students who were in the program for 2 or 4 weeks as others would have had more unique experiences.

RQ 2: Do students of a specific school age group show greater changes in NEP score after participating in a field excursion? Because EE is often taught in science classes, it was hypothesized that older students would begin higher on the NEP scale as they may already have a firmer understanding of the science behind issues of environmental degradation and, therefore, show less increase in pro-environmental attitude. Whereas, the high school/sixth form would show a greater shift in environmental attitude. Students still in high school are less likely to have traveled less, or participated in similar types of research before this excursion; and, therefore, the impact would be greater.

Mean NEP scores for each subcategory was calculated as in RQ1, but response categories were broken down by school grade. School years were coded to a new “years of schooling” category so that United States and Canada grades can be compared to United Kingdom years. School year is self-reported. The grade system used by the U.S. and Canada has very different names than the “form” terminology used in the U.K. The “form” years were recoded as the appropriate U.S. grade level. Years of schooling were treated as a ranked, categorical variable and Repeated Measures ANOVA testing used to study the NEP and value scores between the three questionnaires.

RQ 3: Are there differences in environmental attitudes (NEP scores) or in value systems between the genders before participating in a field excursion? Do those scores change after participating? McStay & Dunlap (1983) showed that women are more likely to act in pro-environmental ways. Therefore, it was hypothesized that women would exhibit more pro-environmental attitudes than men. The null hypothesis states that there is no relationship between gender and NEP score.

Total NEP scores were analyzed as described previously, but were then divided by gender rather than by age or school year. MANOVA testing was used to investigate significance of gender on differences in values and NEP scores as described by Kalof et al. (2000). Mean value scores were calculated within each value subcategory (altruism, self-interest, and traditionalism) and a total value score was found for each gender. NEP scores were compared to “value” scores by chi-square test of independence. This was done for each gender independently to investigate stronger correlations between value and attitude in each individual gender.

RQ 4: Are there differences in either the environmental attitudes (NEP scores) or the value systems of students from the United States, United Kingdom, and Canada? Do those scores change after participating? It was hypothesized that students from the U.S. would show scores the lowest in NEP and value scores because in the U.S. issues of environmental concern are more often taught in science classes and U.S. students score lower on international science scores. Therefore, it was considered likely that the U.S. students would show the greatest change in score. The null hypothesis states that there is no difference in attitude, nor values, between students of the different

nations. Total NEP and value scores were analyzed as previously described and grouped by country of origin of the participant. Percent change in Total NEP scores and Value scores were calculated and Chi-square test of association analysis used to investigate each NEP and value category individually between nations.

RQ 5: Is there a connection between self-reported group dynamics and environmental attitudes or values? Studies have shown that outdoor education programs foster learning as a community (Butcher, 2016; Kelley & Williams, 2013). Therefore, it was hypothesized that students who stayed in touch with members of their group post-field experience would show greater change in environmental attitudes. Respondents were asked in the six-month follow-up whether or not they have kept in touch with people on the trip. In order to rank how well those participants communicated with individuals met on the trip in the 6 months following travel, respondents were given several options that were scored as following: those that reported being social media friends were scored as a “1”; those that reported personal communication via email or a social media messenger application were scored a “2”; those that reported speaking on the phone were scored a “3”; and those that reported seeing one another in person were scored a “4”.

Respondents were also asked to classify their group as “extroverted”, “introverted”, “fun-loving”, “partiers”, “studious”, “hard-working”, and/or “academically driven”. Upon review of the post- assessment data, all groups were described as “extroverted” and “fun-loving”. Therefore, group distinctions were made between groups were described as “partiers” versus those that were only described as more “academically

focused”. Excluding the “fun-loving” and “extroverted” tags, those group descriptions that included the tag “partiers” were scored a “1” and those that did not include that tag were coded a “2”. Individual one-way ANOVA testing was used to compare changes in NEP score and value score within the group qualities to investigate links between greater change in score and the qualities of the group. Chi-square test of association was used to investigate which qualities associated with the students actually keeping in touch.

RQ 6: Is there an association between student view of instructors and in interest in environmental issues? Instructor qualities were selected from a list of leadership qualities published in Forbes magazine (Prive, 2012). Educators must be strong leaders and, therefore, proposedly, possess similar qualities to a business leader. For the purposes of this study, the following seven traits were chosen: communication; sense of humor; confidence; commitment; positive attitude; creativity; and inspiration. It was hypothesized that students in groups with educators that showed the most leadership qualities would show the greatest change in NEP score.

Grade	Meaning
A	The respondent has listed more than two qualities for each question all qualities listed of the respondent's instructor directly match the qualities listed for an ideal instructor.
B	The respondent has listed more than two qualities for each question and more than 2/3 of qualities listed of the respondent's instructor match the qualities listed for an ideal instructor. Or, the respondent has listed only one response, but it is a match.
C	The respondent has listed more than two qualities for each question and less than 1/3 of qualities listed of the respondent's instructor match the qualities listed for an ideal instructor. Or, the respondent has listed only two response and one is a match.
D/E	Less than 1/4 of qualities of the respondent's instructor match the qualities for an ideal instructor.

Figure 9: Rubric for grading the student reported qualities of an instructor versus the student reported qualities of an ideal instructor.

Respondents were asked to select which qualities describe their ideal teacher. They were presented with the same list of characteristics and asked to describe their instructor. Each respondent was graded for matches between ideal instructor and their instructor based on the rubric shown in Figure 9. Chi-square test of association was used to assess which of these grades associated with questions in the six-month follow-up specifically asking if they have made any changes in information gathering and sharing (on social media) within the past six months. Repeated measures ANOVA testing was used to investigate changes in behavior between the pre- and follow-up assessments between scored instructor grades.

RQ 7: Does change in environmental attitude (NEP score) between tests associate with change in self-reported behavior? The goal of EE programs is to inspire

students who are active members of their community. Therefore, it was hypothesized that there would be a relationship between attitude towards the environment and behavior.

Percent change in attitude and value were calculated and compared to coded pro-environmental behavior for the group as a whole. ANOVA testing was used to compare changes to behavior codes. Responses to behavior questions were coded by type of behavior. Behaviors include: being a member of a conservation or environmental club, likelihood of joining a club, reading and sharing environmental information in person and online, making an effort to purchase fruits and vegetables without pesticides or chemicals, using reusable bags, making purchasing decisions based on the environmental impact of the producer, buying recycled products, willingness to pay higher prices to protect the environment, willingness to pay higher taxes to protect the environment and willingness to accept cuts in standard of living in order to protect the environment. These behaviors were edited from the Kalof et al. (2000) study, but edited to include social media aspects in the attaining and sharing of information.

Each behavior was assigned a code: 1 meaning “never”, 2 meaning “not very often”, 3 meaning “often” and 4 meaning “always”. There are three questions that were answerable as “yes”, or “no”. They ask whether the respondent is willing to pay higher prices to protect the environment; willing to pay higher taxes to protect the environment; and willing to accept cuts in standard of living in order to protect the environment. These were each be assessed individually. A “yes” was be coded as a 4 and a “no” as a 1. Then a mean score behavior score was calculated for each student, and mean for the group, so that pre-, post-, and Follow-up scores could be compared with NEP. A Pearson’s

correlation and simple regression was used to investigate any correlation between behaviors with NEP scores. Correlations for percent change and six-month follow-up data were done individually.

Results

With regards to RQ 1 – “*Do students who participate in different field experiences show changes in NEP scores pre- and post-trip?*” – results of the Chi-square goodness of fit test indicated that students did not respond randomly to the NEP questions ($p < 0.05$), except for NEP question 2 - *Humans have the right to modify the natural environment to suit their needs* ($p > 0.05$). It is interesting that this is one of the questions that was reverse scored (to act as a check that the students were not simply ticking boxes without consideration of the question). It is possible, however, that the negative wording of the survey item confused students.

Results of the repeated measures ANOVA for the 2-week and 4-week participants did show a statistically significant change in NEP score between the pre- ($M = 3.195$, $SD = 0.321$) and post- ($M = 2.985$, $SD = 0.174$) assessment at the 0.05 level. Specifically, Wilk's $\Lambda = 0.715$, $F(1, 2) = 6.368$, $p = 0.023$, $\eta^2 = 0.285$. Observed power was 0.659. However, student scores decreased, rather than the expected increase. It is worth noting that these are scores out of a 4-point scale, showing a fairly strong pro-environmental attitude, even prior to travel abroad.

Results of the comparison between pre- ($M = 3.195$, $SD = .321$) and follow up ($M = 3.309$, $SD = 0.273$) NEP attitude scores were not significant; Wilk's $\Lambda = 0.912$, $F(1, 2) = 1.382$, $p = 0.257$, $\eta^2 = 1.382$. Observed power was 0.198. This suggests that strangely

pro-environmental attitudes decline directly after the excursion, but then rebounded within 6 months back to within the students' original attitude scores. It is possible that spending multiple weeks in the field had a deleterious effect on student attitudes, with perhaps students being environmentally idealistic and highly motivated prior to the trip, with the reality of being in a developing country tempering their environmental idealism a little, but in the long- term, the experience did not change their overall attitude.

With regards to RQ 2 – “*Do students of a specific school age group show greater changes in NEP score after participating in a field excursion?*” – results of the repeated measures ANOVA for participants did not show a statistically significant change in NEP score between the pre- and follow-up assessment at the 0.05 level. Specifically, Wilk's $\Lambda = .891$, $F(1, 2) = 0.227$, $p = 0.971$, $\eta^2 = 0.109$. Observed power was 0.090. This is not surprising as the sample size per year of schooling was very small. Table 3 shows mean total NEP score for each participant by year of schooling for the pre-assessment and the six month follow-up ($N = 21$). In order to investigate further and attempt to increase sample size within each category, students were divided into two categories: those in what could be considered the U.S. equivalent of high school ($N = 8$); and those attending a college/university degree program ($N = 13$). Results still yielded no significant difference between the total pre- NEP score ($M = 3.260$, $SD = 0.270$) and follow-up score ($M = 3.295$, $SD = 0.266$). Specifically, Wilk's $\Lambda = 0.983$, $F(1, 2) = .319$, $p = 0.579$, $\eta^2 = 0.017$. Observed power was 0.084. Furthermore, a simple regression was calculated between percent change in total NEP score between the pre-assessment and the follow-up

assessment, and the student age at the time of the trip, showed no statically significant changes ($r = 0.357$, $p = 0.113$).

Table 3: Mean Pre-assessment and Follow-up assessment scores for all participants by years of schooling.

	Years of schooling	Mean	Std. Deviation	N
Pre - Total NEP	11	3.1000	.32527	2
	12	3.3000	.32527	2
	13	3.2500	.26683	4
	14	3.2433	.26764	3
	15	3.1720	.29987	5
	16	3.3767	.33247	3
	17	3.2700	.	1
	19	3.6700	.	1
	Total	3.2600	.26950	21
Follow-up - Total NEP	11	3.3350	.19092	2
	12	3.3000	.42426	2
	13	3.2825	.36854	4
	14	3.3133	.14012	3
	15	3.2120	.15897	5
	16	3.3533	.48952	3
	17	3.1300	.	1
	19	3.6000	.	1
	Total	3.2948	.26583	21

With regards to RQ 3 – “*Are there differences in environmental attitudes (NEP scores) or in value systems between the genders before participating in a field excursion? Do those scores change after participating?*” – results of the one-way MANOVA for participants did not yield statistically significant change in NEP score ($p = 0.621$) nor for the change in “value” score ($p = 0.998$) between the pre- and follow-up assessment for either gender (female: $N = 13$; male: $N = 8$) at the 0.05 level. Interestingly, both genders saw a slight decrease in the mean “value” score with female respondents decreasing by

about 3.96% and male respondents by about 3.97%. Although not statistically significant, this may warrant further investigation with a larger sample size. Results of the Chi-Square test of independence also did not yield statistically significant results for change in NEP ($\chi^2 = 21.00, p = 0.226$), nor for change in Value ($\chi^2 = 21.00, p = 0.337$).

Repeated measures ANOVA comparing pre-assessment to follow-up assessment average scores by each NEP scale category also showed no significant difference for two categories. Specifically “*limits to growth*” ($p = 0.126$), and the possibility of an “*ecocrisis*” ($p = 0.556$). However, the other three did show significant differences in changes from the pre- to follow-up assessments between the genders. Under the “*antianthropocentrism*” category, female respondents did display a slightly more pro-environmental attitude on the follow-up assessment ($N = 13, M = 3.33, SD = 0.59$) than their male counterparts ($N = 8, M = 2.96, SD = 0.41$). Specifically, Wilk’s $\Lambda = 0.810$, $F(1, 2) = 4.464, p = 0.048, \eta^2 = 0.190$. Observed power was 0.518. Interestingly, this difference is due to a reduction in attitude score as shown in Table 4.

Table 4: Mean New Environmental Paradigm (NEP) Score for the Pre-assessment and the Six Month Follow-up.

NEP Category	Gender	Pre Test		Follow-up	
		Mean	StDev	Mean	StDev
Limited to growth	Female	3.08	0.53	3.15	0.44
	Male	2.71	0.41	3.08	0.43
Antianthropocentrism	Female	3.33	0.56	3.33	0.59
	Male	3.37	0.38	2.96	0.41
Nature's balance	Female	3.26	0.41	3.49	0.50
	Male	3.29	0.42	3.04	0.49
Rejection of Exemptionalism	Female	3.18	0.44	3.08	0.47
	Male	2.87	0.40	3.21	0.25
Eco-crisis	Female	3.64	0.48	3.71	0.38
	Male	3.75	0.30	3.71	0.45

There was also a statistically significant difference in the “*fragility of nature’s balance*” category ($p = .031$). As shown in Table 4, female respondents displayed an increased mean NEP score in this category from 3.26 ($SD = 0.41$) to 3.49 ($SD = 0.50$) and male respondents actually decreased from 3.29 ($SD = 0.41$) to 3.04 ($SD = 0.49$). Wilk’s $\Lambda = 0.777$, $F(1, 2) = 5.456$, $p = 0.031$, $\eta^2 = .223$. Observed power was 0.601. Interestingly the “*rejection of exemptionalism*” category showed a significant change between the pre-assessment and the follow-up favoring change in the male respondents. Wilk’s $\Lambda = 0.803$, $F(1, 2) = 4.652$, $p = 0.044$, $\eta^2 = 0.197$. Observed power was 0.535. Mean NEP category score increased from 2.87 ($SD = 0.40$) for male respondents on the pre-assessment compared to 3.21 ($SD = 0.25$) on the follow-up and decreased from 3.18 ($SD = 0.44$) to 3.08 ($SD = 0.47$) for female respondents. Although these changes in individual categories are interesting findings, they do not tell us much about why these changes occurred, but warrant further investigation with a larger sample size.

With regards to RQ 4 – “*Are there differences in either the environmental attitudes (NEP scores) or the value systems of students from the United States, United Kingdom, and Canada? Do those scores change after participating?*” – results of the Chi-square test for association showed no significant difference in change in total NEP score ($\chi^2 = 105.875, p = .377$), nor in change in “total value” ($\chi^2 = 126.000, p = 0.208$). In order to investigate further, repeated measures ANOVA testing was used to compare pre-assessment and follow-up assessment responses for the “total NEP” by country, but this also did not yield significant findings ($p = 0.202$). Nor was there a significant change in “value” results ($p = 0.848$). Table 5 shows the mean pre- and follow-up assessment results for total “value” scores organized by home country of the respondent. As stated previously, the limited sample size likely played a large effect in the lack of significant findings.

Table 5: Mean Total Value Scores by Home Country of Respondent.

	Country of origin	Mean	Std. Deviation	N
Pre - Total Value	United Kingdom	45.5000	3.82575	12
	United States	47.5000	3.53553	2
	Canada	46.0000	2.00000	3
	Brazil	53.0000	.	1
	Ireland	48.0000	.	1
	Norway	48.0000	.	1
	Portugal	49.0000	.	1
	Total	46.5238	3.53014	21
Follow-up - Total Value	United Kingdom	44.5000	5.94673	12
	United States	45.0000	1.41421	2
	Canada	44.3333	5.85947	3
	Brazil	49.0000	.	1
	Ireland	43.0000	.	1
	Norway	46.0000	.	1
	Portugal	50.0000	.	1
	Total	45.0000	5.04975	21

With regards to RQ 5 – “*Is there a connection between self-reported group dynamics and environmental attitudes or values?*” – results of one-way ANOVA analysis for change in the total NEP score between groups showed no significant difference ($p = 0.075$) between the groups listed as “partiers” ($N = 5$) and the groups listed as more “academically focused” ($N = 7$). There was also no significant difference in the change in total “value” scores between groups ($p = 0.799$). Interestingly, when recoded to investigate those groups that only used the “partier” descriptive ($N = 2$), with no conjoining other descriptive other than the ubiquitous “hard-working” tag that was disregarded, there was a significant difference in total NEP score only ($p = 0.049$) at the 0.05 alpha level meaning that it was almost not significant, but a 12.7% Mean increase in NEP score of the “partiers”. Though this is only two respondents, who may actually be

describing the same group, it is an interesting result that may warrant further investigation at least in terms of the Program. Results of the Chi-square test for association also did not yield significant findings ($\chi^2 (3) = 1.029, p = 0.794$). Although not statistically significant it is worth adding that 3 of the 7 respondents from the “academic” group made personal contact outside of email or social media with other students that they met on the trip, whereas only 1 of the 5 respondents from the “partiers” group did. Future investigation should include a way to parse out which respondents were from the same group. As this survey did not include tour dates, it would be impossible to tell with this collected data.

With regards to RQ 6: “Is there an association between student view of instructors and in interest in environmental issues?” results of the Chi-square test for association yielded no significant association between instructor grades, as described in Figure 9, and whether or not students began subscribing to environmental or conservation-based groups online ($\chi^2 (4) = 6.460, p = 0.167$). Further investigation also found no association between instructor grades and whether or not respondents joined environmental groups after the trip ($\chi^2 (2) = 0.093, p = 0.954$). Total respondents for this analysis were only 21 individuals, meaning that the grade categories of “A”, “B”, and “C” only included 8, 10, and 3 individuals, respectively – there were none that scored “D”. This may have had a serious effect on the results of the cross-tabulation. Results of the repeated measures ANOVA testing between the pre-assessment total “behavior” score and the follow-up score was also not statistically significant meaning that there is no statistical difference

between groups. Specifically, Wilk's $\Lambda = 0.980$, $F(1, 2) = 0.184$, $p = 0.834$, $\eta^2 = 0.020$. Observed power was 0.074.

With regards to RQ 7 – “Does change in environmental attitude (NEP score) between tests associate with change in self-reported behavior?” – results showed no significant correlation between percent change in total “behavior” score and percent change in “total NEP” score ($p = 0.430$). Specifically, $F(1, 19) = 0.651$, $r^2 = 0.033$ meaning that there was no significant linear relationship between the two measures. However, when investigating a correlation between the “behaviors” and just the “follow-up” data, there was a weak linear relationship between mean follow-up NEP scores and mean behavior scores ($p = 0.011$). Specifically, $F(1, 19) = 7.894$, $r^2 = 0.294$. Indicating that pro-environmental attitude may have a weak correlation with pro-environmental behaviors. However, this is not altogether surprising as the “behavior” scale used in this study was specifically designed for use with the NEP scale.

Conclusions

Differences in the overall NEP score may not be statistically significant between males and females, but when accounting for each category individually, there were slight differences in three of the five categories: *antianthropocentrism*; *fragility of nature's balance*; and *rejection of exemptionalism*. These differences were masked when calculating the total NEP score. Although they showed statistically significant differences between the pre-assessment and the follow-up, the limited number of respondents makes it difficult to say with confidence that these results are, in fact, due to the nature of the Program of Study. Once adjusting for unaccounted for minors, or incomplete surveys,

only 21 total respondents (over two years) produced usable survey data – 8 male and 13 female. Any attempt to link these changes in attitude to changes in values or behaviors yielded insignificant results.

Only two of the respondents reported being more active in following social media groups after the trip while 14 of the 23 students who completed the follow-up questionnaire reported having followed conservation-based social media groups for more than a year, meaning they already had some level of interest in the environment prior to travel. Total NEP score for the pre-assessment group had a mean score of 3.26 ($SD = 0.31$) out of 4 possible points, showing that the group, on average, did lean towards pro-environmental attitudes. This makes sense due to the rigorous nature of this trip and the time, expense, and distance travelled to take part in such an experience. Only an environmentally-focused person would even be interested in going on such a trip in the first place. It would be interesting to see how this compares to a random sample of the general public, rather than those who are willing to enroll in such a rigorous program. Pre-established attitudes and values that were highly pro-environmental prior to the excursion would make it difficult to show growth on such a limited scale. In many respects, the program is largely preaching to the choir, so to speak. It's possible that the trip may even have, at least initially, have slightly dampened the environmental idealism of participants as they faced the harsh reality of environmental issues and threats in the field. Further analysis may consider expanding the range of Likert responses to allow for more variation.

There may be a certain level of privilege in being able to participate in such an international environmental excursion. Trips such as the one studied here require thousands of dollars per student for travel costs. On top of that students need at least one backpack (though a larger pack and smaller day pack are both recommended), appropriate footwear, sleeping bag, and other field gear such as a water bladder, flashlight (torch) and personal medical kit. These are expensive items. An average student are unlikely to have access to these items in advance, so their cost would have to be added to that of the excursion itself. It is to be noted that, some of the tour group leaders stated that their groups had done fundraisers to cover costs. Regardless, there may be some implicit bias in who is actually capable of acquiring the necessary funding to participate.

Demographic information was not collected in this study, but may warrant further investigation, as this may have played a role in the limited findings of the group dynamics. If the groups were all, in fact, fairly homogenous socio-economically, then this would explain the limited differences in ways that respondents described their groups. All groups were described as some combination of “out-going” or “extroverted”, it is possible that this is because only outgoing individuals were willing to partake in such an adventure, or obtain the funds needed to participate in an excursion.

While programs such as the Program of Study’s Honduran site-based learning experience likely has a profound experience on the students who participate, it is difficult to quantify changes using these current scales because the students already have very strong pro-environmental attitudes. Regardless, such programs are essential for training

students in the techniques needed to become field scientists. These programs can also support local agriculture and international efforts to maintain biodiversity hotspots. This makes the Program of Study a worthwhile experience for students, and worth supporting, as far as global conservation efforts are concerned, but this program may not be the most educational or transformative experience for a student who is not already ecologically inclined. The travel, accommodations, climate and terrain in the expeditionary country are difficult. Such a trip may actually turn some students off from pursuing environmental studies. This could account for the dip in total NEP score recorded in the post- assessment: i.e., their environmental idealism was a little tempered by the harsh reality of actually working in the field.

It is important to note that the lecturers with the program had little background in pedagogy. The primary lecturer had a background in environmental science and some experience teaching undergraduate courses, but no formal training in educational delivery. In private conversation with lecturers, we did discuss teaching techniques such as “wait-time” for questions, a simple technique in which a teacher counts to 10 in their head after posing a group question to allow students sufficient time to process the question rather than just call on the first student to raise their hand. This ensures that most students process the question before they hear the answer from the most responsive student. Guest lecturers were experts in the techniques presented, and some had experience teaching at the collegiate level, but none that were encountered during the site visit had any formal training in dealing with, or teaching, younger students - nor in

differentiating lessons to a diverse academic group, to some of whom English was a second language..

It is also important to note that, though knowledgeable in their fields, many of the researchers also had little educational background. As stated, student tuition and program fees pay for researchers to conduct field work that is often used in international studies. However, there was disparity between how willing the researchers were to discuss what it was that they were doing and why. One researcher did not seem to engage the students at all, but just collected data while students watched. That being said, some researchers were excellent and talked through everything that they were doing. For example, the small mammal expert made sure that he worked slowly so that every student could see how he masses each specimen, he taught students a little bit about each species as they were caught and even started discussions on broader topics such as endemism and invasive species. Providing all researchers and lecturers with some basic pedagogical skills may make the experience more accessible, and rounded, for visiting students.

While students were at the terrestrial site, they had an exhausting schedule. Student groups were often up and in the field as early as 5:15AM and continued through the day until at least 8:30-9:00PM. This included at least 3 long treks on difficult terrain and at least 2 hour long lectures each day. Some of these students had just finished traveling for more than 24 hours from across the Atlantic to climb up a mountain and then sit through lectures. Allowing the students more down time for reflection would be a great benefit for their learning. This could be done by shortening lecture or removing activities. Students should also keep a journal so that they can reflect upon what they

learned and enjoy being in the natural space. The whirl-wind nature of the expedition was likely the reason for the observed decrease in attitude score between the Pre and Post assessments.

Programs such as the one studied here have obvious merit for those students already active in environmental fields of study who are looking to further their knowledge through field experience, but if real change is to be achieved, environmental programs must reach all students – and inspire them become stewards.

Further research

Further investigation into how such attitudes differ between genders may be warranted, but studies should focus on the individual components of the NEP rather than total NEP score. As stated previously, OE and adventure-based learning can be fantastic, formative experiences for the right student, but they are both cost and time prohibitive. EE must be addressed in more formal educational experiences and reach a broader group of students, as opposed to programs that preach to the choir. There must be inclusion of EE into public education if there is to be a real paradigm shift in public attitudes and behaviors. As discussed in Chapter 2, there are serious funding barriers to such inclusion. With this in mind, Chapter 6 will focus on less obvious, non-Federal, sources of funding for U.S. public school teachers to incorporate environmental programs into a more typical school setting.

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CHAPTER SIX – CONCLUSIONS

Environmental issues are social, political, economic, human health, as well as ecological issues (Andrews, 2006; Caldwell, 1996; Kellert, 1997; Wilson, 1998). Therefore, they should be addressed in multiple realms of study within a public school education and not just relegated to the science course curricula. Environmental education (EE) should be a unifying concept across disciplines because it focuses on attitudes and behaviors, allowing teachers to actively engage students in real world, tangible experiences (Gough, 2013; Wals et al., 2014) while promoting a constructive academic community amongst faculty (Monroe & Allred, 2013).

Bridging the gaps in the core subjects will establish a cohesive, *consilient* education that teaches the whole student. Consilience is the linkage of ideologies from various fields of study (Wilson, 1998). As discussed in Chapter 2, this multi-curricular nature has been one of three major barriers to inclusion of EE into public education, along with limited funding and the controversial nature of environmental issues. EE has been grouped into the already time-constricted science courses. However, with careful planning and administrative support, EE can be used as a comprehensive link between subjects, addressing issues of horizontal alignment between departments, and become a focus upon which to build an active academic community, turning this barrier into an asset.

Another one of the three principal barriers to implementation of outdoor education (OE) or EE programs is access to adequate funding. Participants in the programs studied here had access to the funding necessary to participate in such expensive programs. Socio-economic demographics were not collected in either study, however, tuition at one of the U.K. schools encountered while at base camp costs £12,300 per term, meaning it costs a little over \$33,000 per year to attend (according to the school website, which will remain anonymous for the purposes of this study). The county discussed in Chapter 4 spends approximately 50% more than the U.S. national average of total spending per pupil (Turner et al., 2016). Both case studies were novel experiences for students, not part of the regular curriculum, which required a higher level of economic support and privilege than most students can afford. This reiterates the need for supplemental streams of funding for EE in public education. Ideally, public schools would have funding for, and time to implement, intensive, inquiry-based EE programs that get students outdoors. However, as discussed in Chapters 1 and 2, this is rarely the case; in-fact, most schools rely on grants for such programs. Appendix A includes a table of national grants available to public school teachers for implementation of EE programs.

As mentioned, environmental issues can be controversial. OE programs studied in Chapters 4 and 5 did not directly address either of these barriers. Programs such as these are fantastic hands-on experiences for students already interested in environmental issues, but do not use cross-curriculum approaches nor address controversies in order to reach a greater audience. The outdoor facility discussed in Chapter 4 is a great resource, but it was over an hour drive from the school. Most of the students surveyed in Chapter 4 had

not been to the facility in more than 5 years because of limited access. The school of focus in Chapter 4 has a wooded area on school grounds and a stream within a 10 minute walk from school; where the students practiced protocols for use at the outdoor facility. These resources should be more readily used so that students can learn about the natural settings they walk by every day, but may not appreciate. This appreciation for local spaces is key. Outdoor experiences do not need to be as strenuous as the program discussed in Chapter 5. In fact, the hardships involved in the wilderness program may have even turned some students off to conservation field work, as evident in the fact that there was a statistically significant decrease in environmental attitudes between pre- ($M = 3.195$, $SD = 0.321$) and post- ($M = 2.985$, $SD = 0.174$) assessment ($p = 0.023$). This indicates a need for more inclusive, and less physically demanding, programs that can serve a broader range of students.

In both case studies, participants showed pro-environmental attitudes and values prior to engaging in the outdoor experience. Participants in both programs showed environmental attitude scores close to around 3.2 out of a possible 4 points on a Likert scale prior to self-enrolling for these experiences. They also had some level of familial or school district-level economic privilege. This means that both groups may have been relatively homogenous with respect to affluence and environmental perspectives. This would explain why there were no significant findings in the study of attitude diversity across groups in Chapter 5. Both studies show the need to reach more diverse groups of students through comprehensive changes in academic content.

The lack of significant findings throughout both studies suggests that two weeks is not enough time to change one's attitude or behavior. This timing struggle may be linked to the other three barriers discussed. It may be due to limited funding, or that EE is too multi-curricular to fit into one content. Regardless, EE programs such as the two week streams study in Chapter 4, become novel, one-off experiences crammed to the end of an otherwise well-organized curriculum. This disengages students and further disconnects environmental issues from students' world view. To have a profound impact EE must be addressed regularly throughout a child's academic career.

Moving forward

As far as the surveys, themselves, are concerned, environmental attitude, value, and behavior change research should also further investigate differences in the specific categories within the total scales. As shown in Chapters 4 and 5, even when there were no significant changes in total New Environmental Paradigm (NEP) score, there were sometimes significant findings within the individual attitudinal categories. This warrants further investigation. If the goal of education programs is to increase pro-environmental attitude, instructors would want to examine how lessons impact all aspects of attitude, not just total score. Some results even showed decreases in some aspects of attitude scales, such as male respondents showing a decrease in *antianthropocentrism* score in the study discussed in Chapter 5. If one is to establish an effective educational program, it is worth asking why the males found themselves more removed from nature after the program and then directly addressing that in practice.

Also, the NEP scale itself may need reworking for modern students. The language of the scale may be difficult for students, especially those that are non-native English speakers, such as some of the students at the school studied in Chapter 4. The version of the NEP published in 2007 by Manoli et al., for instance, is shorter and may be a more appropriate reading level for these high school students. The behavior scales used for this study – from Kalof et al. (2002) – were modified to include social media behaviors. For example, the original scales asked about whether or not respondents subscribed to environmental newsletters (Kalof et al., 2002), this was modified in the surveys in Chapters 4 and 5 to ask about whether or not respondents followed environmental pages online. Further updates may be necessary to gain better insight into participants' use of social media to engage in environmental issues.

Future development of EE programs must acknowledge and overcome each of the three barriers discussed: (1) Funding, (2) The multi-curricular nature of environmental issues, and (3) The controversial nature of environmental issues. EE programs must not rely on privileged, self-selecting groups for participation. They must reach more students and spark interest in those not already engaged. One way to make funding more readily available to teachers is to reallocate management of the National Environmental Education Act (NEEA), discussed in Chapter 1, back to the Department of Education (DOE) as it was in the 1970, original version of the act. In 1990, the NEEA was moved to the EPA. This made this source of education grants less obviously available for educators outside of the science realm. As shown, previously, only 10% of Federal funding earmarked for EE goes directly into public and private K-12 schools while 55% goes to non-

profits. The DOE already provides teaching grants, by moving management of the NEEA to the DOE it would ensure that some of the education grants are specifically for EE.

In order to address issues of controversy and the multi-curricular aspects of EE, programs should focus on engaging students in the natural spaces within their local community. This will turn these barriers into assets by encouraging students to bridge disciplines and discuss controversial issues in a safe, academic setting. Too often, U.S. students do not learn *in* nature, and are sequestered from experiencing the natural environment, but in order to change behavior, societal attitudes must shift (Saylan & Blumstein, 2011; Schultz & Zelezny, 1998). The key is to actively involve students with the natural world in order for them to find a place within natural spaces (Bekoff, 2014; Ewert et al., 2014; Gough, 2013; Louv, 2012). Goleman et al. (2012) established five practices of emotionally and socially engaged citizenry (p. 12): *(1) developing empathy for all forms of life; (2) embracing sustainability as a community practice; (3) making the invisible visible (linking decision and consequence); (4) anticipating unintended consequences; and (5) understanding how nature sustains life*. Providers of EE should use aims such as these to further develop programs that address all aspects of the human environment.

Utilizing OE programs will engage students in their local community, and engage the community in students' education (Redmond et al., 2010; Wattochow & Brown, 2011). To start the process of crossing curricular bridges, schools should focus on a specific goal, such as nesting gardening or hiking programs within community spaces. The physical environment of an academic setting can influence student identity, aiding in

student understanding of their place within a system (Stedman & Ardoin, 2013). Just the act of learning in a natural space can influence student cognitive development and overall well-being (Hanscom, 2016; Howes et al., 2009; Louv, 2005, 2007, & 2012).

Multi-curricular, school-wide programs will help students ascribe personal responsibility for issues of environmental degradation, limiting their anthropocentric world view. Such efforts will create spaces for students to discuss and examine controversial topics, while motivating them to work towards solutions to environmental problems. The NEEA of 1990 states that it is U.S. national policy to support EE through all academic fields (NEEA, 1990). Programs such as the ones discussed here did not achieve this on a broad scale. Education must instill this sense of place in *all* students, inspiring them to become stewards of their local environment. Only then can we make real change through a national social paradigm shift.

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APPENDIX A: SOURCES OF NON-FEDERAL FUNDING

Introduction

Full incorporation of EE into public school curricula will take a state and federal budget reevaluation, but issues of human caused environmental degradation are dire. It is in our collective best interest to find funding and do what we can to educate youth immediately while working towards a better education system. With this in mind, educators must seek alternative sources of funding for project implementation. Other than the EPA or National Science Foundation grants discussed in Chapters 1 and 2, there are innumerable non-federal sources of grants and funding available for EE or OE programs. However, grant searches can be overwhelming and, counterintuitively, may cost money in order to subscribe to agencies dedicated to finding sources of funding. Table 6 offers 30 national grants that are awarded at least once yearly, organized by the environmental issue the funding is intended to address. Included are timelines for application, average award amounts when available, and a hyperlink to more application information.

Table 6: Nonfederal Sources of Funding for Environmental Education Programs in Public Schools

Community engagement and sustainable development	
The Harley-Davidson Foundation	The goal of this funding source is to build sustainable communities in areas in which Harley Davidson has corporate headquarters by providing funding for programs that focus on health, education, and the environment; specifically environmental education, sustainability, and conservation. Deadlines vary year to year, but are in March, June, September, and December. This may be a good source for any environmental education program that has a community focus. For more information: http://www.harley-davidson.com/content/h-d/en_US/company/foundation.html
International Paper Foundation, USA	Provides funding to non-profits and grants to support areas of critical need such as education and the environmental; specifically sustainable forestry. Application deadlines vary by location. This could be a good source of funding for an invasive species removal project or a trail based project. For more information: http://www.internationalpaper.com/company/regions/north-america/ip-foundation-usa/signature-causes
The Braitmayer Foundation	Provides funding up to \$35,000 for K-12 education programs with innovative ideas. This may be a great source of funding for new outdoor education programs. Application window is in February. For more information: http://www.braitmayerfoundation.org/guidelines/
Captain Planet Foundation	Provides funding up to \$2,500 for K-12 education programs that inspire stewardship through hands-on learning opportunities. This may be a great source of funding for new OE programs. Gardening programs have been awarded funding in the past. Primarily focused on Atlanta suburbs and southern California, but occasionally offers funding nationally. Applications accepted in two windows, mid-January for spring implementation and mid-July for fall implementation. For more information: http://www.captainplanetfoundation.org/apply-for-grants/
KIND Foundation (Kind snack bars)	Each month the KIND Foundation awards funds up to \$10,000 for a community cause. Applicants submit a pitch to the KIND Foundation website and visitors to the site vote on which cause should receive funding. May be a good source for community base engagement program. Application deadlines are rolling. For more information: https://www.kindsnacks.com/foundation/causes/
Gannett Foundation - Community Action Grants	Grants for projects that include education, community development, and environmental conservation. Deadlines in February and August. Grants range from \$1,000-\$5,000 except in the Washington, DC metropolitan area where they may range up to \$10,000. More information: https://www.gannettfoundation.org/guidelines.htm
The Lawrence Foundation	The Lawrence Foundation specifically focuses on environmental economics, previously hosting conferences with the National Resource Defense Council. The Foundation awards grants that help improve the environment and human health and is fairly broad in focus, but specifically funds public school programs. Application deadlines in April and November. More information: http://www.thelawrencefoundation.org/grants/grant-guidelines/
Lowe's Charitable Education Foundation - Toolbox for Education	The Toolbox for Education program provides funding for public school STEM programs specifically through school renovation or technology implementation. This program may be a good source for school improvements that make the facility more environmentally friendly and could play well into implementing technology based environmental education programs such as GLOBE or fieldscope. Application Deadlines in September. Awards of up to \$5,000 go to 1,000 different public and charter schools each year. More information: http://toolboxforeducation.com/
Toshiba America Foundation	The foundation awards grants to a broad array of projects designed to make science and math engaging. This could be a good source for any new hands-on environmental or OE program. Awards up to \$1,000 for grades K-5 and up to \$5,000 for grades 6-12. Applications deadlines vary by grant amount and grade level. More information: http://www.toshiba.com/taf/
Environmental health	
Clarence E. Heller Charitable Foundation	The Foundation supports projects that focus on reducing environmental hazards and to support human health through sustainable agriculture. Funding also available for programs that advance environmental education. In 2017, grants ranged from \$35,000-\$150,000. This may be a good grant for a county-wide or community-based project. Application deadlines in May and November. More information: http://www.cehcf.org/apply-for-a-grant/
Clif Bar Family Foundation	Grants awarded for groups that protect Earth through increased outdoor activity, reduction in health hazards, and creation of a community based food systems. Awards up to \$7,000. Application deadlines three times per year on the first of February, June, and October. More information: http://clifbarfamilyfoundation.org/Grants-Programs/Small-Grants
The Pollination Project - Seed Grants	The Pollination Project makes daily seed grant donations for projects that advance compassion and community. Particular focus in areas of environmental protection and in education, also in human health and animal welfare. Award amounts vary and application deadline is rolling. More information: https://thepollinationproject.org/?gclid=CjwKCAjw8rMBRBOEiwA2F2biAV6vNbd2CL9hphYm6f-u947Tz5oDmjMP3flkw6801qlBKfXy_mJrRoCh-gQAvD_BwE
<i>Table 6 cont. on next page</i>	

Table 6: Cont. - Gardens and Outdoor Education	
Green Education Foundation - Green Thumb Challenge Grant	For student groups with existing gardens. Students compete for a prize through chronicling their garden experience. Award or \$500 to support continued garden programs. Deadlines in late September. More information: http://www.greeneducationfoundation.org/greenthumbchallengesub/green-thumb-challenge-winners
KidsGardening - BEE the Change Summer Pollinator Garden Giveaway	30 grant recipients and one Grand Prize winner. Winners receive collection of local plant seeds for pollinator garden. Half will be private gardens and half will go to school or community gardens. Grand Prize winners receives 80 plants. Deadlines late August. More information: https://www.kidsgardening.org/upcoming-grants-2/bee-change-summer-pollinator-garden-giveaway/
KEEN Footwear - KEEN Effect Grant	Grant money awarded for programs that inspire and promote youth experiences outdoors. Specific focus on nature based play, education, and stewardship programs. Award amounts \$2,500-\$10,000. Application deadline late September. More information: http://www.keenfootwear.com/grants.html - and - https://www.instrumentl.com/grants/keen-effect-grant
Quadrtec Jeep Parts & Accessories - Energize the Environment Grants Program	Grant money for trail and habitat restoration, land management, and education programs. Two \$3,500 grants awarded each year. Application deadlines for fall grants is late June and deadline is late October for spring grants. More information: https://www.quadrtec.com/page/quadrtec-cares-grant-program
New Belgium Brewing Company	Though most may not think to look to a brewery for education grants, New Belgium has an outreach campaign with funding for youth EE programs that utilize interdisciplinary methods to engage students in the outdoors. These education programs are usually linked to one of their other grant areas in sustainable agriculture, smart growth, bicycle advocacy, or water conservation. Awards range from \$500-\$5,000. Youth education applications are due at the end of March. More information: http://www.newbelgium.com/sustainability/Community/Philanthropy
The National Environmental Education Foundation	Funding opportunities cycle through national regions and to address specific issues. All funding opportunities are for environmental education programs. For more information: https://www.neefusa.org/grants
Ittleson Foundation	Grants for innovative projects to increase environmental awareness. 2016 Grants ranged from \$20,000 to \$30,000 and addressed a variety of different topics. This grant may be best for a countywide effort rather than an individual school project. For more information: http://www.ittlesonfoundation.org/the-environment/
National Geographic Explorer Grants	Education grants awarded to innovative programs that may address changes in pedagogy or teaching methodology. This may include new delivery of material, research, or inclusion or new media that has a measured impact on learners. Grant deadlines in early October Award amounts vary. For more information: https://www.nationalgeographic.org/grants
Project Learning Tree - Greenworks Grants	Grants for school based educational projects that bridge the classroom with the natural world. This may include greening the school through energy or water conservation or could be used for habitat restoration. Awards of up to \$1,000. Application deadline is in late September. For more information: https://www.plt.org/resources/greenworks-grants/
Renewable energies	
Alternative Fuel Foundation	Funding for education programs that nurture sustainability, stewardship, and renewable energy. Most recent winners have been in solar and wind projects for schools. Awards generally between \$250-\$500, and larger sums will be considered. Deadlines are rolling. For more information: http://www.alternativefuelfoundation.org/grants/
FirstEnergy - STEM Classroom Grants	For STEM classroom programs and professional development designed to enrich student learning. Awards up to \$1,000 for areas served by FirstEnergy electric companies. Deadlines in late September. For more information: https://www.firstenergycorp.com/community/education/educational_grants.html#gsc.tab=0
Constellation Energy - E ² : Energy to Educate Grants	Projects should address one of the following themes; (1) transportation; (2) backyard power generation; or (3) limiting waste. Project must reach more than 100 students. This may be useful in implementing school wide energy footprint assessment. Awards up to \$25,000 for grades 6-12. For more information: https://www.constellation.com/content/dam/constellation/Community/Tell%20Me%20More%20-%20E2%20Energy%20to%20Educate%20Grants.pdf/subassets/page1.pdf
Waste management	
Artfully Reimagined - ReimaginIt Grant	Artfully Reimagined is an artist cooperative that works with disposable items. Grants awarded for art projects that reuse waste in innovative ways. This includes clothing and jewelry. Awards of \$100-\$500 dollars. Deadlines are rolling. For more information: http://www.artfullyreimagined.com/ReimaginItGrant
<i>Table 6 cont. on next page</i>	

Table 6: Cont. - Atmosphere and Weather monitoring	
American Meteorological Society - Project ATMOSPHERE	Summer training programs for teacher engagement in teaching about atmospheric sciences. Funding available for teacher workshops: stipend of \$600, a food allowance of \$350, round-trip airfare, tuition, and instructional materials included. For more information: https://www.ametsoc.org/ams/index.cfm/education-careers/education-program/k-12-teachers/project-atmosphere/
Biodiversity and conservation	
The Entomological Foundation	The Foundation supports efforts to grow scientific literacy in the U.S. through teacher training and K-12 STEM program support. There is also prize money for educators who use insects in the classroom. Application deadline June 1. For more information: http://www.entfdn.org/educators.html
Patagonia - World Trout Grant Program	Grant funding for organizations and groups that support fishery and hatchery innovations for fresh and saltwater organisms. This includes education programs in fishery science. Awards range from \$5,000-\$15,000. Application window between May 1 and April 30. For more information: http://www.patagonia.com/world-trout-initiative/funding-guidelines.html
John Ball Zoo - Wildlife Conservation Fund	Grant money for wildlife conservation. International funding available with a particular focus on amphibians and reptiles, and those with an education component. Grant deadlines in early September. For more information: http://www.jbzoo.org/conservation/wcf
The Curtis and Edith Munson Foundation	Grant program of about \$1.4 million to support resource conservation in North America. Particular focus in south Florida aquatic ecosystems and in the Washington, D.C. metro area. The size and scope of this award would lend itself better to a countywide initiative (such as watershed management) rather than an individual school. Awards range from \$10,000 - \$50,000, with an average size up to \$25,000. For more information: http://www.munsonfdn.org/guidelines.html

BIOGRAPHY

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