

UNDERSTANDING CONSERVATION: A STUDY OF STUDENT ATTITUDES AND
UNDERSTANDING OF THE EFFECTS OF HUMAN ACTIVITIES ON GLOBAL
ECOSYSTEMS

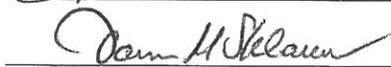
by

Sean R. Tracy
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Committee:



Dr. E.C.M. Parsons, Thesis Director



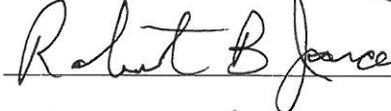
Dr. Dann M. Sklarew, Committee Member



Dr. Erin Peters Burton, Committee Member



Dr. Albert P. Torzilli, Graduate Program
Director



Dr. Robert B. Jonas, Department Chairperson

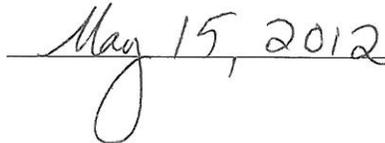


Dr. Timothy L. Born, Associate Dean for
Student and Academic Affairs, College of
Science



Dr. Vikas Chandhoke, Dean, College of Science

Date:



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George Mason University
Fairfax, VA

Understanding Conservation: A Study of Student Attitudes and Understanding of the
Effects of Human Activities on Global Ecosystems

A thesis submitted in partial fulfillment of the requirements for the degree of Master of
Science at George Mason University

by

Sean R. Tracy
Bachelor of Arts
Ithaca College, 2006

Director: E.C.M. Parsons, Professor
Department of Environmental Science and Public Policy

Summer Semester 2012
George Mason University
Fairfax, VA



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DEDICATION

This is dedicated to my mother, Elizabeth H. Tracy. You never let me forget how truly beautiful and wondrous the universe is.

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I would like to thank the many friends, relatives, and supporters who have made this project successful. Also, Drs. Parsons, Sklarew, and Peters, the members of my committee, who were of invaluable help. Thank you for your guidance and continued input. Thank you to the County and the School of focus in this study. Without your help, I would not have had the venue in which to conduct my research. And finally, very special thanks to all of the students who volunteered to participate; thank you for taking part in my experiment.

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LIST OF ABBREVIATIONS

Average	AVG
Dominant Social Paradigm	DSP
Environmental Education.....	EE
Global Learning and Observations to Benefit the Environment.....	GLOBE
Global Rivers Environmental Education Research Network	GREEN
International Union for the Conservation of Nature and Natural Resources.....	IUCN
Mid-Atlantic Marine Educators Association	MAMEA
New Environmental (or Ecological if before 2000) Paradigm	NEP
No Child Left Inside	NCLI
Non-Government Organization	NGO
Program of Study	POS
Research Question	RQ
One Factor Analysis of Variance.....	ANOVA
Self-Reported Concern for Global Climate Issues.....	CGCI
Self-Reported Concern for Issues of Biodiversity Loss	CBdL
Self-Reported Knowledge of Global Climate Issues	KGCI
Self-Reported Knowledge of Issues of Biodiversity Loss.....	KBdL
Standard Deviation.....	SD
United Nations Educational, Scientific, and Cultural Organization	UNESCO
United Nations	UN
United States Department of Agriculture	USDA
Young Men’s Christian Association.....	YMCA

ABSTRACT

UNDERSTANDING CONSERVATION: A STUDY OF STUDENT ATTITUDES AND UNDERSTANDING OF THE EFFECTS OF HUMAN ACTIVITIES ON GLOBAL ECOSYSTEMS

Sean R. Tracy, M.S.

George Mason University, 2012

Thesis Director: Dr. E.C.M. Parsons

There is growing need for environmental literacy in United States public schools (Caldwell, 1996; Kellert, 1997; Wilson, 1984; Zelezny, 1999). This can be achieved through comprehensive integration of environmental issues, not only throughout science curricula, but also by integrating science into all disciplines (Kellert, 1997; Wilson, 1998). The *new ecological paradigm* (NEP) scale, developed by Dunlap and Van Liere (1978), can be used to measure shifts in attitudes towards the environment. This study aimed to measure student environmental awareness in a mid-Atlantic, suburban, public school. Results revealed a discrepancy in self-reported awareness of the environment, and their score on the NEP scale. This indicated that students may think they are more environmentally conscious than they actually are. Current environmental instruction in the school and county of focus is limited. Integration of these topics throughout the year will help students become engaged, literate environmental stewards.

INTRODUCTION

The role of U.S. public education is to provide citizens with the information needed to be informed participants in society's conflicts and developments (Spring, 2004). Currently, debate over the cause of environmental degradation is flaring, but overall, scientific understanding of the human caused degradation is growing (Caldwell, 1996; Schultz & Zelezny, 1998; Wilson, 1984/2002; Zelezny, 1999). Current science curricula in the mid-Atlantic suburban school system of focus in this study are widely deficient in environmental education. Many schools are independently working to correct this as the need for environmental literacy grows. Upon review, neither the State¹ middle school nor the high school science curricula included issues of major ecological significance such as global climate change or conservation of biodiversity listed in the Program of Study (POS). These are two of the most important environmental issues of our time and should be an integral part of the biological and earth science classes (Millennium Ecosystem Assessment, 2005).

The POS is also limited in addressing human attitudes towards the environment. Only one benchmark in the State guidelines refers directly to student attitudes. The County presented a goal stating that students be environmentally literate, stewards who

¹ Per request of the County of focus in this study, the state and county will be referred to as "the State" and "the County" in order to preserve anonymity.

take an active role in preserving the environment; however, this goal has not been actively addressed until this year (2011-2012 school year). The goal also has never formally been assessed to determine if students have become stewards of the environment, meaning that they take an active role in mitigating harm. Because of these deficiencies in the POS, it is difficult to determine exactly what students do know about these issues and how concerned they are about the environment. To date, there is no State accepted standardized assessment used to evaluate or monitor student understanding in this field.

Human Development and Attitudes

In 2004b, *The Journal of Russian and East European Psychology* published a translation of Vygotsky's 1930 "Imagination and Creativity in Childhood" (published in 1967). Vygotsky wrote "Our brain and our nerves, possessing enormous plasticity, readily alter their finest structure under the influence of one or another type of stimulation, and if the stimulation is strong enough or is repeated a sufficient number of times, retain memory traces of these changes" (p. 8). This ability of the brain to retain information and scaffold learning is the basis for most rote pedagogical practices.

Students are asked to practice and recall information and then build upon those experiences. Even inquiry based learning requires some form of prior information so that the students can assimilate data. Vygotsky was a strong proponent of using creativity and imagination through social stimulation, such as group play, to develop these neural pathways. This is in keeping with Dr. Vygotsky's earlier publications introducing childrens' play as a mode of cognitive development.

In his publication on *The Development of Thinking and Formation of Concepts in the Adolescent*, Vygotsky (2004a) wrote that children in adolescence make the move to incorporate more of their surroundings into understanding. This concept ties to the emotional needs of adolescents, but during school years, students build upon a basis of knowledge acquired at an earlier age and now synthesize understanding into broader concepts of morality and judgment. Vygotsky (2004a) went on to explain that this change is the basis for cognition. He made the case that pre-school age students do, in-fact, have the mental capacity to grasp big world issues, but do not have the historical context or the vocabulary to articulate opinions. This is where social aspects of learning are important for the development of a student as an active participant.

Vygotsky (2004b) outlined mimicry as a creative outlet. He wrote how imagination can spark genius only in a social context. “We readily acknowledge and easily recognize the role of creativity in the accomplishments of [Leo] Tolstoy, [Thomas] Edison, and [Charles] Darwin, but we typically believe that such creativity is completely lacking in the life of the ordinary person” (Vygotsky, 2004b, p. 10). However, he went on to explain that this conceptualization of ingenuity is not always true. Vygotsky (2004b) lists several examples of play and collective creativity between children. He attributed genius to the collective mind; to the free flow of thought that naturally occurs through group activities and learning. All innovators are inspired by others; whether through cooperation or competition.

What Vygotsky (1987, 2004a, 2004b) failed to recognize, is that all of his examples of creativity through group play associated with a child’s interaction with the

natural world. This outdoor play would not have been a novel concept to Vygotsky, who died before the age of mobile electronics, but it has become so today despite humans' inherent relationship with nature. Kellert (1997) wrote that "every person – rich or poor, educated or uneducated, city or country dweller – possesses this aesthetic connection to nature" (p. 39). We see this association in modern society in the refusal to be totally removed from nature. Kellert (1997) described examples such as the owning of houseplants, posters and paintings of landscapes, and even the enjoyment associated with a neighborhood tree. This basic human need, to connect with nature, was described by E.O. Wilson in his book, *Biophilia*. Wilson (1984) defined biophilia as, "the innate tendency to focus on life and lifelike processes" (p. 1); that humanity longs for nature.

All humans are attracted to nature; however, that attraction must be nurtured at a young age so that we cannot separate ourselves from it (Louv, 2007; Kellert, 1997; Wilson 1984). Human imagination and the natural world are distinctly intertwined. Vygotsky (2004b) wrote several examples of imagination in play that are intertwined with nature. One such example is that of a young child galloping with a stick between his/her legs pretending it is horse. This example not only depicts the child using a piece of natural as a prop, but his/her imagination places the child riding a horse, actively participating in a relationship with an animal. This is the type of play that Vygotsky (2004b) would refer to as mimicry. The child would most likely be mimicking something he/she had seen others do. Vygotsky (2004b) wrote that such play is a very important form of both social and cognitive development.

Children imagine, and then create, through the lens of the natural world. “Nature offers an essential medium for our development, both individual and collective, a link that is as vital today as it was in the past” (Kellert, 1997, p. 1). The image of a broken branch as a pretend horse shows that human creativity is limited by the observable natural world (Vygotsky, 2004b). We even use the word *nature* to describe observations not defined by science; dubbing imagination outside this quantifiable realm as *supernatural*. According to Wilson (1984), nature is magic. There is nothing supernatural, simply the defined and the yet-to-be defined.

Observations in nature spark the initiative for further discovery. The natural world provides the inspiration for imagination and for play; “The natural world is the refuge of the spirit... richer even than human imagination” (Wilson, 1984, p. 12). This drives the constant progression of science. Such creativity in discovery is because, not only of humankind’s innate love of nature, but of the development and imagination that it arouses within us. This was Vygotsky’s point (2004b); that social play develops the human brain. Kellert (1997) wrote that this interaction with others and with nature is essential for human development.

In a brief history of conservation, Wilson (1984) described how the earliest preserves “were the by-products of selfish interests created, like most early art and learning, for the pleasure of the ruling class” (p. 124); such as a king’s forest left untouched for the sole purpose of the hunt. The earliest environmental management of the modern world was associated with resource management, flood control, and other means of controlling the environment for human consumption (Caldwell, 1996). This

method of management did not take into account the interconnectedness of ecosystems. For example, in 1945, in response to the fallout of World War II, the United Nations (UN) formed the UN Educational, Scientific, and Cultural Organization (UNESCO) (Caldwell, 1996). Among other things, UNESCO has aided in such management to preserve sites for future use and enjoyment.

In 1948, the International Union for the Conservation of Nature and Natural Resources (IUCN) was formed (Caldwell, 1996). However, the IUCN, as indicated by the name, was primarily for the purposes of managing resources. It was not until much later that we began to view the environment from a more holistic point of view. “The Biosphere Conference of 1968... appears to have been the first major international meeting concerned with the global environment, as distinguished from natural resources” (Caldwell, 1996, p. 34). Environmental management can only be effective from a global perspective. Waterways, migrations, air currents, and pollution are not constricted by the boundaries printed on a map. It is important that governments assess environmental issues with an understanding of the interactions of ecosystems.

In order to view the environment this way, the general public must also understand the comprehensive nature of ecosystems. This will require a paradigm shift that begins with public knowledge. Dunlap and Van Liere first discussed measurement of this shift in 1978. Over the past thirty years, they have worked to develop the scale used in this study to assess environmental attitudes. “The new worldview has evolved from early concerns about specific environmental problems and natural resources to recognizing that humans may be fundamentally altering the functioning of the global

ecosystem” (Manoli, Johnson, & Dunlap, 2007, p. 4). This shift in public mindset is paramount for making any progress in mitigating environmental harm.

In his book, *Consilience*, Wilson (1998) discussed the need for bridging curricula across disciplines. He 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). In public school systems, the science POS dictates that students study science as well as other disciplines within science classes. For example, in all sciences, students use mathematics. Students are expected to do low level statistical analysis and convert units in courses such as biology. The chemistry and physics curricula require higher level mathematics, including algebra, trigonometry, and even some lower level calculus. There is also a push for introducing literacy, not only in the school of focus in this study, but in all U.S. schools.

Literacy in the science classroom helps bridge the gaps in the humanities and sciences. In the classrooms surveyed for this study, students were required to read *The Hot Zone* by Richard Preston (1994). This is to help students understand that there are scientific books that are not text books. Preston’s story traced *Ebola* outbreaks and gave students the opportunity to see how scientific studies can be just as terrifying as fiction. The book cover even boasts a similar quote from horror great, Stephen King. Cross-curricular experiences such as the introduction of literacy into the science classroom are great examples of where social science and laboratory sciences can create a holistic experience for students.

Wilson wrote, “In education, the search for consilience is the way to renew the crumbling structure of the liberal arts” (1998, p. 12). In science classes, students learn some history through the study of past scientists. This is often a glaring gap in curricula, but it can be easily bridged. For example, students who learn about the monk, Gregor Mendel, and his pea plants, in isolation they cannot fully understand the astounding breakthroughs of inherited traits. They need to understand that it would be another hundred years before Watson and Crick published on the structure of the double helix.

Students learn the Mendel discovered the Laws of Inheritance and then jump immediately to learning about "Punnett Squares". This is where a brief history lesson could make science more tangible for students. They rarely learn that there was fifty years of innovations before Mendel’s Laws were applied to livestock management by Reginald Punnett. Wilson’s point in *Consilience* is that this blending of curricula should go both ways. Science and the humanities can cross. “Astronomy, geology, and evolution are examples of primarily historical disciplines linked by consilience to the rest of the natural sciences” (Wilson 1998, p. 11). One of the biggest challenges to the consilience of the disciplines lies in one very important definition, the word *theory*.

According to Wilson (1998) the word, theory “taken in everyday context, it is shot through with corrupting ambiguity” (p. 52); the general public has difficulty understanding the difference between the definition of a theory in science versus the definition of theory in the social sciences, or in everyday usage. Scientific theories are often mistaken for hypotheses. In science, a hypothesis is actually generated in order to test an idea whereas scientific theories are synthesized from repeated, empirical data, and

are more akin to scientific laws or rules. The general public has a difficult time understanding this, especially when put into the context of complex global issues, such as climate change.

As science progresses, we begin to see more and more blending of the interdisciplinary lines within the science. Biology, chemistry, and physics, the three core sciences for most public school sequences, are finding overlaps, such as the need to introduce chemistry in biology prior to teaching genetics, or the physics required to understand bonding in chemistry. The County in this study teaches the three subjects sequentially as listed above. Math prerequisites make it difficult for underclassmen to qualify for, and succeed in chemistry or physics without sufficient background in algebra.

Students need to be, at least, co-enrolled in algebra II to enroll in accelerated chemistry courses. This precludes most freshmen from the course. Despite this sequence, the biology course, which has no prerequisites, includes some substantial concepts from organic chemistry. This presents a "catch 22" situation for biology teachers. Teachers must supplement the biology curriculum with introductory chemistry at the beginning of the year so that students have an understanding of carbon bonding prior to a discussion of complex organic polymers such as DNA.

In *Consilience*, Wilson (1998) described a framework to integrate different disciplines in the context of the environment as seen in Figure 1. Most real world issues fall within the rings, but outside the rings lays most educational curricula and, therefore, trained human logic. "As we cross the circles inward towards the point at which the quadrants meet, we find ourselves in an increasingly unstable and disorienting region"

(Wilson, 1998, p. 10). Wilson (1998) presented the example of deforestation.

Environmental Policy, in the top left quadrant of Figure 1, would contain how we manage the forests. This may bleed over the boundaries into social science through our need for the lumber and the economics of management of the forest. This example also shares a border with ethics.

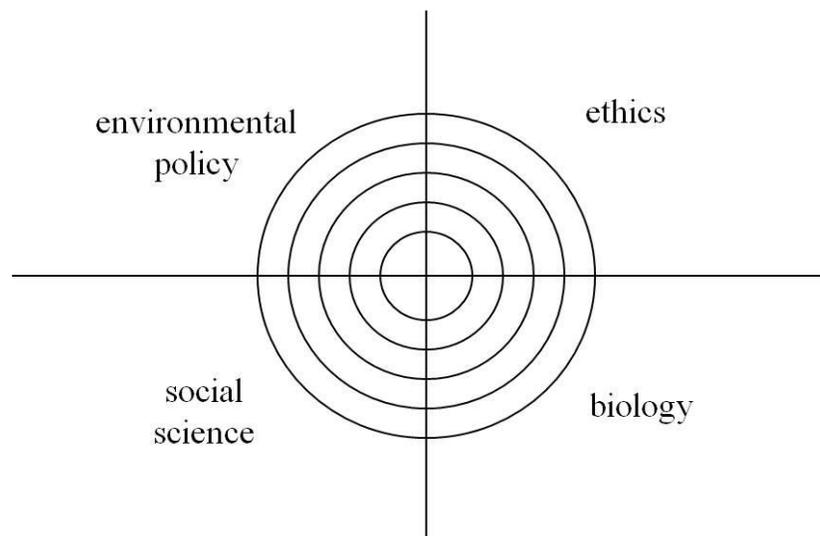


Figure 1: From Wilson 1998, p. 10. This shows the interrelations between different disciplines as they relate to environmental policy

Ethics and social sciences only touch where policy and biology come into play as well. This is consilience. Vygotsky (1987) wrote, “The scientific concept blazes a trail for the everyday concept. It is a form of preparatory instruction which leads to its development” (p. 169). Both Wilson (1984, 1998, 2002) and 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. This problem is that current public schooling trained us to think within the confines of such pre-defined borders.

In the high school in this study, as well as many across the country, the school building itself is segregated by department and discipline. Figure 2 was adapted from Wilson's (1998) and generated for this study. It shows different disciplines and focus of a standard public school education; the humanities, the arts, and the sciences. Humanities include the social sciences, such as languages, history, and civics. "Fine arts" includes both performing and visual. Sciences pertains to all of the hard sciences, typically biology, chemistry, and physics with selected electives and off-shoots such as earth sciences.

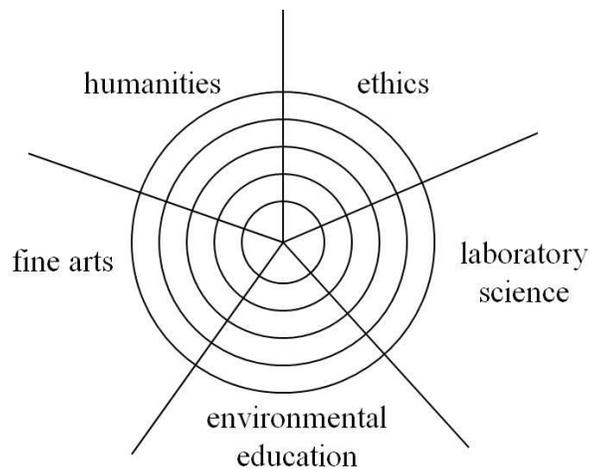


Figure 2: Adapted from Wilson (1998).

Ethics has been included in keeping with Wilson's (1998) Figure 1 and the goal that public education should produce active citizens (Spring, 2004). Ethics shares a border with both the hard and soft sciences. It is an important aspect of the wheel. The purpose of public education is to produce, a well-rounded, individual, ready to take a roll in modern society; ethics must be an integral part of the curriculum. Though students at the school in this study do not take an ethics course, there is an overarching focus on ethics in the school as a whole. The administrative team has experimented with different codes of conduct publicly displayed for students, and even an "ethics day" to focus on the literal meaning of the word.

Presented in this fashion, Wilson's image of consilience in real world examples can be applied to cross-curricular education. Figure 2 represents, not an image of the boundaries between the disciplines, but a target to aim for in the center. As you follow the axis through the rings, classroom lessons should aim for the bull's-eye. Curricula may have individual benchmarks or goals within their own disciplines' region of the wheel, but teaching students within the circles of the wheel allows them to scaffold information with other disciplines.

Vygotsky (1987) wrote that students cannot understand scientific concepts without language development. This blending of the social science curriculum for language and the science curriculum for vocabulary terms is an excellent example of where the two are intertwined. Students learn vocabulary in high school English classrooms, with little regard for application of the terminology. Science classes emphasize the use of such vocabulary with little emphasis on meaning. With careful

consideration, each discipline could be viewed, not in isolation, but as an overall education, and students can apply cross-curricular understanding to real world issues such as that described in Figure 1.

The fine arts share no border with the laboratory sciences as far as the school system is concerned, though this is not always true of the world outside of public school. The reason is that science relies on testable, quantitative facts and explanations whereas “works of art communicate feeling directly from mind to mind, with no intent to explain why the impact occurs. In this defining quality, the arts are the antithesis of science” (Wilson, 1998, p. 218). However, in keeping with the structure of Figure 2, the two can meet in proximity of one of the other disciplines. For example, it is difficult to deny the beauty and artistic quality of the earliest recordings of the mating songs of the humpback whale. This was hard, quantifiable science, collected in the field that created beautiful music. Writings can also bridge this gap. Rachel Carson’s *Silent Spring* blended American literature with quotes from poets such as Robert Frost with science. Such art teeters in the gray area around the bull’s-eye of Figure 2, addressing not only literature and social sciences, but also ethics, laboratory sciences, art, and environmentalism.

Spring (2004) wrote that public education should serve the goals of the greater public; “The public goals for schooling are determined by elected representatives in local, state, and federal governments” (Spring, 2004, p. 7). As previously discussed, consistency in education will increase scientific awareness. Wilson (1998) wrote, “Public intellectuals... have been trained almost without exception in the social sciences and humanities. They consider human nature to be their province and have difficulty

conceiving the relevance of the natural sciences to social behavior and policy” (p. 126). Spring (2004) went on to describe the role of students as an economic and political resource. He described the debate between Thomas Jefferson and Horace Mann as to whether schools should simply present facts and allow students to make their own decisions, or should schools also educate on some moral ground. Mann pushed for education reform to include ethics and morals, but Jefferson believed public education should provide citizens with a basis for reading, writing, arithmetic, and the associated skills of logical reason. Even today this debate continues.

Rachel Carson (1962) alluding to Robert Frost’s famous poem, wrote, “we stand now here where two roads diverge” (p. 278). The more we understand about the environment and human effect on ecological systems, the more important it is to communicate that information with the general public; the next generation of scientists, politicians, and voting citizens. This is why it is critical to integrate environmental science into public school curricula.

Previous Studies Introducing EE into the Classroom

Research by Eagles and Demare (1999) suggested that early environmental education affects prevalence of environmental awareness later in life. The study itself did not cite Wilson (1984), but directly related to the concept of biophilia. The study examined the environmental sensitivity of middle school students before and after environmentally-oriented experiences such as YMCA camping trips. Survey results indicated that these specific experiences did not have a significant effect on student environmental sensitivity, but it was suggested that previous exposure to environmental

issues from television or other media may have impacted student responses (Eagles & Demare, 1999). Scott and Willits (1994) actually suggested that “given the amount of media coverage devoted to environmental problems, it could be that many people have learned the language of environmentalism without developing simultaneous behavioral commitment” (p. 254). Zelezny’s 1999 study supported and elaborated on Eagles and Demare’s (1999) conclusions.

Zelezny (1999) surveyed 9th grade students and found that they responded best to environmental education (EE) in the classroom rather than in novel, out-of-class experiences. Zelezny (1999) concluded that this is due to the fact that outside interventions often include more adult participation (chaperones). Students respond better to peers in a classroom setting, rather than an unbalanced inclusion of unfamiliar adults. Students learn best within a comfort zone, among peers. Vygotsky’s (2004a, 2004b) social constructivist theory supports that peer development is an affective learning tool. Zelezny (1999) applied this theory to EE, linking the development of environmental consciousness to the element of outdoor play.

Public interest in EE has fluctuated over the last century (Hungerford, 2010). Promoting responsible behavior is an important aspect of environmental education and falls within the rings of Figure 2 where the tips of ethics and environmental education connect. Responsible behavior includes respect for other people as well as the environment. An informed member of society can use rational scientific logic to address any situation “And the collective judgment of our people will determine how we manage shared resources—such as air, water, and national forests.” (National Committee on

Science Education Standards and Assessment, 1996). Hungerford (2010) debated whether EE instruction should focus on merely learning about the environment or inviting students to make judgments about larger issues. This also includes responsible use of technology and the understanding of global issues.

Serious focus on EE began in the early 1970s (Hungerford, 2010), around the same time as the passing of the National Environmental Protection Act (NEPA). This is the same paradigm shift referenced by Dunlap and Van Liere (1978), who said, “we increasingly hear of the inevitability of ‘limits to growth,’ the necessity of achieving a ‘steady-state’ economy, and the importance of preserving the ‘balance of nature’” (p. 19). Hungerford (2010) suggested that interests in the decades since Dunlap and Van Liere’s (1978) study continued to grow in biodiversity, climate change, and land-use management. That being said, there is a need for an effective unified approach to actually teaching about the environment because delivering the message to students can be tricky. There is much debate over the best way to do so.

Hungerford (2010) presented both sides of the argument for best practices in EE. Some argue that students should not be asked to make judgments or take stands on science that they do not understand. 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 does not also need to be an environmentalist, just as history of the French revolution need not be presented by an expert in French history. Hungerford (2010) suggested that some believe that EE should focus only on learning about the environment, and not on changing

attitudes; it should be an objective science. This line of thinking directly contradicts the social constructivist model. By not promoting debate, students are not encouraged to work as a collective mind.

Opponents believe that it is the science educators' duty to promote responsible behavior. This is where the ethics portion of the wheel in Figure 2 comes in to play. Hungerford (2010) wrote on this side of the debate; that environmental educators must be environmentalists, proponents for a clean, healthy ecology. Hungerford (2010) attempted to get to the root of why approaches to EE have yet to be unified in the U.S. suggesting that until pedagogical practices can be utilized in a successful manner, efficacy of EE programs will continue to falter. What Hungerford (2010) failed to address was that there will be no unified EE until environmental belief systems are unified, but this is a problem because understanding of environmental systems will not reach the general public without unified EE. Hungerford (2010) did not make suggestions on how to reconcile this cycle, but presented the facts in order to open the discussion.

Moore and Huber (2001) argued for the incorporation of reform based on the National Science Education Standards. These standards were established to judge "the quality of what students know and are able to do" (National Committee on Science Education Standards and Assessment, 1996, p.12). Moore and Huber (2001) presented literature to support the argument for standard based reform and include evidence from previous studies. Despite this primary goal, the secondary goal got most of the attention in this particular paper. The authors aimed for "the development of promising Internet resources for teaching environmental sciences" (Moore & Huber, 2001, p. 21) such as the

Global Learning and Observation program (GLOBE) and Global Rivers Environmental Education Research Network (GREEN).

GREEN and GLOBE are both programs that promote the use of technology to teach responsible behavior in students. These programs are both centered on student use of field techniques in order to collect data such as hydrological and topographic data through learning water and soil sampling techniques. Data is then shared on an online forum so that global students and scientists alike can use the data for independent research. These systems put science students in touch with professionals in the field. They provide scientists with the information they need, collected cheap, and provides students with hands on experiences and real world application of course material.

Moore and Huber (2001) advocated for the implementation of such programs in public schools. The authors link ecological literacy to computer literacy. However, though both forms of literacy are vital to a child's education, they need not be taken hand in hand. If utilized properly, programs like GLOBE and GREEN will promote both ecological and computer literacy, but to reliance on computers to teach students who already spend too much time in front of a screen about nature seems counterproductive. Using technologies in the classroom is important, but students today need little enticing to work online.

GLOBE and GREEN provide excellent resources for teachers, but can easily become a crutch. The most important aspect of these online programs is the outdoor component. If these are used solely as a way to introduce technologies, the outdoor experiences fall by the wayside and a valuable opportunity is lost. And not only a

teaching opportunity, but an opportunity for students to socially and cognitively develop and to imagine as they experience nature. A more solid approach would be to use GLOBE and GREEN in conjunction with an outdoor based program such as the Gardening Pedagogy described by Howes, Grahan, and Friedman (2009), discussed later.

Moseley, Huss and Utley (2010) elaborated on the efficacy of GLOBE as a tool, not just for students, but to help teachers who may not be comfortable teaching about the environment. As Hungerford (2010) suggested, teachers must at least be knowledgeable in environmental sciences to teach EE lessons. The goal of the Moseley *et al.* (2010) experiment was to determine the change in beliefs in efficacy of EE programs after teachers participated in a two week training workshop. After the training, researchers followed up with teachers throughout the school year to assess if their comfort level had changed. Moseley *et al.* (2010) stated that effective teachers have a high sense of efficacy about their own teaching and that confidence with course material is a large factor in teaching efficacy. Moseley and Utley showed that integrating the GLOBE program into elementary science and math curriculum can increase the efficacy of teachers. In the 2010 study, Moseley *et al.* looked specifically at what effect the two week in-service had on teachers after the session was over and again after five months and the implementation of the GLOBE program into science curriculum.

Moseley *et al.* (2010) advocated for use of GLOBE to increase environmental awareness in educators, not just students. Increased awareness and comfort level in the educators themselves should trickle-down to build confidence and understanding in students. This also aligned with the debate presented by Hungerford (2010) which argued

whether or not educators themselves must be environmentalists. Mosely *et al.* (2010) argued that they should at least be environmentally aware in order to accurately present environmentally focused education. This is a running concern in the all scientific education. Science educators integrate mathematics, English, and history, and generally have some background in each subject, but most teachers in other disciplines have a limited background in science education.

The link to computer programs is a good way to integrate technologies, but is also worrisome. As mentioned previously, these could become a crutch for less knowledgeable educators. In his book, *The Future of Life*, Wilson (2002) describes the technophilia phase of human history that we are currently entrenched within. A technocentrist would view ecological problems as fixable, post-damage infliction, through human intuition. Technocentrists generally search for an engineering answer to issues of environmental management; a human-centered point of view. The technocentrist point of view was spearheaded by R. Buckminster Fuller with his 1969 publication, *Operating Manual for Spaceship Earth* (Fuller, 2008). Fuller (2008) wrote about the history of human impact on the environment through the lens of the earth as one multi-faceted machine.

Fuller's views were akin to those in the "Gaia theory", depicting the planet as one giant living organism itself (Botkin & Keller, 2007, p. 10). However, the technocentric-engineer Fuller (2008) wrote about the global system as a spaceship rather than a living, breathing thing. Both beliefs take a global approach and view the planet as one cohesive system and can be effective launch-points for education. That being said, students are

inundated with technology. In order to truly experience nature and to develop in a social context, students must also step away from their lithium powered, display screen views and out into nature. Integrating environmental science into the curriculum will provide more opportunities for teachers to present a well rounded, engaging EE. This can include technologies, but should be outdoors focused, not computer based.

Howes, Graham, and Friedman (2009) looked at a different approach to outdoor based EE. Howes *et al.* (2009) used the term “McDonaldization” to refer to schools that have the mass produced, “Ford production-line” feeling, as too many public schools do. McDonaldized schools have strict schedules, large classrooms, and focus on achievement through test scores. Students are marched through the assembly line with predetermined schedules, sounded by factory whistle-like bells. Much like many of the schools in the county focused on in this study. This product-based system is supposed to be efficient, calculable and controlled.

In 2009, Howes *et al.* implemented a pilot Gardening Pedagogy program. The school and community established a small garden on school grounds that students and teachers could utilize for learning experiences. Howes *et al.* (2009) catalogued the program to evaluate its efficacy. Teachers had issues with keeping students focused on their tasks rather than allowing them to explore. Gardening Pedagogy was supposed to be an inquiry-based, experiential curriculum. 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 made sense for coordination purposes, but

detracted from the goals of outdoor-based pedagogy. More freedom in the curriculum to explore nature allows students time to imagine, time to be creative, and to develop a sense of biophilia. This is the cognitive development that Vygotsky was a proponent of.

The goal of the Howes *et al.* (2009) investigation was to allow for external thinking; to get the students out of the classroom and into nature. Teachers complained about losing classroom time walking to and from the garden and about inclement weather. Howes *et al.* (2009) suggested that teachers capitalize on such moments as learning tools and use the walks to the garden as a time to build social learning rather than view as a time detracted from lesson plans. Students should be encouraged to enjoy nature and reflect on their own impact on the natural setting.

This same line of reasoning can also be applied to the issues with inclement weather. These times can be used as a learning experience to teach about weather systems and allow students to experience environmental concepts such as the water cycle, first hand. A cloudy day or being trapped in a rain storm could become a great introduction to a lesson about the condensation, precipitation and the overall effects of runoff. Using outdoor space and such learning experiences could be directly linked into a lesson utilizing online resources.

In every example described so far, EE can be categorized as a novelty in educative practices. It has always been introduced as some special program or extra project. In the case of Howes *et al.* (2009), it was introduced as something superfluous that the teachers viewed as an inconvenience. This is a running theme for EE in the science curriculum and therein lays the problem. EE should be an integral part of the

curriculum. At an elementary school in the high school pyramid in this study, science teachers participate in a state run program that is intended to do just this and incorporate issues of environmental concern. In this program, the details of which will be left vague by request of the County (all information comes from the program website and personal correspondence with the teachers involved), classrooms receive fish eggs to grow in the classroom. The eggs are of an endemic species to the State and are grown for release in the spring.

Elementary school students spent all winter studying the habitat of the fish, they learned to draw the species, and they counted and measured fish to practice mathematics. They learned how to care for the organism. Through such a program, the State has found a way to make hundreds of new hatcheries without paying for maintenance (the schools fund it through grants and donations). This is a win-win situation that provides a hands-on, cross-curricular learning experience for students and helps the environment by reintroducing native species. High school students at the school of focus volunteer to work with the elementary students. This bridges the social gap between schools and offers the older students the opportunity to work with the species of fish as well.

In the fall and spring, the high school students in the pyramid of focus in this study took field trips to the release location. Last fall, teachers received a U.S. Forest Service grant for equipment and the cost of the actual field trip. Students did a macroinvertebrate and stream quality study. They then took a nature walk to experience the national forest first hand. Students used what they knew about the species to determine if the site was appropriate for the fish. In the spring, the students will return to

the site to release the fish. At the high school level, this was worked into the curriculum as a way to study the measurement of biotic and abiotic factors in systems as well as a study of the needs of populations. By integrating such lessons into the regular curriculum, this becomes a learning experience rather than a novelty.

Through personal communication with teachers at other schools in the county, it was discovered that honors biology teachers at another County high school teach the entire 4th quarter curriculum through the lens of marine issues. The County and State curricula for the end of the year include evolution, ecology, populations, and human anatomy. Teachers presented the idea of using environmental issues as the scope through which to teach these topics at the Mid-Atlantic Marine Educators Association (MAMEA) conference at the College of William and Mary in Williamsburg, VA (October 2011). Such integration of EE would reduce the novelty of using a special program or online resource. This could introduce environmentalism as part of a comprehensive learning experience rather than a one-time project.

State and County Curricula

Science curricula in both the County and the State² of focus in this study are, largely, deficient in mandated environmental science in public schools. The 7th grade, life-sciences curriculum includes benchmarks that would lend themselves into a study of current issues such as climate change, but do not require it. Benchmarks 7.1.4 through 7.1.9, under the first standard, Populations and Ecosystems, focus primarily on the

² Both the County and the State examined will remain anonymous and referred to only as “the County” or “the State” for that purpose

interactions between abiotic and biotic factors within ecosystems. Studies addressing these benchmarks include a general understanding of species interactions and levels of symbiosis. They also include a basic level of systems studies. However, due to content pacing, students rarely get the chance to link these systems interactions to actual ecosystems.

The most efficient way to teach to the standards is to teach a series of generic food webs to ensure that students understand energy transfers within a closed system, when in actuality these interactions influence multiple systems which can be greatly affected by anthropogenic, or human, activities. The state exam enforces simplistic teaching practices by asking only limited questions that relate to isolate feeding systems. Teaching and assessing these systems in isolation misleads students and reinforces habits of human wastefulness by not nurturing global thinking. Students need the opportunity to see these systems as interacting through a global machine or organism, such as Gaia or the Spaceship Earth.

Under the second standard, benchmark 7.2.1, students “apply problem-solving skills when gathering, analyzing, and interpreting scientific information”³. This benchmark and indicators are echoed in the 8th and 9th grade POS as well. This is a prime example of a content area where teachers can include environmental studies in an otherwise deficient curriculum. By introducing case studies and real life examples of

³ Benchmarks quotations cannot be directly cited without jeopardizing the anonymity of the County researched. All information was retrieved from publicly available County POS and Standards.

species interactions, students can learn the importance of anthropogenic effects on the environment or the importance of why protecting endangered species is important will make topics relevant for students and increase environmental awareness.

An example of such a teaching strategy was developed by Tracy (2011). This teaching module, available online at the Encyclopedia of the Earth, introduces students to the importance of oil spills and their effect on the environment. It walks students through how oil use has progressed throughout time, what it does to the environment, and why it is harmful. This module was written as a multi-block lesson, but can be shortened and worked into a unit on interpreting scientific information. Students are given resource packets and asked to defend different interest groups to decide whether or not a moratorium on deep water drilling was necessary after the Deepwater Horizon incident. By analyzing data from point of view of the oil companies, local fish and wildlife experts, scientists and both local and federal governments, students must decide for themselves whether or not drilling should proceed and if the fish are safe to eat. This reinforces rational thinking and promotes social learning while teaching environmental literacy.

The goal of benchmark 7.3.3 in the 7th grade life-sciences curriculum is that “students access and communicate scientific information using technologies”⁴. This is defined by indicators based around students’ ability to use electronic databases in order to access information. The benchmark also addresses student ability to analyze accessed data. Databases such as those offered by the GLOBE and GREEN programs give students

⁴ Quotations taken from publicly available County documents

access to a host of national data pertaining to environmental issues. As mentioned, the GLOBE network is a free, online forum for students, teachers, and scientists from several government agencies including NASA, NOAA, and NSF. The network allows members to interact and share data (GLOBE, 2012). Students can collect data for class projects and upload it for use by the scientists in national surveys. Integrating outdoor education can address technology standards if done properly.

Performance indicator 7.5.3-c is one of the only indicators to directly address how the student, personally affects the environment. The indicator states: “discuss [the] student’s role in sustaining a balanced environment”⁵. This indicator is important in understanding the current state of ecosystems and how human interactions can affect the environment as a whole. It was also listed in the 8th and 9th grade POS. Further study needs to be conducted in order to gain insight as to how educators choose to address this benchmark. In the school of focus for this study, teachers address the issue by including a “Fragile Earth”⁶ portion to the ecology unit. After instructing students on interactions between biotic and abiotic factors, teachers deliver an overview of multiple environmental issues such as, the ozone layer, runoff pollution and eutrophication, and climate change. Such a presentation is spread over several days. At present, the lesson is presented as a PowerPoint, with little time for discussion. It falls under the category of novelty, as discussed previously, and is not an integrated part of the overall ecology unit.

⁵ Quotations taken from publicly available County documents

⁶ Information from personal communication with the department at the school studied.

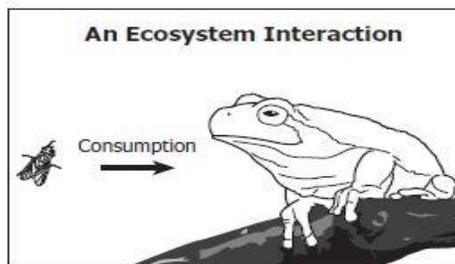
The problem is, because these topics are not specifically addressed by the State curricula, they are glossed over in lessons. The state exam contains little to no questions pertaining to these topics so teachers have little justification for inclusion into an already limited schedule. In high school biology especially, the ecology unit is often underemphasized. Upon review of the 2006 examination, it was found that 11/50 (22%)⁷ of the questions were from the “Interaction of Life Forms” unit, but none addressed specific issues of environmental concerns. A similar trend was discovered after review of subsequent examinations. The number had actually decreased by the time of 2008 examination.

Table 1: Total number of ecology questions on the 2008 State examination

Scope of question	Number of questions	Percent of total exam (out of 50 questions)
Bacteria and pathogens	2	4%
Evolution	4	8%
Food webs/energy transfer	2	4%
Populations	1	2%
Fossil Fuels	1	2%

⁷ Data accessed through the State department of education website

The 2008 examination was the most recent biology examination available for full review at the time of this study. Upon review, 20% (10/50) of the questions related to the portion of the exam pertaining to the more ecological units. These were categorized as “Interaction of Life Forms”.⁸ Questions were categorized and represented in Table 1. Upon review, the two bacteria questions both pertained to the infectious nature of bacteria as a living organism and had nothing to do with ecosystems. The second question was specifically a knowledge based question addressing the definition of the word, “pathogen”. Evolution questions focused mostly on geological time and natural selection, specifically geographic versus behavioral isolation and the definition of the terminology associated with selective pressures.



The interaction pictured represents —

- F** growth
- G** respiration
- H** energy and nutrient transfer
- J** herbivory and decomposition

Figure 3: Depicts a simplistic food web taken from the 2008 State examination.

⁸ Information acquired from published tests available on the State website

As discussed previously, energy transfer questions showed only rudimentary, over-simplistic organism interactions. One such example is provided in Figure 3. This shows the question as it was asked directly on the high school biology state examination (2008). Figure 3 shows a fly with an arrow towards a frog's mouth reading "Consumption". The heading reads, "An Ecosystem Interaction". This question was supposed to test a student's knowledge of energy and nutrient transfer through a system, but is so overly simplistic in its depiction of the ecosystem interaction that the image is not even necessary. These are the types of food chains (if a chain with two links can even be considered a chain at all) that students need to learn for the exam. In actuality, this question is testing the student's understanding of the word, "consumption" *not* their understanding of how organisms interact within an ecosystem.

The one question that pertained to populations asked students to read a map depicting where mammoth fossils were found and asked them to discern information about population densities and migration. This tested the student's knowledge of the vocabulary words such as the word "migration" and their ability to read a map, *not* their understanding of populations. Of the 10 total questions from the unit pertaining to the environment and ecosystems, there was only one question in the 2008 examination that directly addressed any issue of environmental concern.

The question asked students to identify which of the four options listed were *not* naturally occurring, and could alter ecosystems. This question then listed floods, a volcanic eruption, wildfires, and the burning of fossil fuels. The question inferred that fuel combustion does in fact alter ecosystems. The question was more rigorous than the

consumption question, but it did not require the students to understand how or why the burning of fossil fuels can affect the environment. Students should learn, and be assessed on, issues such as photochemical smog and tropospheric ozone, on acid rain, and on climate change. It does appear, according to the availability of study packets for subsequent years' examinations, that more emphasis will be placed on the environment. A new "Biomes, Ecosystems, and Human Impacts" study section was recently added to the 2010 exam. Further review will need to be conducted when those examinations become available for review.

Despite the shortcomings in the curriculum, there is interest in the County in becoming more environmental focused. The problem is how to approach sensitive topics in the curriculum. This is in line with more national movements to educate our youth about the complex issues of environmental degradation. Personal communication with the environmental education coordinator, an assistant to the K-12 Science Coordinator of the County cluster, comprised of 4 high school pyramids including the school of focus in this study, revealed information about the cluster and County initiative to be more environmentally friendly. This Green Initiative was new this year (2011-2012) and is based on County goals that have been long overlooked.

According to a County goal "Responsibility to the Community", students in the County are to "Be respectful and contributing participant in their school, community, country and world" and they are to "Exercise good stewardship of the environment."⁹

⁹ Data publicly available on the County website and in a powerpoint outlining the Green Initiative, provided through personal communication with Green Initiative staff (4/3/2012).

The goal is to produce literate, active, environmental stewards. The mission for this initiative closely aligns with that of the 'Eco-Schools USA' program. Eco-Schools strive to produce students who are excited about spending time outdoors and understand the value of diversity in nature.¹⁰ According to information provided by the Green Initiative staff, the County currently has 40 Eco-Schools, at least 33 edible gardens, and 41 school consultants; this all in the first year of operation. So far, more elementary schools than middle or high schools have become involved, but more are joining.

Projects include growing of monarch butterflies, development of more edible gardens so that school cafeterias can serve the food grown at schools, native gardens in school courtyards to promote biodiversity and outdoor learning space, rain water collection and drainage projects, and removal of invasive plant species. The high school of focus in this study will begin an invasive species removal project in the fall of 2012. This Green Initiative is a good way to include environmental education into school projects. Each involved school needs an ecology club or action committee to help implement projects. However, teachers need to incorporate these projects into the science curriculum as well as other disciplines. In order to assess the efficacy of such programs, we also must assess student attitudes towards the environment.

Developing a New Environmental Paradigm and a Scale for Assessment

In 1978, Dunlap and Van Liere published an assessment tool for environmental awareness and attitudes called the New Ecological Paradigm (NEP) in *The Journal of Environmental Education*. The name of the NEP was given as a reference to previous

¹⁰ Information provided through personal communication with Green Initiative staff (4/3/2012).

studies that defined the Dominant Social Paradigm, or DSP (Dunlap & Van Liere, 1978). Dunlap & Van Liere explained the DSP as the lens through which society viewed reality. It was suggested that the society, at the time of publication and arguably still today, had a largely anti-environmental DSP, but a new world view was forming. Due to publications such as 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) a NEP was beginning to take hold. Also, government attitudes were shifting; as evident in the groundbreaking 1972 Stockholm conference on the Human Environment. Out of Stockholm the United Nations Environment Programme (UNEP) was established. Stockholm also was "the first time, NGOs and other nongovernmental actors were prominently engaged" in such an international conference (Speth & Haas, 2006, p. 60). This would lead to more public involvement and the importance of public awareness of the issues.

In this wake of environmental awareness and hope, Dunlap & Van Liere (1978) dubbed the growing proenvironmental paradigm the "New Ecological Paradigm", an ecologically focused DSP. In order to assess shifts in attitude, the researchers developed a NEP scale. Development of this scale began three years prior to publication, in 1975 (Dunlap, 2008). Dunlap & Van Liere (1978) set out to assess the NEP and, in doing so, develop an accurate instrument to continue assessment. Three decades later, Dunlap revisited the NEP, calling it the "world's most widely used measure of environmental concern" (Dunlap, 2008, p. 3). However, Hawcroft & Milfont (2010) wrote that "there is considerable variation in the way the NEP Scale is used" (p. 143). Later discussion will

address when the scale is or is not appropriate for use. In 2000, Dunlap, Van Liere, and Mertig revised the NEP, in doing so, they renamed it the New Environmental Paradigm scale, replacing the word *Ecological* with *Environmental*. This was to further assess the role of human activity in interrupting normal ecological processes (Dunlap *et al.*, 2000).

Regarding the revised NEP Scale, 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 beyond the original three facets of balance of nature, limits to growth, and antianthropocentrism” (p. 432). Also, the team strove to include more items relating directly to anthropogenic activities such as depletion of stratospheric ozone and climate change. In a 1998 study, Schultz & Zelezny assessed students at universities in 5 countries. This was continued in a 1999 study with a survey of 14 countries. The purpose of the 1999 study was to assess proenvironmental behavior across cultures. The study utilized a 4 page instrument to examine attitudes along with other ethical and moral inclinations such as religious affiliation. Due to time constraints, the survey used in this study adhered primarily to the NEP scale and assessing students’ level of self-reported knowledge and concern. The instrument used in this study was a 2 page document designed to take no more than 15 minutes of classroom time. This was per the request of the host institution so as not to impede on the teachers’ lessons.

Schultz (2001) described three different aspects of environmental attitudes; egoistic, altruistic, and biospheric. Egoistic attitudes were defined as environmental concerns that only benefit the self. In an earlier writing, Schultz stated, “Egoistic concerns are based on a person’s valuing himself or herself above other people and above

other living things” (Schultz, 2000). Altruistic attitudes described those attitudes that one would feel for the benefit of others; for example, the preservation of biodiversity for aesthetic value or for sake of future research. Both of these are valid reasons for preservation, but neither benefit the self, this attitude shows empathy for other humans. Biospheric attitudes were described as the idea of preservation for preservation’s sake. This is an ecocentric view of the environment and is often a hard sell for political or economic motivation. Using the example of biodiversity, biospheric views would be the concept of conservation because humans do not have the right to overexploit. Such assertions were measured by the NEP scale.

The NEP scale assessed “the degree to which a person views humans as an integral part of the natural environment, rather than as separate from nature” (Schultz, 2001), but, according to Schultz & Zelezny (1999), does not distinguish between egocentric beliefs and the more altruistic or biospheric, ecocentric beliefs. For the purposes of this study, the distinction is not necessary. The goal of the County school system is to produce environmentally active students, it does not specify *why* the student is active, and for that purpose, distinction was not be made. Schultz & Zelezny (1998, 1999) also criticized the revised NEP scale for its applicability to non-western nations.

Dunlap (2008) rebutted this by showing that there have been international studies (including a few by Schultz & Zelezny) in which the revised NEP scale can be used. As far as this study is concerned, the revised NEP scale was used as an assessment of attitudes in a suburban school in the eastern United States. Any lack of applicability abroad was not an issue for a U.S. based survey, despite the fact that the students are

multi-cultural. They have all received the same U.S. public school education for the duration of the year of this survey.

This study aimed to assess student understanding of these topics and their attitude towards the environment. The results of this study could help in the awareness of educators of how concerned or focused their students may be. Also, this study offered suggestions for areas of the POS where EE can be implemented, not only to teach skills such as scientific reasoning, but to improve student sensitivity to environmental issues such as the effects of anthropogenic CO₂ emissions and issues of conservation.

Accordingly, the study will explore the following research questions.

Research questions

The purpose of this study is to investigate the level of student understanding of environmental issues and concern for human impact on the environment through the following research questions (RQ):

1. Do students understand the surveyed issues of environmental importance?
2. Are students concerned with human impact on the environment?
3. Do students actively try to mitigate personal harm to the environment?
4. Does attitude towards the environment depend on academic achievement in science classes (science grade)?

METHODS

Sample

The participants in this study consisted entirely of students enrolled in honors biology in a mid-Atlantic, suburban, public high school. Honors classes were selected because generally, the honors curriculum has more freedom of pacing to branch from State examination preparation, which would allow teachers to address EE to a greater degree, also allowing for more time for surveying without significant disruption of the course pacing. Selection of honors classes means that groups were intact prior to selection and not randomly assigned.

Honors students should, on average, have a higher reading level and better understanding of science than the lower level classes. This means that students will be more apt to respond knowledgeably to every question, decreasing response bias, however, Dunlap & Van Liere (1978) suggested that “we would expect better educated individuals to be more favorable toward the NEP, both because they are more likely to have been exposed to ‘ecological’ ideas... and because the more education one has the better one can comprehend the rather complex concepts involved in the NEP” (p. 25). This discrepancy was not addressed in this study, but could be addressed by continued surveying of classes at various levels of instruction.

According to the School Profile (accessed through the County website), the school had 1,545 students enrolled in general education as of the 2010-2011 school year; the year before this study was completed. This school was selected because it is one of the more socially, ethnically, and economically, diverse schools in the county. According to the School profile, in 2010-2011, around 17% of the student population was defined as Asian, 11% Black (Not of Hispanic origin), more than 40% Hispanic, and about 25% White (Not of Hispanic origin).

According to personal communication with the school's administrative staff, the school contained students representing at least 70 nationalities with at least 40 different home languages spoken. It was stated in the school profile, in the 2010-2011 school year, 68.46% of the school was considered English proficient; 31.54% were considered Limited English Proficient. This was taken into account with the group selected for surveying. By selecting only honors classes the rate of language proficiency in respondents would be higher without limiting the diversity.

In the 2010-2011 school year almost 60% of the student population (more than 950 total students) received free or reduced lunch. According to the County Financial Services webpage, "Families who earn less than 130 percent of the poverty level are eligible for free meals and those with incomes between 130 and 185 percent of poverty

level qualify for reduced price meals.”¹¹ This is in keeping with the National School Lunch Program guidelines set by the USDA.

According to administrative staff at the school, these numbers do not accurately reflect the poverty level of the area because each year, a significant number of waiver forms are not turned in. The Principal suspected that parents are either too embarrassed to file the paperwork, or too busy to sign and return the forms necessary for their student to receive these services (information from personal communication). Regardless, percentage of students on free or reduced lunch was used as a demographic measure of economic status of the area. As stated previously, this study did not explicitly focus on socio-economic status, but the school profile suggested that this venue for research would give the most diverse population in an already limited sample.

Instrument Development

This study utilized a modified NEP scale published by Manoli, Johnson, and Dunlap (2007) and obtained through personal communication with Dr. Dunlap (11/17/2011). Modification was necessary in order to address reading level restrictions in students surveyed. Fry readability tests placed the original 1978 version of the NEP scale at approximately an 11th grade reading level. Readability scores were difficult to ascertain because the scale is based on a ratio of number of syllables and words per section of reading. As a questionnaire has no paragraphs, this was difficult to assess. Researchers

¹¹ URL not provided to maintain anonymity of the County studied. All information is publicly available on the County website. Percentages of poverty level for Free/Reduced lunch were set by USDA National School Lunch Program.

treated each question as a sentence and each section as a paragraph. This method would not be appropriate in an actual use of the Fry score, but was necessary to gain a basic understanding of appropriate age for the original questionnaire.

The NEP scale, used for this study was modified by Manoli *et al.* (2007). In personal communication, Dr. Dunlap referred to it as the “Child NEP” scale. The Fry readability test placed the child NEP scale between a 6th and 7th grade reading level. Based on the English proficiency of the school studied, this was deemed a more appropriate level for students in high school biology. According to administrative staff, approximately 60% of students enrolled in the high school studied read at a middle school grade level. By using the Child NEP scale it would ensure that even if some students read below their grade level, they could still understand the questionnaire.

Gender and socioeconomic status were not surveyed for this study. Scott and Willits (1994) wrote, “we have found no significant relationship between gender and acceptance of the NEP” (p. 256). Hawcroft and Milfont (2010) reiterated this. They found that there are very few studies that consistently used the NEP Scale to correlate environmental attitudes with another characteristic of the respondents. They proposed that future researchers provide more demographic information so that links could be made, but that was not the purpose of this study.

All participants were in 9th grade and enrolled in honors biology so that age and educational level would be consistent. Milfont and Hawcroft (2010) suggested using a shortened version of the NEP scale so that time would not constrain participants. The instrument used in Manoli *et al.* (2007) included 11 items, but researchers dropped the

11th item because “students had trouble understanding it” (Manoli *et al.*, 2007, p. 7). The NEP scale used for this study contained only the first 10 items of the Child NEP scale, rather than the 15 from the original NEP (Dunlap and Van Liere, 1978), revised 12 (Dunlap *et al.*, 2000), or the 11 items from Manoli *et al.* (2007).

The items utilized in the knowledge and concern scale were modified from a survey used by Ashley Sitar-Gonzalez in 2007. The questionnaire was obtained through personal communication (12/27/2011) and was in the process of being published at the time of this study. The study focused on college student attitudes and media (Sitar-Gonzalez, 2011). This questionnaire was modified for use with high school students.

Pilot survey

In order to further develop this survey, a pilot was conducted with 15 students enrolled in an upper level, senior, *environmental science* course at the same school of this study. The course is a rigorous, lab based course that blended hard science with social sciences. Students learned field techniques and about how environmental policies affect the public (and vice versa). Students actually had the opportunity to receive dual credit in the sciences and humanities for completion of this course. At the time of the pilot study students were studying attitudes towards the environment and had already covered a semester of environmental systems and ecology. Students were asked to complete the survey and note any questions they had about wording, importance of questions, as well as general concerns. Most students completed the survey with ease. Two students pointed out errors in the Likert-type scale used. They felt the wording of “No opinion” would be

better way to convey the neutral position of the revised NEP scale. This modification was made for use in the actual survey.

Procedures

One week prior to survey distribution, regular classroom teachers distributed the parent letter home and informed consent form (Appendix B: Forms and Letters Home) to all honors biology students. The survey was given during the 3rd quarter of school, after the students had an understanding of biology, in general, but prior to studying any ecology. A total of 124 students were given permission to participate. Of this, three students did not complete the survey, one student was absent and was unable to make up time for the survey, and one student was a recent transfer from another country and an 11th grade student. It was decided that data collected would not be aligned with other students who had been in the same, 9th grade class the entire year so this questionnaire was not included in the data processing. Therefore, a total of 119 of the 161 students enrolled in honors biology completed the survey.

Individual classroom teachers monitored which students returned consent forms. Surveys were completed during the School's imbedded remediation period to limit disruption of classroom instructional time, as per request of the County human subjects review board. On the day of the survey, assent forms and questionnaires were distributed to students who had returned signed informed consent forms. Questionnaires were distributed by regular classroom teachers and supervised by the researchers. However, researchers did not remain in the room for the duration of the survey to reduce bias in responses. In order to increase anonymity, surveyors placed all questionnaires in

unmarked folders. This ensured that no student could be linked to a particular teacher. All consent and assent forms were maintained by the researcher. Questionnaires collected were assigned a number that was not linked to the student consent or assent forms. Students who did not participate were given an alternate assignment as deemed fit by the regular, classroom instructor. A candy incentive was provided to those that completed the survey.

Data Analysis

Data were analyzed using IBM SPSS 18 software, Student Version for Windows. First, a chi-square test for goodness of fit was performed on the survey questions 3, 10, 11, and 12 to determine if responses were randomly selected. Survey question 3 asked students to rank their environmentalism as one of three choices ranging from “Very environmentally conscious”, “Environmentally aware”, to “Not very environmentally conscious”. The question was written in such a way as to make students who were less environmentally conscious feel comfortable answering. This was done to avoid satisficing on this sensitive subject. This question of interest was intentionally left closed ended in order to force students to select a response. Chi-square test for goodness of fit was also performed for all 10 items of the Child NEP scale (survey question 10), all 8 items in the Self-Reported Knowledge section, (survey question 11) and all 8 corresponding items in the Concern section (survey question 12). To ensure that students did not respond randomly.

In regards to RQ 1: “Do students understand the surveyed issues of environmental importance?”, survey questions 4 and 5 were analyzed for understanding of the issues of

global warming and greenhouse gas emission. In survey question 4, students were asked if global warming exists. Percent response was analyzed to compare to scientifically accepted data. As a follow-up to question 4, students were asked if global warming is human caused. Response choices included, “No”, “Yes”, “Partially”, or “Not Sure”. Percent responses were calculated. Survey question 5 asked students to report if greenhouse gases were “Increasing”, “Decreasing”, “Neither”, or “Not Sure”. Percent responses were calculated and compared to current scientific data.

In order to address the how comfortable students felt with their own knowledge of environmental issues, survey question 11 asked “How much do you feel you know about the following?”. The question provided a Likert-type scale containing 8 items relating to climate change and biodiversity loss. The ranking scale was from 1 to 5 with 1 being “Nothing”, 2 being “Very little”, 3 a “Moderate amount”, 4 being “More than average”, and 5 being “A lot”. First, the mean was calculated for each individual rank within the Likert-type scale to find the percent response for each rank. Next, self-reported knowledge level was averaged for each student and assigned a score of “Self-Reported Knowledge of Issues of Biodiversity Loss” (KBdL). Items 1, 2, 4, 6, 7, and 8 related to biodiversity loss. The means of these items was calculated to assign a level of knowledge. Items 3 and 5 included “Global warming” and “Climate change”; knowledge level was averaged for each student and assigned a score of “Self-Reported Knowledge of Global Climate Issues” (KGCI).

Items 4 and 7 could be associated with issues of climate change as well, but they were not included in this study because of the more abstract nature of the relationships.

Had “Pollution” (item 4) specifically read “Emissions” and item 7, “Rainforest loss” been stated as “Deforestation” they would be directly included as issues of climate change. As stated in the survey they were intended to be listed as issues of biodiversity loss. It is also important to understand that biodiversity loss and climate change are not mutually exclusive, but for the purposes of curriculum development, this study sought to establish weaknesses in student understand with specific areas of interest.

To address RQ 2: “Are students concerned with human impact on the environment”, question 12 asked “How concerned are you about the following topics”. The question provided the same 8 items presented in survey question 11. The ranking scale was also from 1 to 5 with 1 being “Not at all”, 2 being “A little concerned”, 3 being “Moderately concerned”, 4 being “Very concerned”, and 5 being “Extremely concerned”. First, the mean was calculated for each individual ranking within the Likert-type scale in order to find the percent frequency of response for each rank of the scale. Next, the mean of the concern level was determined for each student and assigned a score of “Concern of Issues of Biodiversity Loss” (CBdL). Items 1, 2, 4, 6, 7, and 8 related to biodiversity loss. The mean of these items was used to assign a concern score.

Items 3 and 5 included “Global warming” and “Climate change”; the mean of these two ranking was determined for each student and to assign a score of “Concern for Global Climate Issues” (CGCI). Once concern scores were assigned, Pearson’s correlation coefficient was calculated to determine if there is a significant relationship between total concern score (mean of the CBdL and the CGCI) and total knowledge score (mean of the KBdL and KGCI). It is important to note that biodiversity loss and climate

change are not mutually exclusive, one can exacerbate the other, but for the purposes of curriculum development, this study sought to establish weaknesses in student understanding with specific areas of interest.

A Levene's test for homogeneity of variances was used to determine variance among the three designations listed in survey question 3. Students were asked to identify themselves as "Not very environmentally conscious", "Environmentally aware", or "Very environmentally conscious". One factor analysis of variance (ANOVA) testing was then utilized to determine if there were links between the student attitudes towards issues of environmental concern (survey question 3) and the total mean score of the CBdL and CGCI. Tukey post-hoc analysis tested for significant differentiation among the three reported designations.

Survey question ten was analyzed in keeping with methods from Manoli *et al.* (2007). First, items on the Child NEP (survey question 10) were organized into three categories as established by Dunlap and Van Liere (1978) and Dunlap *et al.* (2000): Rights of Nature (survey question 10: items 1, 4, and 7), Eco-Crisis (items 2, 5, 8, and 10), and Human Exemptionalism (items 3, 6, and 9). Items of the Child NEP were initially ranked 1-5 from "Strongly Disagree" to "Strongly Agree" in order to calculate total frequency distributions in percent response for each rank on the Likert-type scale. Then researchers reversed scoring of the ranks to 1 "Strongly Agree" to 5 "Strongly Disagree" for the negatively worded items 3, 6, 7, and 9. From this dataset, total NEP scores were calculated by computing the mean for each of the three categories, Rights of

Nature, Eco-Crisis, and Human Exemptionalism. Then mean of the three category scores was calculated to determine overall NEP score.

In regards to RQ 3:” Do students actively try to mitigate personal harm to the environment?”, frequency of response for survey questions 2, 6, and 7 was calculated. Survey question 2 asked students if they thought they should know more about the environment. The only option of response was “Yes” or “No” to force respondents to choose. Survey question 6 asked students if they took an active role in learning about the environment and had a short answer portion for students to explain. Pearson’s chi-square was computed to test for association between responses to survey questions 2 and 6. Question 7 asked if students thought that their school should be more environmentally friendly. It contained a follow up to ask if they would be willing to help. Frequency of response was calculated for each question to gain better understanding of how active students in the surveyed population were.

With regards to RQ 4: “Does attitude towards the environment depend on academic achievement in science classes (science grade)?”, homogeneity of variance was tested using Levene’s test. Then ANOVA testing was utilized to determine if there are links between the student attitudes towards issues of environmental concern as reported by each student’s total NEP score and the student performance in science classes.

Student summative grade to date was self-reported. Grades were scored according to County GPA scores: 4.0 for a reported “A”, 3.0 for a reported “B”, 2.0 for a “C”, 1.0 for a reported “D”, and a 0.0 was assigned for a reported “F”. ANOVA testing was conducted for these five designations. To further understand the connection between

success in science class and environmental awareness, a chi-square test for association was conducted to determine any possible association between student reported environmental awareness (survey question 3) and the self-reported grade in science class (survey question 9).

Using the methods described for RQ 2, each student was then assigned an individual NEP score based on the mean of the scores for each of the three NEP categories (Dunlap & Van Liere, 1978; Dunlap *et al.*, 2000; Manoli *et al.*, 2007). Finally, Pearson's correlation was calculated to test for association between self reported GPA (survey question 8) and NEP scores.

RESULTS

The results of the chi-square analysis for goodness of fit for survey question 3 indicated that observed results differed from the expected and therefore students did not respond randomly to question 3, $\chi^2(2) = 102.118, p=.000$. This showed that a significant portion of the students (91 out of 119) did consider themselves “Environmentally aware”. Further results of the chi-square analysis for goodness of fit also indicated that each item in all three Likert-type questions (survey questions 10, 11, and 12) also had observed frequencies that did not reflect the expected frequencies of equal responses for each rank within the Likert-type scale. Once again, this indicated that students did not respond randomly and therefore did respond on their own accord.

In order to address the issue of whether students understand the surveyed issue of environmental importance, first, we calculated the frequency of response for survey questions 4 and 5. Survey question 4 first asked students if global warming exists. 96.6% of students (115/119) responded, “Yes”, global warming does exist. As a follow up question, students were asked if global warming was caused by humans. Table 2 shows frequencies as percentage of distribution.

Only those who answered “Yes” to question 4 were asked to continue on to the follow up question. Table 2 shows that 93.3% of students understood that there is some anthropogenic affect on global warming by answering either “Yes” or “Partially”. Only

2.5% of students (3 students of the total 119) responded that humans do not have any role in global warming and 1.7% of students responded, “Not Sure”.

Table 2: Follow up responses to survey question 4.

	No	Yes	Partially	Not Sure
If “yes” [to question 4], is global warming cause by humans?	2.5%	47.9%	45.4%	1.7%

Survey question 5 asked students if greenhouse gases were increasing, decreasing, if gases are neither increasing nor decreasing, or if the students did not know. Table 3 shows that only 53.8% of students responded that greenhouse gases are, in fact, increasing. Even though a vast majority of students acknowledged that humans at least have some effect on global warming (as indicated by Table 2), only 46.2% of students surveyed actually identified this major the cause of the problem. 38.7% of students surveyed reported “Not Sure”.

Table 3: Survey question 5

	Increasing	Decreasing	Neither	Not Sure
Are greenhouse gases increasing or decreasing?	53.8%	5.0%	2.5%	38.7%

To further investigate student understanding of environmental issues, students were asked to rate how comfortable they felt with material. Self-reported knowledge level was scored for each student in two different categories: Self-Reported Knowledge

of Issues of Biodiversity Loss (KBdL) and Self-Reported Knowledge of Global Climate Issues (KGCI). To ascertain the level of understanding, first the frequency of responses for each item was calculated. Table 4 shows the overall percentage of response for each item. Students ranked how much they felt they knew about each subject. Findings suggested that most students responded within the middle ranges of knowing “Very little”, a “Moderate amount”, or “More than average”. Students tended not to answer at the extremes of the Likert-type scale.

Table 4: Self reported knowledge level

	Nothing	Very little	Moderate amount	More than average	A lot
1. Loss of natural resources	2.5%	22.7%	49.6%	19.3%	5.9%
2. Overfishing	14.3%	35.3%	28.6%	16.0%	5.9%
3. Global warming	0.8%	12.6%	27.7%	39.5%	18.5%
4. Pollution	0.0%	5.0%	25.2%	41.2%	27.7%
5. Climate change	1.7%	17.6%	37.8%	25.2%	17.6%
6. Endangered species	0.8%	13.4%	31.1%	31.1%	23.5%
7. Rainforest loss	4.2%	27.7%	37.0%	22.7%	8.4%
8. Illegal hunting	15.1%	31.9%	27.7%	16.8%	8.4%

The mean of items 1, 2, 4, 6, 7, and 8 as, seen in Table 4, was calculated for each student to find KBdL. The mean of items 3 and 5 was calculated for each student to find a KGCI. Table 5 shows that students reported knowing only a moderate amount about biodiversity loss ($M = 3.16$, $SD = 0.36$). KGCI was reported slightly higher, but still within the moderate range ($M = 3.51$, $SD = 0.44$) meaning that the overall knowledge level was reported to be slightly above the moderate ranking ($M = 3.33$, $SD = 0.40$). This

suggested that students did not appear confident in their own knowledge of the items presented. Each item listed was selected specifically as an issue that would be tangible to students and easily incorporated into a middle or high school curriculum.

Table 5: Average knowledge score

	AVG	SD
Knowledge of issues of biodiversity loss	3.16	0.36
Knowledge of global climate issues	3.51	0.44
Total knowledge	3.33	0.40

Total concern level scored slightly higher than total knowledge level ($M = 3.79$, $SD = 0.48$). Table 6 shows that the students reported being moderately to very concerned about the issues presented, whereas they reported only moderate knowledge levels (Table 5). Further study was conducted to assess any correlation between knowledge and concern scores.

Table 6: Average concern score

	AVG	SD
Concern for issues of biodiversity loss	3.61	0.41
Concern for global climate issues	3.97	0.54
Total concern	3.79	0.48

The Pearson correlation coefficient (Table 11, Appendix D: SPSS Data Output) between the total knowledge scores and the total concern level for each student was statistically significant, $r(119) = .415$, $p = .000$. Though a low correlation, there was a

weak positive linear relationship between knowledge level and concern level for this population. This indicated that students may show more concern if they understood more about each topic.

Frequencies of response for each item of concern level were reported in Table 7. This was in keeping with the data presented in Table 6 showing the mean of the total concern. CGCI was slightly higher ($M = 3.97$, $SD = 0.54$) than CBdL (3.61 , $SD = 0.41$). Research question 2 asked if students are concerned with the environment. Total concern level was reported as “very concerned”. Students reported the highest level of concern for pollution. Interestingly, there is a discrepancy in the frequency level of concern for items 3 and 5. For item 3, global warming, 47.1% of students responded “Extremely concerned”. 77.4% of students responded either very or extremely concerned. Conversely, only 31.1% reported extreme concern for climate change.

Table 7: Self reported concern level

	Not at all	A little concerned	Moderately concerned	Very concerned	Extremely concerned
1. Loss of natural resources	1.7%	10.1%	24.4%	42.9%	21.0%
2. Overfishing	3.4%	26.9%	43.7%	17.6%	8.4%
3. Global warming	1.7%	6.7%	14.3%	30.3%	47.1%
4. Pollution	0.8%	3.4%	12.6%	30.3%	52.9%
5. Climate change	2.5%	10.9%	22.7%	32.8%	31.1%
6. Endangered species	1.7%	9.2%	22.7%	28.6%	37.8%
7. Rainforest loss	4.2%	16.0%	24.4%	28.6%	26.9%
8. Illegal hunting	11.8%	18.5%	31.1%	23.5%	15.1%

To further investigate the link between concern for issues of the presented environmental issues and student environmental awareness, ANOVA was conducted. The

results of Levene's Test of Equality of Variances (Table 12, Appendix D: SPSS Data Output) showed that the null hypothesis of equal variances in the dependent variable across groups could not be rejected, $F(2,116) = .262, p=.770$. Therefore, assumption of homogeneity of variances was met. The results of the omnibus F-test in the ANOVA (Table 13, Appendix D: SPSS Data Output) showed that there are statistically-significant differences in attitude among the three designations at the .05 level of significance, $F(2, 118) = 3.044, p = .051$.

Tukey post-hoc analysis (Table 14, Appendix D: SPSS Data Output) indicated that there was a statistically significant difference between students that identified themselves as "very environmentally conscious" and "not very environmentally conscious", $p = .042$. However, there was not a statistically significant difference between those that identified themselves as "environmentally aware" and "not very environmentally conscious", $p = .357$. Nor was there a statistically significant difference between those that identified themselves as "environmentally aware" and those that identified as "very environmentally conscious", $p = .150$. This indicated that those that reported towards the neutral, middle of the scale were not significantly different, but that those that reported to the two extremes were significantly different in their concern level for the issues presented.

With regards the NEP scale, Table 8 shows the frequency of response for each ranking by item. Items of interest included items 1 and 8 as both showed the highest level of consensus for responses. Item 1 stated that plants and animals have the same right as people to live. 52.9% strongly agreed with this statement and a total of 84.8% of students

responded in the affirmative. Only 5.0% responded on the negative side of the scale with 10.1% neutral. Item 8 showed shared the highest consensus, stating that people are treating nature poorly. 52.9% of respondents agreed with this statement and 86.5% of students responded in the affirmative.

Table 8: NEP frequencies of response

	Strongly agree	Agree	No opinion	Disagree	Strongly disagree
Plants and animals have as much right as people to live.	52.9%	31.9%	10.1%	5.0%	0.0%
There are too many (or almost too many) people on earth.	20.2%	36.1%	37.0%	5.9%	0.8%
People are clever enough to keep from ruining the earth.	21.8%	31.9%	25.2%	15.1%	5.9%
People must still obey the laws of nature.	37.0%	42.0%	16.8%	3.4%	0.0%
When people mess with nature it has bad results.	43.7%	37.0%	11.8%	6.7%	0.8%
Nature is strong enough to handle the bad effects of our modern lifestyle.	7.6%	16.8%	13.4%	40.3%	21.8%
People are supposed to rule over the rest of nature	3.4%	4.2%	31.9%	40.3%	19.3%
People are treating nature badly.	33.6%	52.9%	8.4%	2.5%	1.7%
People will someday know enough about how nature works to be able to control it.	8.4%	26.1%	44.5%	16.8%	4.2%
If things don't change, we will have a big disaster in the environment soon.	44.5%	40.3%	10.1%	5.0%	0.0%

Overall NEP score, calculated as described by Manoli *et al.* (2007) is shown in Table 9. The mean of three categories established by Dunlap and Van Liere (1978) was calculated to assign a total NEP score for the group of students surveyed. On average, students ranked slightly above neutral toward the affirmative with a score of 3.69 ($SD = 0.47$); with 3 meaning “No opinion”, and 4 being in agreement. Students tended to agree more strongly with the items linked to the Rights of Nature ($M = 4.05$, $SD = 0.49$) and Eco-Crisis ($M = 4.06$, $SD = 0.41$), but scored attitudes towards Human Exemptionalism slightly lower than neutral ($M = 2.95$, $SD = 0.47$) indicating that students tended to agree

that the nature is being harmed and that nature has rights, but tended to disagree and to place humans as exempt from the environment and separated from nature.

Table 9: NEP score by category

	AVG	SD
Rights of Nature	4.05	0.49
Eco-Crisis	4.06	0.41
Human Exemptionalism	2.95	0.51
Total NEP	3.69	0.47

Items 3, 6, 7, and 9 of the child NEP scale (Table 8) all were reverse scored for calculation of the total NEP score as described previously. Item 3 stated that people are clever enough to keep from ruining the earth, 31.9% of students agreed with this statement, indicating that they do place humans as exempt and able to manage the environment. This was supported by responses to item 6, which stated that nature can handle the bad effects of human lifestyles. Only 62.1% of students responded in the negative, meaning that 37.9% of students either reported neutral or agreed that nature can handle our modern lifestyle. Item 9 presented the idea that humans will progress and figure out how to control nature. 44.5% of students responded neutral to this item and 26.1% agreed with the statement. Overall, 79.0% of students responded in the neutral or affirmative, and only 21.0% disagreed. Overall, students displayed optimism for human ingenuity and placed humans as managers of nature rather than part of it.

In order to determine whether students actively tried to mitigate personal harm to the environment (RQ3), first frequency of response was calculated for survey questions 2,

6, and 7. Students were provided with only options of yes or no for all three questions. Questions 6 and 7 contained follow-up questions for clarification. Survey question 2 asked if students thought that they should know more about the environment. Question 6 asked students if they took an active role in learning about the environment. The question provided space for an open ended explanation of how. Question 7 asked students if they thought the school should be more environmentally friendly and then followed up by asking if they would be willing to help.

Table 10: Frequency of response for survey questions 2, 6, and 7

	Yes	No
2. Do you think you should know more about the environment?	94.1%	5.9%
6. Do you take an active role in learning about the environment?	25.2%	74.8%
7. Would you like to see your high school become more environmentally friendly?	96.6%	3.4%
7. Follow-up: If yes, would you be willing to help?	79.8%	18.5%

A majority of students reported that they should know more about the environment, but do not actively do so. Table 10 shows that 94.1% of students responded yes to question 2, but only 25.2% of students reported taking an active role in learning about the environment. 96.6% reported that they thought their school should be more environmentally friendly, and a majority of those that responded said they would be willing to help. There is no way to quantify how many of these students actually *would* participate in school greening events, but it is a large number of reportedly willing students.

Results of the Pearson's chi-square test for association (Table 15, Appendix D: SPSS Data Output) indicated that there was not a significant association between student responses to questions 2 and 6, $\chi^2(1) = 2.507, p=.113$. This supported the findings from the overall percentage frequencies. Students who reported that they should know more about the environment did not necessarily take an active role in learning about the environment. Cross tabulation (Table 16, Appendix D: SPSS Data Output) indicated that 82 of the 119 students responded yes to question 2 stating that they should know more about the environment, but responded no to question 6 stating that they did not take an active role in learning about the environment. A total of 30 students responded yes to both questions.

To address associations between attitude and academic achievement, ANOVA testing was used to compare each student's total NEP score and their self-reported grade in science class. The results of Levene's Test of Equality of Variances (Table 17, Appendix D: SPSS Data Output) showed that the null hypothesis of equal variances in the dependent variable across groups could not be rejected, $F(4,114) = .441, p=.779$. Therefore, assumption of homogeneity of variances was met. The results of the F-test in the ANOVA (Table 18, Appendix D: SPSS Data Output) showed that there was not statistically-significant differences in total NEP score attitude among the five achievement levels at the .05 level of significance, $F(4, 114) = .391, p = .815$. This indicated that student achievement in science class did not have a significant association with attitude towards the environment as reported by the student's NEP score.

To further investigate any connection between achievement in science class and attitudes towards the environment a chi-square test for association (Table 19, Appendix D: SPSS Data Output) was used to compare self-reported science grade (survey question 9) and reported level of environmental awareness (survey question 3). Results of the chi-square test indicated that there was a statistically significant association between the three designations of self-reported environmental awareness, $\chi^2(8) = 16.363, p=.037$. Results of the crosstabulation (Table 20, Appendix D: SPSS Data Output) indicated that only students with grades of an A or B classified themselves as very environmentally conscious.

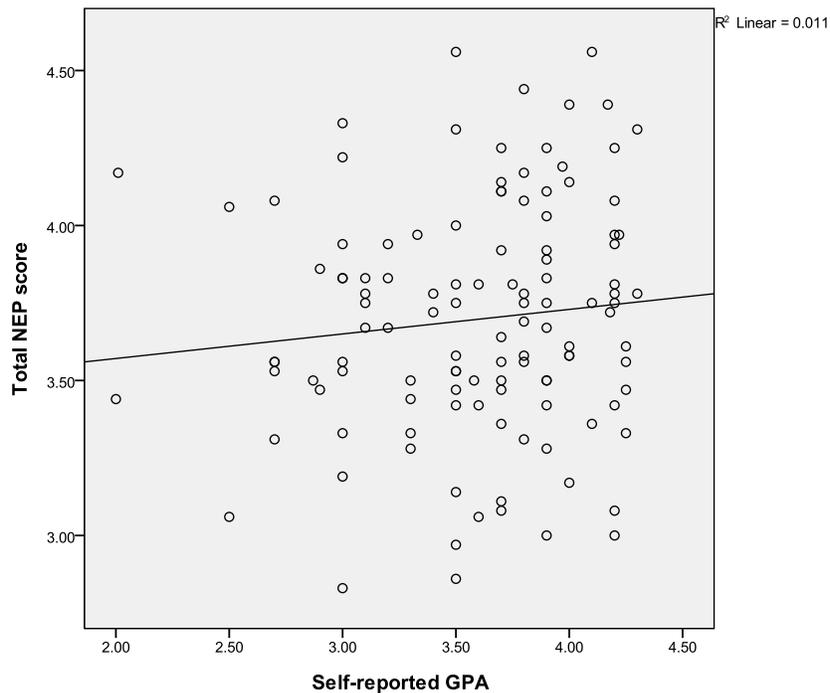


Figure 4: Correlation between GPA and NEP

The Pearson correlation coefficient between total NEP score and self-reported GPA (Table 21, Appendix D: SPSS Data Output) was not statistically significant at the 95% confidence level, $r(117) = .106, p = .257$. This indicated that there was not a linear relationship between overall student achievement in school and the total NEP score. Figure 4 shows the relationship between GPA and total NEP score. This reaffirmed that individuals do not need to be top students to have a positive attitude towards the environment.

DISCUSSION

As stated previously, one goal for the County was for each student to be a “respectful and contributing participant in their school, community, country and world” and to “Exercise good stewardship of the environment.”¹² According to the textbook used by the environmental science class studied for the pilot survey in this study, stewardship was defined as a “shared responsibility for the sustainable care of our planet” (Raven & Berg, 2006, p. 11). Though the NEP scale is not a good indicator of proenvironmental behavior, it is an effective tool in assessing student attitudes towards the environment. Scott and Willits (1994) did not find a significant correlation between individuals that expressed support for the new environmental paradigm and those that actively engaged in proenvironmental behaviors, suggesting that there was not a significant link between attitude towards the environment and behavior.

The NEP scale was designed as a measurement for changes in environmental attitudes. For the purposes of this study, it was be used to gauge high school student attitudes where assessment has never been performed. The instrument was not intended to be used as a predictor of proenvironmental behavior or stewardship. Dunlap (2008) himself wrote, “there was never any reason to expect that the NEP Scale would be a

¹² Data publicly available on the County website and in a powerpoint outlining the Green Initiative, provided through personal communication with Green Initiative staff (4/3/2012).

strong predictor of behaviors” (p. 12). So, for that purpose, the follow-up questions for survey questions 2, 6 and 7 on the questionnaire were used to gain insight into student proclivity towards proenvironmental behavior.

Cross tabulation (Table 16, Appendix D: SPSS Data Output) indicated that 82 of the 119 students responded yes to question 2; stating that they felt that should know more about the environment, but responded no to question 6, indicating that they did not take an active role in learning about the environment. Such data should be carefully inspected by the County as to why students do not take an active role in learning about the environment despite their apparent concern for issues of environmental importance.

In developing a model for studying stewardship, Schultz and Zelezny (1998) presented the idea that proenvironmental behavior is altruistic in nature. They defined *altruism* as a reference to a “helping behavior motivated by an internal value and without expectation of anything in return” (Schultz & Zelezny, 1998, p. 541). This is the concept of stewardship; students would take an active role in mitigating environmental harm without reward. The 1998 study focused on predictors of behaviors, but utilized the NEP scale as a baseline to determine value systems. Figure 5 (Schultz & Zelezny, 1998) depicts a model for how an individual can move from values to action.

First, an individual must be aware of all consequences in behavior. Then, one must take responsibility for said behavior. In order to predict behavior, one must assess each aspect along the line from value to behavior. The instrument used in this study asked for self-reported awareness in survey question number 2. This along with knowledge questions (number 4, 5, and 10) as well as concern level (number 12) helped assess

whether or not students are inclined to be stewards. The follow up of question 7 asked students directly if they would be willing to help make their school more environmentally friendly. Students showed overwhelmingly neutral levels of concern for the environment.

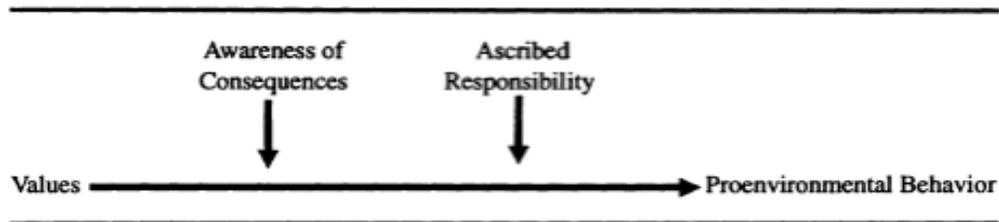


Figure 5: From Schultz & Zelezny (1998). Depicts a model for proenvironmental behavior.

Total NEP score was slightly above neutral ($M = 3.69$, $SD = 0.47$), as was the total concern score was ($M = 3.79$, $SD = 0.49$). Total knowledge score was also in this same range ($M = 3.33$, $SD = 0.40$). All three of these scores did not indicate a group of students who could be described as caring, participating, active environmentalists. This is disconcerting because the students surveyed were volunteers, 76.4% of who identified themselves as environmentally aware. On top of this, the students surveyed were all enrolled in honors level, accelerated science course, presumably by personal choice. Further study into the lower level classes at this and other schools could shed more light on the overall student attitude. Regardless, there needs to be a shift in how and when these students are exposed to issues of environmental importance so that the students are comfortable with the information and willing to act.

The results showed that there was no significant association between NEP score and success in science classes (Table 18). Despite this, there was a statistically significant association between self-reporting of environmental awareness and success in science class (Table 19). This discrepancy may indicate flaws in the child NEP scale; however, it is far likely that this indicated a level of satisficing in respondents for survey question 3, environmental awareness. Students may have claimed to be more environmentally aware than they truly were. The child NEP asked students to respond to specific issues of environmental concern, whereas the level of awareness was a simple nominal ranking. It was easier to claim awareness without an in-depth assessment of actual feelings. The fact that there was no statistically significant difference between those that identified themselves as environmentally aware versus those at either of the two extremes of the ranking, but there was a difference in those at the extremes, suggested that some of the students who reported themselves as environmentally aware may actually not be, hinting at a discrepancy in how aware they *thought* of themselves compared to how aware they truly were.

In order to gain insight into this discrepancy, we conducted a follow-up analysis of the association between level of environmental awareness and total NEP score. Results of the F-test in the ANOVA (Table 22, Appendix D: SPSS Data Output) showed that there was not statistically-significant differences in total NEP scores among the three self-reported awareness designations at the .05 level of significance, $F(2, 116) = 1.054, p = .352$. This supported the findings that students may have thought of themselves as more environmentally aware than they actually were. In future studies, survey question 3 could

be rewritten to allow for more designations rather than the just the three that were presented in this study.

With regards to actual student activity, 94.1% of students responded yes to question 2, indicating that they thought that they should know more about the environment, but only 25.2% of students reported taking an active role in learning about the environment in survey question 6 (Table 10). This begs the question as to why these students have not taken an active role. It was most likely a lack of motivation due to a lack of exposure to the topics. Findings indicated a weak, but significant positive linear relationship between knowledge level and concern. If the students were actively engaged in learning about these topics in multiple classes, they may be more likely take initiative to do further study outside of the classroom. To exacerbate the issue, it could also be that students had been receiving mixed messages in the media and have not had access to reliable sources, as was indicated by Eagles and Demare (1999). Media plays a large role in the lives of youths; it is possible that they do not take an active role because of the misconceptions continuously displayed to them.

As far as knowledge and understanding of the issues was concerned, there were a few important misunderstandings that surfaced. Results, as shown in Table 7 indicated a discrepancy in the frequency level of concern for items 3 and 5 of survey questions 11 and 12; global warming and climate change respectively. 47.1% of students responded “Extremely concerned” for item 3, global warming. This rank showed the highest level of concern for all items with a total of 77.4% of students that responded either very or extremely concerned. Conversely, only 31.1% reported extreme concern for climate

change, with a total of 66.9% of students who reported being either very or extremely concerned indicating a misunderstanding in the link between climate change and global warming.

Students did not seem to connect the link that global warming causes climate change. Botkin and Keller (2007) defined climate change as a “change in mean annual temperature and other aspects of climate over periods of time ranging from decades to hundreds of years to several million years” (p. G-3), and defined global warming as “natural or human cause increase in the average global temperature” (p. G-8). Both definitions include the concept of changes in global temperatures. Raven and Berg (2006) specifically cited the greenhouse effect and its role in global warming as the cause of climate change (p. 478). The fact that students showed differences in concern level for these two issues showed that there may have been a misunderstanding in the concepts themselves. Further examination would shed light on this issue.

CONCLUSIONS

Results of this study showed a clear distinction between how environmentally aware students thought they were and how environmentally aware they actually were according to the NEP scale. This discrepancy in student attitude was not surprising and indicated that the schools and county have not yet effectively integrated EE into the curriculum. This year the County began a Green Initiative to address stated goals of producing active, aware students. Further study in subsequent years could assess whether this initiative will work. Students surveyed reported that they thought they should know more about the environment and results showed a positive linear association between students' knowledge and concern for important environmental issues. This means that the more they know, the more likely they will be to show concern for the issues. Schultz and Zelezny (1998) showed in Figure 5 that both understanding and concern are important steps on the path to action and proenvironmental behaviors. Though the NEP scale is not a predictor of proenvironmental behavior, the combination of knowledge and concern could be indication of future action.

Regulations and practices in the current public school system lead to silent springs of inactive review. Students take a break from engaging lessons to spend the season preparing for standardized assessments. There is a need for summative assessment. Schools should continuously monitor how their student body progresses from year to year

so that administration can effectively manage schools. However, there is often far too much emphasis placed on one large test. Regular, formative assessment would be a more appropriate way to monitor student achievement. The County of focus in this study does *some* formative assessment in science classes. Each year students take two online quizzes designed to prepare students for the end of the year state exam, however, these assessments are not always relevant to what is being taught at the time of the testing window because there is no standardized sequence or pacing guide for teachers. Access to such resources would ensure that teachers county-wide are on the same page. Communication with the cluster director of the group that includes the School in this study revealed that the County has actually developed such a guide and it will be in place for teachers next year. Hopefully this will be useful in producing more relevant formative assessments. However, ultimately, assessment will not change unless policies change.

Government participation is vitally necessary to achieve a paradigm shift, but all citizens must do their part as well. Hardin (1968) referred to this collective effort as a *mutual coercion mutually agreed upon*; meaning that society, as a whole, needs to agree to change behaviors. Revamping how our teachers teach is one collective agreement that needs to be addressed politically. Richard Louv is a strong proponent of government involvement in addressing the issue of EE and has helped spearhead the *No Child Left Inside* amendment to the Elementary and Secondary Education Act of 1965 (Louv, 2011). In an address to the House of Representatives, he said, “A public movement is growing to leave no child inside. But government, with its influence over parks, open space and how we shape cities, education and health care, has a crucial role to play” (Louv, 2007, p. 1).

The No Child Left Inside (NCLI) Act of 2011 set goals to establish grant programs for environmental education to improve environmental literacy (No Child Left Inside Act, 2011). According to govtrack.us (2011), the bill was introduced on July 14, 2011, but has yet to be referred to committee and has only a 1% chance of being enacted. Such an amendment would open pathways for educators to gain access to grants for program development.

Policy change is necessary, but is not the only answer to the problem. “Although curriculum of the public schools shifts with changing political and economic goals, the actual methods of instruction, despite attempts at reform, remain relatively constant” (Spring, 2004, p. 265). Educators need to adjust teaching methods in order to address the lack of EE. The Gardening Pedagogy described by Howes *et al.* (2009), was unsuccessful because teachers had difficulty stepping outside of the usual pedagogical practices. EE should be less regimented than a walled classroom. It needs to feel natural to the students, but with current time limitations and summative assessments, teachers cannot allow students the time needed to explore nature.

Students are not the only ones who need better education. Educators themselves need to be more proficient in EE, especially those that do not have any science background. This is where government programs like those that could come out of NCLI Act, or other modes of government or private funding. Teacher training is difficult to fund, but grants through agencies such as the National Science Foundation (NSF) provide valuable field experiences for teachers. Investing in teacher experience increases confidence in educators and will trickle down to students (Moore & Huber, 2001).

Dunlap and Van Liere first wrote about a proenvironmental paradigm shift in 1978. Now, almost 35 years later, environmentalism is still not a social norm. To complete this shift we must actually develop and promote a culture of proenvironmental action. It is not enough to teach children about nature, they must experience it collectively. Educators must develop lessons that are not only inquiry based, but social in nature. “Human beings are fascinated by other human beings... we are pleased endlessly to watch and analyze our relatives, friends, and enemies” (Wilson, 2012, p. 290). This is evident in students’ incessant texting, use of social media, and the success of reality television. Educators should harness these outlets for a proenvironmental voice. Currently, administrators at the school of focus have prohibited teacher use of social media. Student organizations manage their own pages, but teachers may not connect with students through this medium. This greatly limits educators in reaching students in a forum that they are used to reading. Tweets, posts, pins, and blogs can be a great source of information if teachers can manage what the students see. It is a shame that there is such disconnect in the growing digital age.

The comedy in this tragedy is that the same tools that students use to isolate themselves indoors; computers, tablets, phones, etc, can access almost limitless information on issues such as those addressed by a comprehensive EE program. Valuable common resources like GREEN and GLOBE are available online, but defeat the purpose of outdoor, nature-based EE if it is all conducted in front of a computer. The two forms of education should supplement one another to provide a cohesive modern education that includes both EE and media literacy so that students can rationalize which

online information is valid. Educators must learn to effectively use both digital *and* natural resources so that students can step away from the screen and into a stream. That is, if students are even allowed outside in the first place.

At the school of focus for this study, there are several cloistered courtyards that currently are covered with sod and non-native shrubs. These areas are closed to students at all times, as is the county park across the street. Outdoor space needs to be made available to students. One courtyard is directly across from the cafeteria. This should be open to students during lunch time. The area is completely enclosed by the school building itself, so that opening the space would not create any security risks. In addition, the school's environmental club could organize students to plant native shrubs. This would make management of the area easier and will provide a safe, contained space that the students can explore in their free time. Providing safe areas in which students can experience nature will actually aid in cognitive development (Louv, 2007; Kellert, 1997; Wilson, 1984). Such projects will take an attitude change, not only in students, but in school administration.

Results of this study showed that surveyed students acknowledged that human actions harm nature and that nature does have rights, but they also tended to place humans as exempt from the environment and separated from nature. This hints at their lack of understanding of ecosystems. Students clearly were aware of human mistreatment of the environment, but placed humans as managers of nature rather than a part of it. This reinforces the idea that these topics should be integrated throughout the year. Not only with this reduce the novelty of EE, but students would have more time to freely discuss

the issues in a rational and interactive way. Appropriate teaching opportunities are available through the State indicators already present in the curriculum. They need be taken advantage of.

Wilson (2012) wrote on the social development of humans, as a species, through the lens of evolutionary biology. Humans have evolved to learn from one another. One could argue that this has been the reason for our evolutionary success, but without proper education, it may also be our downfall. “We are terribly confused by the mere fact of our existence, and a danger to ourselves and to the rest of life” (Wilson, 2012, p. 7). Though published almost 100 years earlier, Vygotsky’s work in peer education reflected this concept. Humans work best as a collective mind; creativity through imagination and social play. In order to actually achieve any success in the realm of EE, teachers must bridge gaps between curricula to produce a consilient, proenvironmental culture among students. A culture that is proactive and pro-science.

“This all brings us to a realization of the enormous educational task which must be successfully accomplished right now in a hurry” (Fuller, 2008, p. 45). Vygotsky (2004a) wrote that young students have the cognitive abilities to understand complex issues such as biodiversity loss or climate change, even if they do not have the vocabulary or life experience to articulate it. Exposing children such issues regularly will help incite an environmental paradigm shift. In order to do this, educators must be better educated, children need access to the outdoors, and EE needs to be effectively integrated across all disciplines.

Dunlap (2008) wrote, “In the long term, it will rest on the ability of scientists, citizens, and policy makers to recognize and acknowledge the reality of ecological deterioration” (p. 15). A cohesive, cross-curricular and proenvironmental public education will ensure that these future scientists, citizens, and policy makers are aware of the consequences of human actions. Having better understanding, these future leaders will be more likely to take evasive action and steer our spaceship earth out of spiraling collapse.

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APPENDIX A: QUESTIONNAIRE

Environmental questionnaire

Page 1

➤ *This is an anonymous survey. Please answer all of the following to the best of your ability. Please be honest and provide a response to each question.*

1. Which grade are you currently in?

9th ___ 10th ___ 11th ___ 12th ___

2. Do you think that you should know more about the environment?

No Yes

3. Which of the following best describes you? Please circle one response

Very environmentally conscious

Environmentally aware

Not very environmentally conscious

4. Does global warming exist? Circle "Yes" or "No" and then follow the directions.

No Yes

If "yes", is global warming caused by humans? Circle one response.

No Yes Partially Not Sure

5. Are greenhouse gases increasing or decreasing? Circle one response.

Increasing Decreasing Neither Not Sure

6. Do you take an active role in learning about the environment?

No Yes

If "Yes", please briefly describe how _____

7. Would you like to see your high school become more environmentally friendly?

No Yes

If "Yes", would you be willing to help? Yes No

8. To the best of your knowledge, what is your current GPA? _____

If you do not know, what was your GPA on your last report card? _____

9. Which of the following grades do you generally receive in science classes (*circle one*)?

A B C D F



Environmental questionnaire

10. Please place a check mark in the box the best describes how you feel about each statement:

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Plants and animals have as much right as people to live.					
There are too many (or almost too many) people on earth.					
People are clever enough to keep from ruining the earth.					
People must still obey the laws of nature.					
When people mess with nature it has bad results.					
Nature is strong enough to handle the bad effects of our modern lifestyle.					
People are supposed to rule over the rest of nature					
People are treating nature badly.					
People will someday know enough about how nature works to be able to control it.					
If things don't change, we will have a big disaster in the environment soon.					

11. How much do you feel that you *know* about the following?

1- Nothing 2-Very little 3-Moderate amount 4-More than average 5-A lot

Loss of natural resources	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Overfishing	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Global warming	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Pollution	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Climate change	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Endangered species	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Rainforest loss	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Illegal hunting	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>

12. Personally, how *concerned* are you about the following topics?

1- Not at all 2-A little concerned 3-Moderately concerned 4-Very concerned 5- Extremely concerned

Loss of natural resources	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Overfishing	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Global warming	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Pollution	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Climate change	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Endangered species	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Rainforest loss	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>
Illegal hunting	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	5 <input type="checkbox"/>

Thanks again for your help!

APPENDIX B: FORMS AND LETTERS HOME

Dear Parent/Guardian,

Your student's class will be participating in a voluntary, anonymous survey to be used in my Master's Thesis projects. The study aims to discover student attitudes towards the environment and understanding of environmental issues. The goal is to gain an understanding of how the [REDACTED] curriculum presents environmental issues and what is retained by students.

There is no cost to you or any other party. There are no risks in participating in this survey. The survey will take approximately 20-30 min of class time. Those students not participating in the survey will have an alternate assignment as seen fit by the classroom instructor.

Please read the attached consent form and sign if you will allow your student to complete the questionnaire. No identifying information will be linked to your student if you chose to allow him/her to participate. Only those students with signed consent forms will be allowed to participate.

Thank you for your time and consideration! Please contact me if you have any questions or concerns.

Sincerely,

Sean R. Tracy
Honors Biology and IB Environmental Systems and Societies
JEB Stuart High School - FCPS
Falls Church, VA
(703) 824-3900
srtarcy@fcps.edu

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¹³ The highlighted region has been blacked out to keep the County of study anonymous.

Understanding conservation: A study of student attitudes and understanding of the effects of human activities on global ecosystems.

PARENTAL CONSENT FORM

RESEARCH PROCEDURES

This research is being conducted to assess your child's understanding of and attitudes towards the effects that human activities may have on the environment. If you agree to participate, your child will be asked to respond to a paper-based questionnaire. Student responses are anonymous and will not affect their grade in the class in which they participate in this survey.

RISKS

There are no foreseeable risks for participating in this research.

BENEFITS

There are no benefits to your child as a participant other than to further research in environmental education and curriculum development. The benefits to future public school students may include a more comprehensive, environmental experience in science classes.

CONFIDENTIALITY

The data in this study will be confidential. All questionnaires will be anonymous. Names and other identifiers will not be placed on the surveys or research data collected. School names will be coded and maintained by the researcher.

PARTICIPATION

Your child's participation is voluntary, and he/she may withdraw from the study at any time and for any reason. If you decide not to allow your child to participate, or if you withdraw from the study, there is no penalty. There are no costs to you or any other party. Students not participating will receive an alternate assignment to be determined by the regular classroom teacher.

CONTACT

This research is being conducted Sean R. Tracy in the School of Environmental Science and Policy at George Mason University. He may be reached at 571-431-6441 or via email at srtracy@fcps.edu for questions. The Principal Investigator, Dr. Chris Parsons, may be reached at 703-993-1211. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research. This research has been reviewed according to George Mason University procedures governing your participation in this research.

CONSENT

I have read this form and agree to participate in this study.

Name

Date of Signature

Version date: March 14, 2011

Understanding conservation: A study of student attitudes and understanding of the effects of human activities on global ecosystems.

ASSENT FORM

RESEARCH PROCEDURES

The reason for this study is to discover what you know about the environment and your attitudes towards the effects that human activities may have on the environment. If you agree to participate, you will be asked to respond to a paper-based, anonymous questionnaire. Your responses will not affect your grade in the class in which you participate in this survey.

RISKS AND BENEFITS

There are no foreseeable risks for participating in this research. There are also no direct benefits to you, but the information that you provide may help researchers develop a better, more engaging science curriculum for future students.

CONFIDENTIALITY

Your name will not be on the questionnaire that you fill out. You will not be asked to fill out any information that may identify you.

PARTICIPATION

Your participation is voluntary, you may withdraw from this study at any time and for any reason. If you decide not to participate, or if you withdraw from the study, there is no penalty. Students not participating will receive an alternate assignment to be determined by the regular classroom teacher.

CONTACT

This research is being conducted Sean R. Tracy in the School of Environmental Science and Policy at George Mason University. This research has been reviewed according to George Mason University procedures governing your participation in this research. The researcher may be reached at 571-431-6441 or via email at srtracy@fcps.edu for questions or to report a research-related problem. The Principal Investigator, Dr. Chris Parsons, may be reached at 703-993-1211. You may contact the George Mason University Office of Research Subject Protections at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.

CONSENT

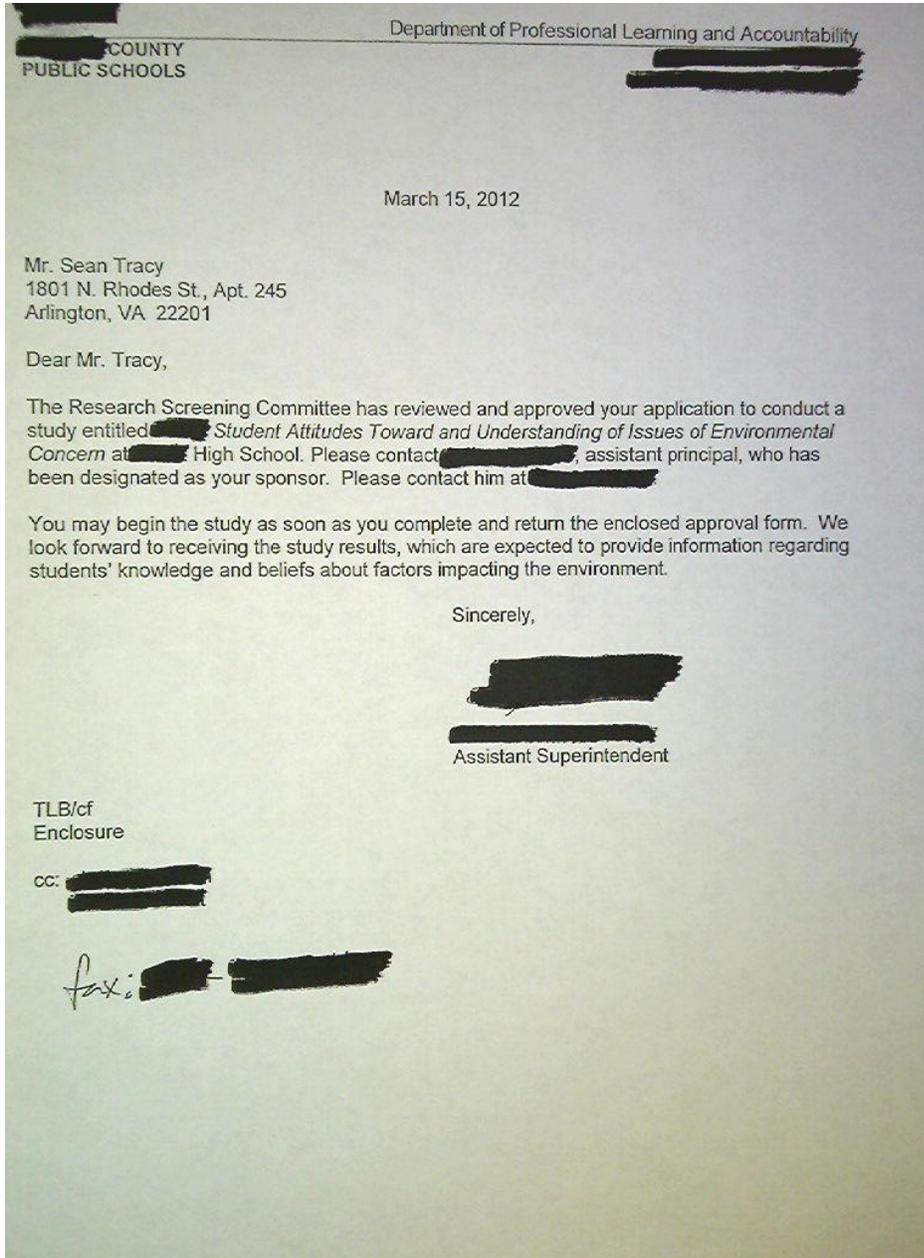
I have read this form and agree to participate in this study.

Name

Date of Signature

Version date: March 14, 2011

APPENDIX C: APPROVAL FORMS



APPENDIX D: SPSS DATA OUTPUT

Table 11: SPSS Output – Pearson correlation for total knowledge and concern

Correlations			
		TotalK	TotalC
TotalK	Pearson Correlation	1	.415**
	Sig. (2-tailed)		.000
	N	119	119
TotalC	Pearson Correlation	.415**	1
	Sig. (2-tailed)	.000	
	N	119	119

** . Correlation is significant at the 0.01 level (2-tailed).

Table 12: SPSS Output – Equality of variances among concern level and awareness

Between-Subjects Factors			N
Q3	1 - Not very environmentally conscious		21
	2 - Environmentally aware		91
	3 - Very environmentally aware		7

Levene's Test of Equality of Error Variances^a

Dependent Variable: TotalC

F	df1	df2	Sig.
.262	2	116	.770

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Q3

Table 13: SPSS Output – ANOVA testing for concern level and awareness

ANOVA

Total Concern

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.232	2	1.616	3.044	.051
Within Groups	61.577	116	.531		
Total	64.808	118			

Table 14: SPSS Output – Tukey post-hoc analysis for concern and awareness

(I) Q3	(J) Q3	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.2426	.17638	.357	-.6614	.1761
	3	-.7786*	.31798	.042	-1.5335	-.0236
2	1	.2426	.17638	.357	-.1761	.6614
	3	-.5359	.28577	.150	-1.2144	.1425
3	1	.7786*	.31798	.042	.0236	1.5335
	2	.5359	.28577	.150	-.1425	1.2144

Based on observed means.

The error term is Mean Square(Error) = .531.

*. The mean difference is significant at the .05 level.

Table 15: SPSS Output – Chi square test for association between questions 2 and 6

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.507 ^a	1	.113		
Continuity Correction ^b	1.288	1	.256		
Likelihood Ratio	4.212	1	.040		
Fisher's Exact Test				.190	.123
Linear-by-Linear Association	2.486	1	.115		
McNemar Test				.000 ^c	
N of Valid Cases	119				

Table 16: SPSS Output – Cross tabulation of questions 2 and 6

		Q6		Total
		No	Yes	
Q2	No	7	0	7
	Yes	82	30	112
Total		89	30	119

Table 17: SPSS Output – Equality of variances of science achievement and NEP score

F	df1	df2	Sig.
.441	4	114	.779

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Q9

Table 18: SPSS Output – ANOVA testing for achievement in science and NEP score

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.237 ^a	4	.059	.391	.815
Intercept	659.636	1	659.636	4348.389	.000
Q9	.237	4	.059	.391	.815
Error	17.293	114	.152		
Total	1636.592	119			
Corrected Total	17.530	118			

a. R Squared = .014 (Adjusted R Squared = -.021)

Table 19: SPSS Output – Chi square test for association between questions 3 and 9

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.363 ^a	8	.037
Likelihood Ratio	18.949	8	.015
Linear-by-Linear Association	6.019	1	.014
N of Valid Cases	119		

a. 10 cells (66.7%) have expected count less than 5. The minimum expected count is .29.

Table 20: SPSS Output – Crosstabulation of questions 3 and 9

			Q9					Total
			F	D	C	B	A	
Q3	1	Count	2	1	2	14	2	21
		Expected	.9	.9	2.6	7.8	8.8	21.0
		Count						
		Std. Residual	1.2	.1	-.4	2.2	-2.3	
	2	Count	3	4	13	27	44	91
		Expected	3.8	3.8	11.5	33.6	38.2	91.0
		Count						
		Std. Residual	-.4	.1	.5	-1.1	.9	
	3	Count	0	0	0	3	4	7
		Expected	.3	.3	.9	2.6	2.9	7.0
		Count						
		Std. Residual	-.5	-.5	-.9	.3	.6	
Total	Count	5	5	15	44	50	119	
	Expected	5.0	5.0	15.0	44.0	50.0	119.0	
	Count							

Table 21: SPSS Output – Correlation between GPA and total NEP

Correlations

		Q8	TotalNEP
Q8	Pearson Correlation	1	.106
	Sig. (2-tailed)		.257
	N	117	117
TotalNEP	Pearson Correlation	.106	1
	Sig. (2-tailed)	.257	
	N	117	119

Table 22: SPSS Output – Analysis of association between NEP and awareness

Dependent Variable: TotalNEP

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.313 ^a	2	.156	1.054	.352
Intercept	622.956	1	622.956	4197.024	.000
Q3	.313	2	.156	1.054	.352
Error	17.218	116	.148		
Total	1636.592	119			
Corrected Total	17.530	118			

a. R Squared = .018 (Adjusted R Squared = .001)

CURRICULUM VITAE

Sean R. Tracy graduated from Joseph A. Foran High School in Milford, Connecticut in 2002. He received her Bachelor of Arts in biology with a focus in secondary education from Ithaca College in 2006. He has been a science educator and tutor in four different eastern U.S. states, with experience in grades 8-12 as a public school teacher certified in both biology and chemistry. At the time of this study, he was employed as a biology and environmental science teacher.