THE USE OF ECOLOGICAL PRINCIPLES AS THE BASIS OF A NONFORMAL ENVIRONMENTAL EDUCATION EVALUATION TOOL

by

HOLLY E. WATKINS-RUTLEDGE

(Under the Direction of Michael T. Mengak)

ABSTRACT

A set of eight general ecological principles were identified by the USDA Forest Service and the University of Georgia. These principles were thought to represent common themes on which environmental education (EE) programs are based. Several widely-used and locally-used EE programs were surveyed to determine the frequency of references to the eight general ecological principles. An evaluation tool based on the eight general ecological principles was developed for nonformal EE and pilot tested at the Sewee Center in Awendaw, South Carolina. The results of the EE program survey suggest that the eight general ecological principles are frequently referenced in both widely-used and locally-used EE programs, and they are a unifying theme in nonformal EE. The pilot study results suggest that an evaluation tool based on the eight general ecological principles is logistically sound.

INDEX WORDS: environmental education, evaluation, nonformal education, ecological education

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DEDICATION

To my parents, for all of the sacrifices they made for my sister and I, their tremendous encouragement, support, and love. You inspire me to put my heart into everything I do. Thank you for teaching me to never say "I can't". I'm so thankful to have such wonderful parents, and I love you both very much.

To my sister, for humoring me with your stories of life in the big apple, and for letting me pay you for your car two years after I "bought" it. You are a great sister and friend, and I love you very much.

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CHAPTER 1

INTRODUCTION

Background of the Study

This study initially began in an effort to improve the environmental education (EE) programs offered by the United States Department of Agriculture (USDA) Forest Service. A social scientist from the USDA Forest Service sought to create an easy-to-use evaluation tool that could be adapted to multiple EE programs. With the assistance of faculty and graduate students from the University of Georgia (UGA) Institute of Ecology, an evaluation tool based on eight general ecological principles was designed. The eight general ecological principles were thought to represent the most common general concepts on which EE programs are based.

Study Objectives

There were two objectives for this study:

1. To determine the frequency of references to the eight general ecological principles in some of the most widely used EE programs, as well as some less frequently used EE programs in the United States.
2. To determine the logistical success of an evaluation tool based on the eight general ecological principles by conducting a pilot study at the Sewee Environmental Education Center.

Literature Review

Environmental education is a dynamic, wide-ranging discipline. Because it is so diverse, it is often difficult to define, and there is no single, specific, widely accepted definition. However, the National Environmental Education Advisory Council (NEEAC) (1996) provides a broad definition of EE as ".....a process that creates awareness and understanding of the relationship between humans and the many environments – natural, man-made, cultural, and technological. Environmental education is concerned with knowledge, values, and attitudes, and has its aim of responsible behavior." Environmental education is taught in multiple settings, from the formal classroom (taking place in a public or private school in grades K-12, and at the college and university level) to the nonformal setting (taking place outside of the formal classroom, including areas such as museums, nature centers, aquariums, and many other locations) (NEEAC, 1996). In addition, EE is offered to teachers, environmental professionals, and all community members through in-service training programs and outreach programs. Additionally, EE is offered by various non-profit organizations which make EE materials available through Internet access.

The discipline of EE emerged in the 1960s with the growing concern over human impact on the environment (Thomson & Hoffman, 1999). Much of this concern began as a result of the 1962 publication *Silent Spring* by Rachel Carson, which documented the effects of pesticide use on the environment (Thomson & Hoffman, 1999). In the 1970's two documents were produced that have served as frameworks for EE across the globe, the Belgrade Charter of 1975, and the Tbilisi Declaration of 1978 (Thomson & Hoffman, 1999). The Belgrade Charter was the result of a United Nations' conference focusing on culture, education, and science (UNESCO-UNEP, 1976). This document explains the framework and broad, guiding principles for EE world-wide.

The objectives for EE listed in the charter were based on awareness, knowledge, attitudes, skills, evaluation ability, and participation (UNESCO-UNEP, 1976). The Tbilisi Declaration was a product of the first intergovernmental conference on EE (UNESCO-UNEP, 1978). This declaration reemphasized the objectives listed in the Belgrade Charter. In addition, it further expanded the roles of global EE to include: the use of scientific data to foster sustainable environmental attitudes and actions, and to educate about the interdependence of economic, political, and ecological factors world-wide (Hungerford, Bluhm, Volk, & Ramsey, 1997). EE should cater to all socio-economic classes, all ages, and all educational backgrounds (Hungerford et al., 1997).

The first national milestone in EE was the passage of the National Environmental Policy Act (NEPA) of 1969. The main purpose of this act was to encourage and promote environmental protection and welfare in the United States (NEPA, 1969). The following year the National Environmental Education Act of 1970 was authorized. This act, which was funded from 1971 to 1975, mainly focused on EE in formal education (Braus & Disinger, 1996). It also authorized the creation of the Office of EE, the National Advisory Council for EE, and the establishment of a domestic grants program (National Environmental Education Act of 1970). Environmental education of the 1980s existed without federal funds, and as a result many EE programs did not survive (Braus & Disinger, 1996). In 1990, the National Environmental Education Act was signed into law by President George H. W. Bush (National Environmental Education Act of 1990). This law was much more extensive than its predecessor and authorized EE training programs, grants, internships, fellowships, and awards. It also created the EE Advisory Council and Task Force, the National Environmental Education and Training Foundation, and the Office of EE (National Environmental Education Act of 1990).

Although general frameworks were in place, EE continued to evolve into a very diverse discipline without any specific guidelines. However, in 1996, the National Science Education Standards set forth a set of general standards to guide science courses in grades K-12 (NAP, 1996). These standards could be used to help guide EE programs in formal and nonformal education settings. The North American Association for Environmental Education (NAAEE) responded with the production of a set of common guidelines for educators, policy makers and the public as a whole to use to guide EE (NAAEE, 1999). The publication, *Excellence in EE – Guidelines for Learning (K-12)*, provided learning guidelines for grades K-12 on various topics in EE. In addition, the National Environmental Education Advancement Project (NEEAP) established a set of standards specifically for nonformal EE. Although standards do exist for EE, their lengthiness and specificity prevents many nonformal EE administrators from quickly and easily adapting them to their EE program.

Numerous studies have yielded results suggesting that education standards are very important because they provide a foundation for teaching and learning as well as instruments for student achievement (Leising & Pense, 2001). The lack of a succinct list of EE standards not only makes it difficult for some EE programs to guide student learning, but this also prevents EE program administrators from being accountable. More emphasis is currently being placed on accountability in education, including nonformal EE. Accountability in nonformal EE is often used as a tool to secure future funding. In order for nonformal EE administrators to show accountability, they must be able to document successful program implementation. Results from an evaluation of their program would meet this need. However, a report prepared by NEEAC (1996) that assessed EE in the United States listed a lack of evaluation as a common challenge in EE. This challenge also was confirmed by a survey conducted by the National EE Advancement

Project (NEEAP) in 1995. The survey revealed that only three states in the U.S. included evaluation in the structure of state-funded EE programs (NEEAC, 1996). There are currently no universal, nonformal EE evaluation tools available.

Evaluation in EE has recently gained momentum. The Teton Summit for Program Evaluation in Nonformal Environmental Education was held in 2000. This summit was held in order to explore the issues associated with evaluation in EE, and to begin the standardization process for the criteria for EE evaluation (Wiltz, 2000). The International Union for Conservation of Nature and Natural Resources (IUCN) Commission on Education and Communication produced the document *Evaluating EE* (2003). This document explains the purpose of evaluation, outlines the steps behind the evaluation process, and it provides instructions on creating, using, and learning from evaluation tools (Stokking, Van Aert, Meijberg, & Kaskens, 1999). A similar document was produced by the Canadian Parks and Wilderness Society (CPAWS), and the Sierra Club of Canada. It provides environmental educators with background information about evaluation and instructions for building an evaluation program (Thomson & Hoffman, 2003). With these resources available, the task of creating an individual program evaluation tool is made less cumbersome.

In addition to guidelines for constructing evaluation tools, environmental educators also have access to some pre-constructed, ready-to-use evaluation tools. One of these is the Children's Environmental Attitude and Knowledge Scale (CHEAKS). The items included in this evaluation tool were constructed based on the ecology scale for adults by Maloney, Ward, and Braucht (Leeming, Dwyer, and Bracken, 1995). The evaluation tool consists of 66 items. Thirty-six of the items are true-or-false questions to ascertain the attitude that each student has toward various aspects of the environment (Leeming & Dwyer, 1995). The remaining 30 items are

constructed in a multiple-choice format, and are designed to test student knowledge (Leeming & Dwyer, 1995). The knowledge-based questions included in this tool, however, are mainly based on how human behavior affects the environment (Leeming & Dwyer, 1995). Although this evaluation tool has been well-researched to gain knowledge about it's validity, it is quite lengthy and may not be practical for use in many EE settings.

Other, more-specific evaluation tools have been designed and tested. For example, the Great Bay National Estuarine Research Reserve created a ten-question, multiple-choice and true-or-false evaluation form for school groups that is based specifically on facts that are taught at their facility (Hefferman, 1998). Although this evaluation form is specific to this EE center, environmental educators could use the format as a guide to construct their own version. Other EE program administrators have used pre-tests and post-tests to evaluate the effectiveness of their programs, including the Conservation Education programs offered by the Chesapeake Bay Foundation (Zint, Kraemer, Northway, & Lim, 2002). Once again, the evaluation tools used by the Chesapeake Bay Foundation are specific to their programs.

Although resources to design an evaluation tool are available, and some pre-constructed evaluation tools are available for environmental educators to use, there is still a gap in EE evaluation that has yet to be filled. Environmental educators need an easy-to-use evaluation tool that is highly adaptable, quickly and effectively administered, and could provide educators with information necessary to improve their EE programs. Such a tool would need a very general basis, such as on ecological concepts. Although such a tool would have some limitations, it would be more easily adaptable than many of the evaluation tools that are currently available. The benefits of a highly adaptable evaluation tool would allow many EE program administrators to improve their programs by identifying areas of weakness. In addition, program improvement

could also result from using funds that are secured through the use of an evaluation to show accountability.

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CHAPTER 2

ECOLOGICAL PRINCIPLES – A UNIFYING THEME IN ENVIRONMENTAL EDUCATION[1]

[1]Ruteldge, H. E., McDonald, B., and Mengak, M. T. To be submitted to *Journal of Environmental Education*

Abstract

The use of ecological principles as the basis of a succinct list of general environmental education (EE) standards can help bring unity and strength to EE. The importance of understanding general ecological principles has been recognized by a wealth of EE literature, and general ecological concepts are prevalent in both widely used and locally adapted EE programs. In addition, an understanding of general ecological principles is included in both the National Science Education Standards (NSES), and NAAEE (North American Association for Environmental Education) Guidelines for Excellence. In this study, 94 activities from five EE programs were surveyed for frequency of ecological references. Survey results revealed 97.7% of the activities included references to at least one ecological principle, and 73.4% of the activities included references to at least four ecological principles. The implications of general ecological principles as a common thread in EE are discussed.

Key words: environmental education, nonformal environmental education, evaluation, ecological principles

Introduction

Evaluation of nonformal environmental education (EE) has always been a challenge. There are several reasons for this: the focus of EE programs varies greatly; each EE program can serve multiple age groups; the setting in which EE programs take place is often outside a classroom; and the length of EE programs varies. In addition, financial and time constraints often prevent environmental educators from conducting any type of program evaluation, and a lack of evaluation construction and analysis training among nonformal environmental educators often impedes evaluation. Another problem, and perhaps the most significant, is the lack of general

standards for nonformal EE. The multidisciplinary and interdisciplinary nature of EE makes it difficult to develop general standards (Tan, 2004). However, a set of general standards for nonformal EE would be an important step in bringing unity to this increasingly fragmented discipline.

Fortunately, the education reform that began in the 1980s led to the development of national education standards (NAAEE, 1999). However, it was not until 1999 that a set of standards was created for EE and published in *Excellence in EE – Guidelines for Learning (K-12)* (NAAEE, 1999). In this publication, general EE guidelines are suggested for grades K-4, 5-8, and 9-12, including guidelines in four strands: questioning-and-analysis skills, knowledge of environmental processes and systems, skills for understanding and addressing environmental issues, and personal and civic responsibility (NAAEE, 1999). These guidelines can be very useful to both formal and nonformal environmental educators. However, a short, succinct and general set of EE standards could be more easily used to guide virtually any nonformal EE program. A condensed set of science-based standards would be highly adaptable regardless of the program focus, age of participants, and method of delivery. This also would provide focus and unity to the increasingly fragmented field of EE.

The lack of a short, manageable list of broadly applicable EE standards motivated the United States Department of Agriculture (USDA) Forest Service to identify the most common, general themes in all environmental studies. A USDA Forest Service social scientist, faculty members, and graduate students from the University of Georgia's Institute of Ecology compiled a list of eight general ecological principles: (1) adaptation, (2) behavior, (3) diversity, (4) emergent properties, (5) energy flow, (6) growth and development, (7) limits, (8) regulation (see Table 1 for a brief description of each principle) (Barrett, Peles, & Odum, 1997).

These principles are considered to be transcending, or applicable across vast scales of biological organization (Barrett, Peles, & Odum, 1997). The identification of these eight ecological principles was initiated to help guide the USDA Forest Service's nonformal environmental education EE evaluation efforts. These ecological principles were then used as the basis from which to create a nonformal EE evaluation tool. Pilot studies utilizing this evaluation tool are currently under way. The focus of this analysis was to determine if the eight ecological principles were appropriate to use as the basis of general EE standards. This was done by analyzing the extent to which the eight transcending principles are incorporated into five popular EE programs.

Literature Review

Several national and international conferences were held in the 1970s and 1980s which led to the creation of an EE framework (Archie & McCrea, 1996). The Tbilisi Declaration, which resulted from the first intergovernmental EE conference, suggested five groups of objectives for EE: attitudes, awareness, knowledge, participation, and skills (NAAEE, 1999). The framework established as a result of numerous EE conferences had a focus of active participation by citizens to resolve and prevent environmental problems (Archie & McCrea, 1996). As suggested in more recent literature, the goals of EE continue to have a general basis in the Tbilisi Declaration (Archie & McCrea, 1996).

Another significant impact on EE was the emergence of the field of ecology (Braus & Disinger, 1996). Although this scientific field began in the 1920's (Braus & Disinger, 1996), it was not until publications such as Rachel Carson's *Silent Spring* that the public really began to recognize the interconnection of all living things (Bowers, 1993). Ecology is a central theme in many EE frameworks. Ecology, as defined by the late Eugene P. Odum is "....literally, the study

of households, including plants, animals, microbes, and people that live together as interdependent beings...." (Odum, 1997). Odum also gives a more general definition of ecology as "....the study of the earth's life-support systems" (Odum, 1997). Each of the EE frameworks summarized in NAAEE's *Excellence in EE – Guidelines For Learning (K-12),* includes an understanding of ecology as a main objective (NAAEE, 1999). Eight frameworks are summarized in the 1999 NAAEE publication, including those by Stapp and Cox (Environmental Education Model), Roth (Environmental Literacy: Its Roots, Evolution, and Directions in the 1990's), and Hungerford, et al. (Environmental Education Literacy Consortium – Environmental Literacy Framework) (NAAEE, 1999). Also, after reviewing the actual guidelines for K-4, 5-8, and 9-12 in this publication, we found that each of the eight ecological principles is included in the guidelines at each grade grouping. The Tbilisi conference also identified ecological interdependence as a learning goal of EE (Bell, 2004). Stables and Bishop (2001) identify understanding of ecological issues as one sign of strong environmental literacy. Numerous other publications exist which identify ecological understanding as a basis of sound EE programming.

In recent years, numerous new disciplines of science have emerged from general ecological sciences such as landscape ecology, ecosystem management, and conservation biology (Barrett, 2001). These new disciplines have opened many doors in the field of EE, but at the same time, they also have contributed to a lack of understanding of the interconnectedness between physical and biological processes (Carter, Heppner, Saigo, Twitty, & Walker, 1990). However, it is the relationships between multiple disciplines (multi-disciplinary approach) that are used more and more frequently to solve environmental problems (Barrett, Peles, & Odum, 1997). Orr (1999) recognizes that an understanding of "how the world works as a physical system" will assist students in understanding systems in general, even economic systems. By

emphasizing general ecological principles that are transcending (those that are applicable from the cellular level to the level of the ecosphere) in EE, students will not only gain a greater understanding of the environment, but they will be better equipped to solve the increasingly complex problems faced by society (Barrett, Peles, & Odum, 1997); and they also will be able to transfer their knowledge of the environment to various other disciplines. Transcending concepts also are mentioned in *Project 2061*, where the recognition of patterns within the diversity of life on earth is cited as a necessity for a sound understanding of the environment (AAAS, 1993).

Methodology

The main objective of this study was to determine how frequently the general ecological principles are referred to in three of the most widely used EE programs in the U.S. The three EE programs that were chosen include Project Learning Tree, Project Wet, and Project Wild. These three programs were identified in *The Biodiversity Collection*, a collection of EE materials that is considered to be an exemplary resource (World Wildlife Fund, 1998). We compared these three programs to two other EE programs—Ecosystem Matters and Sewee Earth Stewards. Ecosystem Matters was chosen for this survey to determine if this EE publication from the USDA Forest Service, a cooperative agency in this EE evaluation project, had incorporated the eight ecological principles into their major EE activity resource guide. Sewee Earth Stewards was chosen for this survey because it was written specifically for one EE Center and it presented us with the opportunity to compare a site-specific program to the more widely used programs. In addition, the Sewee Center is involved in pilot studies for the ongoing EE evaluation project mentioned earlier.

We obtained the curriculum guide for each of the five selected EE programs. Then, the following procedure was used to randomly select activities in each program guide to assess the level of incorporation of the transcending principles:

Step 1:

Individual activities listed in the table of contents were numbered beginning with the number one in Project Wild and Project Wet. In Project Learning Tree, there are five separate books of activities; one book contains activities for grades K-8 and four other books contain activities for grades 9-12. In this case, activities in all five books were numbered beginning with the first activity listed in the K-8 book as number one. This set of numbers was continued sequentially in the other four books using each table of contents until all activities were assigned a number. The four books of activities for grades 9-12 were placed in alphabetical order based upon title before numbers were assigned to their activities. In Ecosystem Matters, individual activities listed in the alphabetical index were numbered beginning with the number one because the table of contents was organized by grade category, with some activities found in multiple categories. The Sewee Earth Stewards activity guide lacks an index and table of contents. So, activities were assigned a number beginning with the number one, in the order in which they are found in the program guide. Because the Sewee Earth Stewards activity guide contains pre-lessons, activity lessons, and post-lessons, only the actual "activities" were numbered.

Step 2:

After all activities were numbered, we used a random number generator to select 25% of the activities to survey in that particular program.

Step 3:

Each program was surveyed to determine which, if any, of the eight ecological principles were evident. Both explicit and implicit references to the eight principles were determined. The definitions for the terms explicit and implicit as stated in *Webster's New World College Dictionary* (2000) are as follows:

Explicit – Clearly stated and leaving nothing implied; distinctly expressed; definite; distinguished from implicit.

Implicit – Suggested or thought to be understood, though not plainly expressed; implied.

Explicit references were easily identified. For example, if the word "diversity" is specifically stated, or a synonym of diversity, then that particular activity has an explicit reference to the ecological principle of diversity. In addition, if an example of diversity is stated, or if the definition of diversity is stated, then that particular reference is also considered to be an explicit reference to the ecological principle of diversity.

Implicit references were identified by phrases or words included in the activity that imply a specific principle such as an analogy to the specific principle. For example, the principle of diversity can be implied by the following phrase, "….different animal species could not survive if they all consumed the same type of plant." Implicit references are more difficult to identify, especially to someone with little background in biology. Examples of explicit and implicit references are included in Table 2.

Each program activity was surveyed using the forms included in Appendix A and Appendix B. This survey was conducted by a graduate student with a B.S. and M.Ed. in Biology and who is currently working toward a M.S. in Forest Resources with an emphasis on wildlife

ecology; so the identification of references to the ecological principles are based upon the researcher's extensive knowledge and experience with biological processes, literature, and field work.

Survey Results

A total of 94 activities from the five EE programs were surveyed. In these activities there were 1,260 explicit references to the ecological principles and 814 implicit references to the ecological principles. A summary of all results is presented in Table 3. Of the 94 activities surveyed, 92 (97.9%) included references to at least one ecological principle and 69 (73.4%) included references to four or more ecological principles.

The activity book for Project Wild contained a total of 113 activities, and 28 of these were surveyed. Of the 28 activities surveyed, 22 contained references to four or more ecological principles (implicit and explicit combined). After reexamining the activities with less than four references to the ecological principles, we found that four of the six had a social sciences (human behaviors, conducting surveys, study of attitudes, etc.) focus rather than a biological sciences focus. The remaining two activities focused on using observation skills to study some aspect of the environment.

Project Wet contained a total of 91 activities, 23 of which were surveyed. Seventeen of the surveyed activities contained four or more references to the ecological principles. After reexamining the six activities that contained fewer than four references to the ecological principles, we found that five had a strong language arts or social sciences focus. The remaining activity was based on water pollution, but focused on chemical aspects of water pollution.

Project Learning Tree contained a total of 128 activities, and 32 were surveyed. Twenty of the surveyed activities contained four or more references to the ecological principles. Once the

activities that included less than four references to the ecological principles (12 activities) were reexamined, we found that five of the twelve activities had either a language arts or social sciences focus and the remaining seven had a strong ecology focus, but simply contained minimal references to the ecological principles. For example, one of the activities focused on the diversity of life on earth, but all ecological principle references were either from the principle of diversity or adaptation. There were many missed opportunities in this particular activity to incorporate additional principles. These missed opportunities to include transcending principle references were common to the remaining activities that focused on biological sciences.

Ecosystem Matters contained a total of 30 activities, eight of which were surveyed. Seven of the eight activities included references to four or more transcending principles. The only activity that had less than four references to the ecological principles focused on language arts, as it required students to write a letter regarding a controversial issue involving the environment.

The Sewee Earth Stewards program contained a total of 11 activities, three of which were surveyed. All three of these activities included references to four or more transcending principles.

Discussion

After reexamining all activities that included references to fewer than four ecological principles, we found that all of the activities could be easily revised to include additional transcending principles. Table 4 contains examples of suggested revisions. The program survey results show the ecological principles are clearly evident in the overwhelming majority of all activities surveyed, as 97.9% included references to at least one of the eight ecological principles and 73.4% included references to four or more of the eight ecological principles. We concluded that general ecological principles are already being integrated into some of the most widely used

EE programs, perhaps as a response to the wealth of EE literature that recognizes the understanding of ecological principles as a necessary foundation for EE. The incorporation of ecological principles into the programs we surveyed strengthens the idea of using these principles as a succinct list of general EE standards.

It is important to note that the findings of this study in no way suggest that environmental educators should not consider NAAEE guidelines for learning and national science education standards (NSES) when developing their EE programs. Instead, the findings simply reinforce the recognition that EE is deeply rooted in the understanding of general ecological principles and this knowledge should be used to build capacity within EE. The NAAEE guidelines for learning include all eight ecological principles in the Knowledge of Environmental Processes and Systems strand for each grade level (1999), and the NSES include all eight ecological principles in the Life Science Content Standards for each grade level (NRC, 1996).

Because general ecological principles are already prevalent in EE, the future development and revision of EE resources should focus on ecological principles as a common theme in EE. Doing so would bring unity to the field of EE by taking even a very specific activity and relating it to a much broader scale. This transfer of knowledge has been recognized as a crucial milestone in understanding any topic in EE (Barrett, Peles, & Odum, 1997; Barrett, 2001), as well as influencing environmentally friendly behavior (Kaiser, Wǒlfing, & Fuhrer, 1999).

If the eight transcending principles are used as a list of general EE standards, then an evaluation tool based upon the understanding of these eight general ecological concepts should be applicable to many widely used EE programs as well. The use of the eight transcending principles as the basis of an evaluation tool would lend itself to the creation of a knowledge-based evaluation, but would not address environmental attitudes, actions, etc. However, the

ecological understanding that such a tool would evaluate is very broad and transcending, which is a necessary precursor to influencing changes in environmental attitudes and actions. In addition, environmental educators might simply add questions to such an ecologically based evaluation to assess student attitudes, actions, concerns, etc. An evaluation of this nature would not only provide valuable information about what students have learned, but it also could include the opportunity to gain access to individual feelings about, or actions in regard to, the environment.

Although this study focused on some of the most widely used EE programs, a survey of other programs would provide additional evidence of general ecological concepts being frequently included in existing EE programs. If, after surveying additional programs, it was found that the ecological principles are frequently included, it would add strength to the idea of using ecological principles as the foundation of general and succinct EE standards. To add strength to this study, it may also be useful to have multiple environmental educators survey programs, and the numbers of implicit and explicit references noted by each educator could be averaged. Care would need to be taken, however, to ensure that all participating educators have a similar knowledge base.

Conclusion

Using ecological principles to guide the creation of a succinct list of general nonformal EE standards would help to bring unity to EE. Not only would it assist students in their understanding of the interconnectedness of the biotic and abiotic components of their everyday environments, but it would also help educators relate even very specific lessons to the “big picture’. The ability to relate general ecological understanding to an understanding of the environment and other areas can be easily accomplished through EE.

The implications of our results should simply reinforce what we already know—that ecological understanding is a common theme among existing EE guidelines, and basic principles of ecology are prevalent in both widely used and locally adapted EE programs. If environmental educators recognize these two commonalities, then EE would build much strength for years to come. Knowing that the necessary tools are already present, it is now up to environmental educators to look for these principles in their own EE programs, and use them to build unity in the dynamic field of EE.

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Table 1-1. Descriptions of the eight ecological principles and associated concepts that were referenced in the surveyed EE programs.

Principle	Description	Associated Concepts
Adaptation	The way a life system looks or behaves is not random or accidental; rather it is the result of changing to survive in a dynamic environment	Evolution, Life History Patterns, Natural Selection, Survival, Predator-Prey Interactions
Behavior	Living systems evolve behavioral responses to stress and disturbances to enhance survival	Reproduction, Predator-Prey Interactions, Dispersal, Survival (humans and other animal species), Pest Control (exotics, nuisance animals), Harvesting
Diversity	Changes in environmental conditions over time have led to variety within each level of organization	Competition, Land-Use Practices, Genetics, Survival, Fragmentation
Emergent Properties	When different levels of organization are functioning together, new properties are created that were not operational at lower levels	Complexity, Synthesis, Teamwork, Government
Energy Flow	Energy cannot be created nor destroyed but it can change form. Energy quality is always degraded through transformation	Thermodynamics, Food Chains, Tropic Levels, Heat Exchange
Growth and Development	As organisms and systems increase in size, changes occur that allow survival Growth rate slows as maximum capacity is met.	Succession, Reproduction, Population Dynamics, Competition
Limits	There are limits to how much can be tolerated by living systems	Sustainability, Conservation, Disease, Natural Disaster, Agriculture, Pollution
Regulation	Energy is spent or a signal is sent to increase or decrease some function to maintain balance	Feedback Loops, Organismal Systems, Cybernetics

Table 1-2. Examples of explicit and implicit references from randomly selected activities in Project Wild, Project Wet, Project Learning Tree, Ecosystem Matters, and Sewee Earth Stewards

Program/Activity	Principle	Reference
Explicit References:		
Project Wild/ Bearly Born	Growth and Development	"The fetus actively develops for only about three months."
Project Wet/ Molecules in Motion	Emergent Properties	"Water is made of molecules; each water molecule contains two hydrogen atoms and one atom of oxygen."
Project Learning Tree/Tipi Talk	Adaptation	"Afterward, they should assess the pros and cons of those structures and determine how the homes are adapted to the conditions and functions they serve."
Ecosystem Matters/ If You Owned The Ecosystem	Diversity	"In a healthy ecosystem, the native biodiversity is intact and the system operates in ways to maintain that diversity."
Sewee Earth Stewards/Field Trip Two to Ion Swamp	Emergent Properties & Growth and Development	"A decaying plant, for example, will be broken down into nutrients that enrich the soil, which in turn supports the growth of more plants"
Implicit References:		
Project Wild/ Graphananimal	Diversity	"Name five animals that might be found in each of the following areas: forest, desert, plains, stream, pond, ocean, seashore, park."
Project Wet/ Energetic Water	Energy Flow	"Have students: relate inventions to examples of how water has actually been used to conduct work."
Project Learning Tree/Sunlight and Shades of Green	Limits	"What would happen if the sun stopped shining?"

Table 1-2 continued

Ecosystem Matters/ A Happy Forest	Regulation	"They [trees] don't understand they need this [fire] and they are afraid of the damage fire can do."
Sewee Earth Stewards/Focus On Reptiles	Regulation	"The turtle is cold-blooded, so it's internal temperature is dependent on the temperature of the air."

Table 1-3. The total number of explicit and implicit references in each EE program surveyed, and the percentage of surveyed activities with references to four or more and one or more ecological principles

Program (# of surveyed activities)	Total Explicit References	Total Implicit References	Total Combined References	% of Surveyed Activities That Include Four Or More Principles	% of Surveyed Activities That Include One Or More Principles
Project Wild (28)	345	269	614	79%	100%
Project Wet (23)	286	190	476	74%	95.7%
Project Learning Tree (32)	428	245	673	63%	96.9%
Ecosystem Matters (8)	93	85	178	88%	100%
Earth Stewards (3)	108	25	133	100%	100%
Totals	1260	814	2074	73.4% (average)	97.9% (average)

Table 1-4. Examples of transcending principles in NAAEE *Guidelines For Learning* and NSES

Source	Guideline	Principle
NAAEE Guidelines For Learning – Grades 5-8 Strand 2 – Knowledge of Environmental Processes and Systems Strand 2.2 – The Living Environment	Organisms, populations, and communities: Trace and give examples of connections among organisms at those levels [species, population, community, and ecosystems] of organizations.	Emergent Properties
	Heredity and evolution: Describe some ways in which variation among individuals of the same species can sometimes give certain individuals an advantage within a specific environment.	Diversity
NSES – Grades 9-12 Life Science – Content Standard C	Matter, Energy, and organization in living systems: As matter and energy flows through different levels of organization of living systems – cells, organs, organisms, communities – and between living systems and the physical environment, chemical elements are recombined in different ways.	Energy Flow Emergent Properties Diversity
	The behavior of organisms: Like other aspects of an organism's biology, behaviors have evolved through natural selection. Behaviors often have an adaptive logic when viewed in terms of evolutionary principles.	Behavior Adaptation

CHAPTER 3

ECOLOGICAL PRINCIPLES AS THE BASIS FOR EVALUATING ENVIRONMENTAL EDUCATION PROGRAM EVALUATION: A CASE STUDY[1]

[1]Rutledge, H. E., McDonald, B., and Mengak, M. T. To be submitted to *Journal of Environmental Education*

Abstract

A set of eight ecological principles were initially identified to guide the USDA Forest Service's efforts to improve evaluation of their nonformal conservation education programs. The principles were then used to create a tool for evaluating environmental education (EE) programs. The creation of this evaluation tool has evolved into a wide-scale, nonformal EE evaluation project called EUGENE (Ecological Understanding as a Guideline for Evaluating Nonformal Education). The EUGENE evaluation system was piloted with a site-specific EE program, Sewee Earth Stewards. The main goal of the pilot study was to collect information about the logistics of using the evaluation tool and to determine if the evaluation tool would provide environmental educators with information that could be used to improve their program. Quantitative analysis of 294 pre- and post-tests revealed a statistically significant change in mean scores. Qualitative analysis of the pilot study suggests that an evaluation tool based on the eight ecological principles is logistically sound. The results of the pilot study will be used as a foundation on which to construct a universal evaluation tool for nonformal EE.

Key words: environmental education, nonformal environmental education, evaluation, assessment

Introduction

In 2003, eight general ecological principles were identified by a social scientist from the United States Department of Agriculture Forest Service (USDA FS), and faculty and graduate students from the University of Georgia's (UGA) Institute of Ecology. The ecological principles are considered transcending principles because of their applicability to multiple levels of organization and understanding (Barrett, Peles, & Odum, 1997). The eight principles identified

by the UGA Institute of Ecology and the USDA FS take into consideration key EE principles as listed by the North American Association for Environmental Education (NAAEE), the National Environmental Education Advancement Project (NEEAP), and the five basic environmental concepts explained in Odum's textbook *Ecology* (Odum, 1963). In addition, the identification of key ecological principles as opposed to general biological principles supports the main goal of the National EE Act, which is improving ecological literacy (NEEAC, 1996). The principles also represent "transcending processes", meaning they apply at all levels of environmental organization (Barrett, Peles, & Odum, 1997). By using these transcending processes as the basis of standards for learning, students will be more likely to understand the relationship between physical and biological processes (Barrett, Peles, & Odum, 1997). A description of the eight ecological principles is as follows:

1. Adaptation – The way living systems in ecosystems look and behave is not a random occurrence but instead is the result of millions of years of changing to better survive in a given environment.
2. Behavior – The different ways organisms act can have different impacts on the survival of organisms. Living systems have behavioral responses to external stress and disturbances which enhance their survival.
3. Diversity – Over time, changes in environmental conditions have led to variety within each level of biological organization in all organisms.
4. Growth and Development – Living components of the environment follow a basic pattern of growth and development and where upon reaching the maximum number of living things which that environment can support, the rate of growth slows.

5. Emergent Properties – When different levels of organization are functioning together, new properties are created that were not operational at lower levels of functioning.
6. Energy Flow – Energy cannot be created nor destroyed in ecosystems and energy quantity is always degraded after it is converted from one form to another.
7. Limits – There are limits to how much stress and abuse ecological processes can withstand before degradation occurs.
8. Regulation – Biological or ecological signals (i.e., feedback) are sent to decrease or increase the amount of energy used for some function in order to keep the environment (internal or external) regulated or balanced.

These ecological principles were initially identified to guide USDA FS efforts to improve evaluation of their nonformal conservation education programs. The identification of the principles also has led to the creation of a wide-scale, nonformal EE evaluation project called EUGENE (Ecological Understanding as a Guideline for Evaluating Nonformal Education). EUGENE is a cooperative project involving the Environmental Protection Agency (EPA) Office of EE, the USDA FS, UGA, and the South Eastern Wildlife and Environmental Education (Sewee) Association. The ultimate goals of EUGENE are to bring unity to EE by developing a short, succinct list of general, nonformal EE standards based on the eight ecological principles, and to use these principles to develop a universal, nonformal EE program evaluation tool. The main goal of this paper is to present environmental educators with information about the logistical success of using the EUGENE system of evaluation.

Literature Review

There are thousands of nonformal EE programs available throughout the United States, and they vary greatly in scope and administration. Some programs are administered nationwide

such as Project Learning Tree and Wonders of Wetlands, while others are found only at the local level such as the Manatee Awareness Program in Florida (Monroe, Chang, Marcinkowski, Kaucheck, & Smith, 2003). Programs exist for all ages from Pre-K to adult, and some programs are taught strictly at an EE center while others utilize time in a formal classroom setting (in a public or private school) as well as student participation at an EE center (Monroe et al., 2003). Many EE programs involve outdoor or field-study activities.

The importance of EE has been recognized globally; the Belgrade Charter of 1975 was the result of a United Nations conference focusing on culture, education, and science (UNESCO-UNEP, 1976). This document explains the framework and broad, guiding principles for EE world-wide. Also, the first intergovernmental conference on EE in 1977 produced the Tbilisi Declaration (UNESCO-UNEP, 1978). This declaration reemphasized the objectives listed in the Belgrade Charter. In addition, it further expanded the roles of global EE to include: the use of scientific data to foster sustainable environmental attitudes and actions and, to educate about the interdependence of economic, political, and ecological factors world-wide (Hungerford, Bluhm, Volk, & Ramsey, 1997). Although general frameworks were in place beginning in the late 1970's, EE continued to evolve into a very diverse discipline without any specific guidelines.

The first milestone for EE in the United States was the passage of the National Environmental Policy Act (NEPA) of 1969. The main purpose of this act was to encourage and promote environmental protection and welfare in the United States (NEPA, 1969). This paved the way for more national environmental policies, including the National Environmental Education Act of 1990 which was signed into law by President George H. W. Bush. In 1999, NAAEE (North American Association for Environmental Education) published of a set of common guidelines for educators, policy makers, and the public as a whole to use to guide EE

(NAAEE, 1999). The publication, *Excellence in EE – Guidelines for Learning (K-12)*, provided learning guidelines for grades K-12 for various topics in EE. Also in 1999, NEEAP established a set of standards specifically for nonformal EE. These standards were made available in the NAAEE publication *Nonformal Environmental Education Programs – Guidelines for Excellence.* Although standards do exist for both formal and nonformal EE, there is still a lack of a succinct list of standards that could be easily adapted to guide virtually any EE program. By establishing such a set of universal, nonformal EE standards, program administrators would be able to use them as a guide to realize their goals of sound understanding (Mordock & Krasny, 2001).

The lack of a small and succinct set of standards for nonformal EE programs prevents many program administrators from evaluating their program's effectiveness. This is because curricular standards are typically used not only to guide instruction but they also serve as a guide to evaluation creation. Numerous studies have yielded results suggesting that both curricular and performance standards are important in any education program because they provide a foundation for teaching and learning as well as providing instruments (to create evaluations) for student achievement (Leising & Pense, 2001). Patton (1997), a former president of the American Evaluation Association, defines program evaluation as the "systematic collection of information about the activities, characteristics, and outcomes of programs for use by specific people to reduce uncertainties, improve effectiveness, and make decisions with regard to what those programs are doing and affecting". Although formal and nonformal EE standards exist, their lengthiness and specificity may not be easily adapted by nonformal EE program administrators as a tool to evaluate student understanding. A survey conducted by NEEAP revealed that in 1995 only three states in the U.S. included evaluation in the structure of state-funded EE programs

(NEEAC, 1996). In 1996, the National Environmental Education Advisory Council (NEEAC) prepared a report assessing EE in the United States. Eight major EE challenges were recognized in the report, with one being the lack of evaluation (NEEAC, 1996). Until recently, nonformal EE program administrators have not been required to report attainment of goals (Wiltz, 2000). However, the present state of the economy has motivated many government agencies and private funding organizations to require evidence of effective programming (Wiltz, 2000). An easy-to-use and highly adaptable nonformal EE evaluation tool would not only help environmental educators gain knowledge about student learning, but it also would help show accountability.

Currently, the Children's Environmental Attitude and Knowledge Scale (CHEAKS) is the only evaluation tool available to nonformal EE that contains some knowledge-based questions, and is somewhat adaptable. However, this evaluation tool is used mainly to gather information on environmental attitudes (about such topics as pollution, energy use, and recycling) (Leeming & Dwyer, 1995). The knowledge-based questions included on the scale also have a strong emphasis on environmentally friendly behavior. Although the CHEAKS evaluation instrument is a valid and reliable evaluation tool (Leeming & Dwyer, 1995), it may be difficult to adapt to an EE program whose administrators wish to evaluate student knowledge gain. In addition, scoring and analysis of test results would be very difficult for most environmental educators without the costly assistance of an evaluation professional.

The Children's Attitudes Toward the Environment Scale (CATES) is also somewhat adaptable. This evaluation instrument was used to evaluate EE at The New Jersey School of Conservation (NJSOC) (Smith-Sebasto & Semrau, 2004). In this study, the evaluation instrument was used as a pre-test and post-test before and after students participated in one EE program consisting of seven EE lessons. This study sought to determine the students' attitudes toward the

environment (Smith-Sebasto & Semrau, 2004). Although the CATES evaluation tool can provide information regarding attitudes, it lacks knowledge-based questions.

Other studies have been conducted on evaluation in nonformal EE. However, most of these utilize evaluation instruments designed specifically for each study (Leeming, Dwyer, Porter, & Cobern, 1993), so they would be difficult to adapt to other EE programs. For example, the Chesapeake Bay Foundation's (CBF) conservation education programs for children were evaluated using an evaluation tool designed specifically for CBF (Zint, Kraemer, Northway, & Lim, 2002). This evaluation tool yielded valuable information to CBF about environmentally responsible behavior in program participants (Zint et al., 2002). However, some site-specific instruments often lack reliability and validity (Leeming, et al., 1993). Although literature exists regarding nonformal EE evaluation, a very important concern of environmental educators—the logistical problems of EE evaluation—is seldom mentioned. The need for an easy-to-use (without the assistance of professional consultants), cost-free, and quickly administered EE evaluation instrument still exists. Such an instrument would simplify the logistics involved in the evaluation process, such as administration, data entry, and statistical analysis. Although there would be problems associated with the simplification of an evaluation instrument (such as limiting the type and amount of information that is gained by the EE educators), simplification is necessary to create a more universal evaluation tool. The purpose of this study was to determine if the EUGENE system of evaluation is logistically sound.

Methodology

Study Site and EE Program

The Sewee Visitor and Environmental Education Center is located in Awendaw, South Carolina, approximately 20 miles north of Charleston. The Sewee Center is jointly operated by

the USDA FS and the United States Fish and Wildlife Service (USFWS), and is located within the Cape Romain National Wildlife Refuge (NWR). Amenities of the center include interpretive exhibit halls, classrooms, and walking trails. The Sewee Association was formed as a nonprofit organization to help support refuges of coastal South Carolina, and it administers the Sewee Earth Stewards program at the Sewee Visitor and EE Center. This program was created by the National Fish and Wildlife Foundation in conjunction with the USFWS. The main objectives of the program are to educate students about local conservation issues and community stewardship. Sewee Earth Stewards is an eight-week program designed to teach local fifth-graders about the flora, fauna, and history of coastal South Carolina. The program emphasizes study on public lands in partnerships with federal agencies, nonprofit organizations, and schools. Sewee Earth Stewards is designed to include field trips to a local swamp, visits to the Sewee Center, and activities that are facilitated by individual formal classroom teachers. The Sewee Center staff volunteered to participate in EUGENE pilot studies in an effort to improve the Sewee Earth Stewards program.

Participants

The population for this study consisted of 354 fifth-grade students from four middle schools located within 40 miles of the Sewee Center. Socioeconomic differences did exist among the participating schools, but were not the focus of this study. Students participated in the Sewee Earth Stewards in Fall 2004. Of the 354 students who participated, 294 were present for both the pre- and the post-test. Results from only the students that were present for both tests were analyzed for this study.

Evaluation Instrument

The eight ecological principles were used to develop a series of true-or-false statements. Four statements per principle were developed by a USDA FS social scientist and a graduate student from UGA. The entire set of 32 statements was validated by faculty and graduate students from the UGA Institute of Ecology. Validation was accomplished by faculty and graduate students independently placing the statements into one of the eight ecological categories using a blind process. The 32 statements were then used to create a pre/post-test (Appendix A). The pre-test and post-test were identical. The statements were written on a fourth to fifth-grade level. This grade level range was chosen because the pilot study site administers their Earth Stewards program to this grade level range. As a pilot test, Sewee Center staff administered the pre/post-test to fifth grade students participating in their Sewee Earth Stewards program in Fall 2004. The results from the Fall 2004 pilot study revealed no significant increase when comparing the pre-test score to the post-test score.

After discussing test administration, format, and results with Sewee Center staff, we agreed to change the format of the pre/post-test to yes-or-no questions instead of true or false. This was done to make the pre/post-test seem more like a questionnaire than an actual test. Each true-or-false statement was reviewed and rewritten in the form of a yes-or-no question (Appendix B). In addition to revising the format of the questions, we added small, clipart images to every other question on the document. The word “Eco-questionnaire” was added to the top of the document along with a brief set of instructions to the students. Once again, the goal was to make the document appear less like a test and more like a questionnaire that was simply seeking to gather the opinions of the students.

Another change made to the original pre/post-test document was the addition of student identification information. We wanted to be able to easily match pre- and post-tests for each

student, so the revised format required students to write their initials as well as their birthday at the top of the document. We also added an area for the student's group name, such as the teacher's name or a group number that the teacher assigned. One additional area was added so a unique code could be included with each pre- and post-test for record-keeping purposes. At the end of the eco-questionnaire, students provided their age and gender.

Evaluation Procedure

The eco-questionnaire and a set of administration instructions were given to Sewee Center staff (Appendix C). After reviewing the information, we discussed the material with staff members to ensure understanding and to answer any questions. As an introduction to the Sewee Earth Stewards program, Sewee Center staff conducted a presentation to groups of participating students at the students' school. At the end of the presentation, Sewee Center staff administered the pre-test using the instructions in Appendix C. After collecting the completed pre-tests, the Sewee Center staff sent the pre-tests to us for data input and analysis. Student data and test answers were input into an Excel spreadsheet and transferred to SPSS (Statistical Package for Social Sciences) for analysis.

The post-test was administered by Sewee Center staff using the same set of instructions that were used to administer the pre-test. The post-test was administered on the last day of the Sewee Earth Stewards program. Completed post-tests were sent to us for input and analysis. Care was taken to ensure that all students were administered the pre- and post-tests using the same method, and preferably by the same individual. Our null hypothesis was that mean student score for the pre-test and post-test were equal. We were interested in knowing if the mean post-test score increased or decreased, so we used a 2-tailed, paired t-test. We used a Pearson correlation

coefficient to determine if the pre- and post-test score were correlated. We set the statistical significance level at alpha = 0.05.

Findings

Quantitative Analysis of Results

There was a difference in the mean score of the pre- and post-test (Table 1; t = -2.406, P = 0.22). The scores of the pre- and post- test were significantly correlated (Table 1; $r^2 = 0.989$, P= 0.05). A summary of the results is presented in Table 1. Although the overall mean pre-test score was only slightly lower than the mean post-test score (1.0 %), the paired t-test results showed a significant difference between the two scores. Furthermore, the results were correlated ($r^2 = 0.989$), but that was expected considering that the pre-test and post-test were identical.

We did not analyze differences between mean pre-test scores and mean post-test scores for each school because that was not an objective of this study. In addition, the overall objective of EUGENE was to create a universal EE evaluation tool that will be administered to students with a variety of learning backgrounds. By focusing on overall pre-test and post-test scores, and not those from individual schools, we will be better able to modify our evaluation instrument so it will be appropriate for all learning backgrounds.

Qualitative Analysis of Results

One of the purposes of the EUGENE pilot testing was to try to identify which questions (individual questions and the ecological principle included) were most often answered incorrectly. A summary of the results for each question is included in Table 2. Of the 32 questions included on the evaluation instrument, 18 questions showed an increase in the mean post-test score compared to the mean pre-test score; 10 questions showed a decrease in the mean

post-test score compared to the mean pre-test score; four questions showed no change from the mean pre-test score to the mean post-test score.

Two of the 32 questions showed a negative net change over 2%. Question one (Can desert plant grow in a rainforest?) showed a decrease of 3.7% and was based on the principle of adaptation. Although this principle is integrated into the Sewee Earth Stewards program, adaptation of various animals such as alligators and birds of prey are closely studied rather than adaptations of plants. This may have contributed to a decrease when comparing mean pre-test score to mean post-test score for this question. As part of the Sewee Earth Stewards program, students visit a nearby swamp. It is here that students may have observed various plants that may also be found growing near the beach or in non-swampy inland areas. This observation may have led students to answer the question incorrectly.

Each of the four questions that showed no change from mean pre-test score to mean post-test score had pre-test scores over 93%. This suggests that perhaps these questions were too easy and they may need to be revised utilizing alternate wording or written for a higher level of comprehension.

A general summary of the net change in mean post-test score compared to mean pre-test score for the four questions based on each ecological principle is presented in Table 3. This table was used to help us determine if one or more ecological principles had a negative change in mean post-test score compared to mean pre-test score more frequently than others. All of the ecological principles showed a positive change in the number of students who answered correctly when comparing pre-tests to post-tests for at least one question. All but three ecological principles (diversity, growth and development, and limits) showed a positive change when comparing pre-tests to post-tests for two or more questions.

Discussion

The results of this study have led us to two major questions that we hope to answer through additional research. First, "What is an acceptable baseline percentage for the mean pre-test score?" The individual mean pre-test score for all but six of the 32 questions was above 75%. The wording of each question may have a slightly different level of difficulty, so we need to determine an acceptable baseline pre-test score for each question. Then, we will be able to determine an acceptable baseline for the overall mean pre-test score. The fact that the overwhelming majority of questions had a mean pre-test score above 75%, leads us to question whether or not the questions were too easy for fifth-grade students. Each question needs to be carefully reviewed for level of difficulty, and care should be taken to use the same level of difficulty on each question if at all possible.

The second question we hope to answer with additional research is, "What is an appropriate level of net change when comparing mean pre-test score to mean post-test score?" The greatest amount of positive change from mean pre-test score to mean post-test score was 5.8% (Table 2). This particular question (number 26) had a mean pre-test score of 61.9% and a mean post-test score of 67.7%, both of which are much lower than the overall mean. One may argue, however, that any increase in score from pre-test to post-test is adequate. So, perhaps before additional research is done on the appropriate level of net change in test score, we should focus on the questions where no change or a negative change occurred. The information in Table 3 provides a good starting point for this future study, as the principles of diversity, growth and development, and limits had only one of the four questions for each result in a positive change.

It is important to note that the ecological principles used as the basis of the EUGENE evaluation instrument have been validated in a previous study (Rutledge, 2005). In that study, we

found that all eight ecological principles are frequently referred to in three widely used EE programs (Project Learning Tree, Project Wet, and Project Wild), a USDA FS program (Ecosystem Matters), and Sewee Earth Stewards program (Rutledge, 2005). Based on the results of the EE program surveys and relevant literature, we found that the eight ecological principles provide an appropriate basis for the creation of a universal EE evaluation tool (Rutledge, 2005).

Sewee Center educators made comments about the evaluation instrument and administration. For instance, the educators felt that instructions were easy to understand and that the entire pre/post test process took very little time. A sample of comments and suggestions made by Sewee Center educators is included in Table 4. The educators at the Sewee Center agreed to continue conducting pilot administrations of the evaluation instrument. Revisions to the instrument will be made beginning in Summer 2005 and will be included on the instrument used in pilot administrations in Fall 2005.

One of the most important results of this study is the knowledge gained regarding the logistics of EUGENE implementation. Sewee educators commented favorably on the ease and speed of administering EUGENE. Additionally, they made favorable comments on the minimal preparation time needed to use EUGENE. The feedback provided by Sewee Center educators is significant to this study because it has confirmed the accomplishment of one of the major goals of EUGENE—to create an easy to use (little preparation time and rapid administration) evaluation system. The fact that the Sewee Center educators have been able to easily administer the evaluation instrument, and have already been able to identify areas in their program where improvement can be made is very promising. Sewee Earth Stewards was designed specifically for the Sewee Center. Because we successfully applied this evaluation system to a site-specific

program, this indicates the potential universal applicability and adaptability of this method of evaluation.

Sewee Center educators will use results of future pilot administrations to identify areas of program weakness. They have already used results of this study to identify activities in which they have previously missed opportunities to emphasize understanding of certain concepts. For example, the field trips to the swamp provide opportunities to emphasize the importance of the adaptations of plants found growing there. In addition, Sewee Center staff has become more aware of the general ecological concepts that are included in their program activities. As a result, educators at the Sewee Center more deliberately include the ecological principles in their teaching. Some formal classroom teachers also have taken the pre-test or post-test along with their students. One teacher commented that he did not fully understand one of the ecological principles until after taking and reviewing the test.

Limitations and Relevance

The lack of a baseline pre-test and post-test score has been acknowledged as a limiting factor in this study. The establishment of baseline scores will be a future priority in this project. In addition, other EE settings will need to be tested in future pilot administrations of the evaluation instrument. Additional EE centers that utilize different program content and format need to be included in this study. Not only would this add to our sample size, but it also would provide us an opportunity to test the pilot evaluation instrument using other site-specific programs and more widely used programs.

The pre- and post-test format is easy to administer and analyze, however sensitization to the evaluation form may have influenced the results as noted in previous studies (Smith-Sebasto

& Semrau, 2004). Future efforts of this project may seek to determine if other evaluation designs may be more appropriate.

We have shown that a succinct list of ecological principles can be used to construct an EE evaluation tool that is logistically applicable to a small-scale EE program as well as logistically successful. It is important to note that EUGENE is designed to eventually help environmental educators gather information about ecological knowledge gained, not attitudes or behaviors changed. Our study is the first step of many that will be necessary to create an EE evaluation tool that is logistically sound; one that is easy to use and yields valid information pertaining to student knowledge gain. Now that we know EUGENE will work logistically, we can focus our efforts on revising the questions included on the evaluation. All questions on the evaluation will be reviewed, but the first questions to be revised will be those that showed negative change on the post-test score compared to the pre-test score. We will rewrite the questions using the MS Word 7.0 Flesch-Kincaid method to ensure appropriate reading level for specific age groups. The assistance of graduate students in elementary education will be used to reevaluate the wording of the evaluation questions. Additionally, necessary steps will be taken to ensure the evaluation instruments (for specific age groups) are valid and reliable. Reports of future pilot studies will include a detailed account of the methodology used to revise and implement the evaluation tools (Leeming et al., 1993).

It is also important to note that the statistical tests used to analyze our results were very simplistic. However, this study did not warrant the use of complex statistical analysis. We were trying to keep statistical analysis to a minimum so that the final EUGENE system would be easy to use, and would not require a detailed statistics knowledge base. Statistical analysis of future pilot study data will be completed exclusively with the use of Excel or other applicable software

common to most computer users. In addition, our study did not focus on the statistical significance of pre-test and post-test results. Instead, we were mainly seeking to determine if EUGENE could be implemented logistically in evaluating a specific EE program.

Conclusion

The results of this pilot study of EUGENE have provided us with information that will assist in the revision of the evaluation instrument, and evidence that will help us gain other participants for future pilot studies. The development of a widely applicable nonformal EE evaluation system must seek to balance practicality and validity. We realize this study only provides a small amount of information about the EUGENE evaluation instrument as a valid learning tool for environmental educators, but knowledge of the practicality or logistical success of EUGENE can be used as a foundation on which to construct a highly adaptable, evaluation tool for nonformal EE. If EE centers had access to an easy-to-use and highly adaptable evaluation form, the benefits would be enormous; EE program administrators would be able to show accountability and identify areas of program weakness. Ultimately, the improvement of EE programs as a whole would assist in accomplishing the long-standing goal of EE, environmental sustainability.

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Table 2-1. Results (in percent correct) of a matched pair t-test between mean pre-test and post-test scores of 294 fifth grade students participating in Sewee Earth Stewards in Fall 2004

	Mean	N	Standard Deviation	Standard Error Mean
Pre-test	84.41	294	15.35	2.71
Post-test	85.39	294	15.00	2.65

Table 2-2. A summary of the number of students (N=294) participating in the Fall 2004 Sewee Earth Stewards program who answered each pre-test and post-test question correctly, the percentage of students who answered each pre-test and post-test question correctly, and the net percentage change of the post-test score compared to the pre-test score for each question .

Question #	Principle Included	Pre-test # correct	Pre-test % correct	Post-test # correct	Post-test % correct	Net Change (%)
1	A	250	85	239	81.3	-3.7
2	GD	219	74.5	224	76.2	-1.7
3	R	279	94.9	276	93.9	-1.0
4	EF	272	92.5	274	93.2	0.7
5	B	262	89.1	270	91.8	2.7
6	L	163	55.4	147	50.0	-5.4
7	L	290	98.6	290	98.6	0
8	D	289	98.3	288	98.0	-0.3
9	EF	280	95.2	277	94.2	-1.0
10	A	274	93.2	274	93.2	0
11	EP	276	93.9	282	95.9	2.0
12	D	286	97.3	285	96.9	-0.4
13	L	256	87.1	268	91.2	4.1
14	B	276	93.9	278	94.6	0.7
15	GD	233	79.3	240	81.6	2.3
16	D	285	96.9	290	98.6	1.7
17	EP	234	79.6	232	78.9	-0.7
18	R	237	80.6	242	82.3	1.7
19	GD	287	97.6	287	97.6	0
20	EF	177	60.2	189	64.3	2.1
21	B	274	93.2	280	95.2	2.0
22	A	85	28.9	92	31.3	2.4
23	GD	277	94.2	277	94.2	0
24	EP	214	72.8	220	74.8	2.0
25	EP	228	77.6	235	79.9	2.3
26	EF	182	61.9	199	67.7	5.8
27	L	272	92.5	269	91.5	-1.0
28	D	283	96.3	281	95.6	-0.7
29	B	249	84.7	263	89.5	4.8
30	R	252	85.7	255	86.7	1.0
31	R	230	78.2	239	81.3	3.1
32	A	271	92.2	272	92.5	0.3
Entire test	--	--	84.4	--	85.4	1.0

Principle key: A=adaptation, B=behavior, D=diversity, EF=energy flow, EP=emergent properties, GD=growth and development, L=limits, R=regulation

Table 2-3. Net change in mean post-test score compared to mean pre-test score for each question on the "Eco-questionnaire" administered to 294 fifth grade students participating in the Fall 2004 Sewee Earth Stewards program (based on ecological principle type).

	Change from pre-test to post-test			
Ecological principle	Question 1	Question 2	Question 3	Question 4
Adaptation	Negative	No change	Positive	Positive
Behavior	Positive	Positive	Positive	Positive
Diversity	Negative	Negative	Positive	Negative
Growth and Development	Negative	Positive	No change	No change
Energy Flow	Positive	Negative	Positive	Positive
Emergent Properties	Positive	Negative	Positive	Positive
Limits	Negative	No change	Positive	Negative
Regulation	Negative	Positive	Positive	Positive

Table 2-4. Comments and suggestions made by Sewee Center educators regarding the EUGENE evaluation instrument design and administration of the instrument during the Fall 2004 Sewee Earth Stewards program.

Topic of comment/suggestion	Comment/suggestion made by Sewee Center educators	Implications of discussion with Sewee Center educators
administration	Instructions that educators use are very clear and work well.	No changes to educator instruction sheet will be made.
administration	It takes very little time (approximately five minutes) to administer the pre-test or the post-test.	No changes in administration procedure will be made.
administration	Future Sewee programs (such as summer programs) may not allow for time to administer a pre-test and post-test to the same group.	Summer programs will administer pre-test only to some groups of students and post-test only to different groups of students (all from same grade level). This will be taken into consideration when analyzing data from summer programs.
instrument	Several students had questions about question number 17 and 22.	These questions will be reviewed and alternate wording will be considered.
Instrument	The yes or no question format is easy for students to understand and not too much like a test.	The yes or no format will be kept. Researchers asked Sewee educators if a Lickert Scale would be appropriate for a future study and they concluded it would take too much time for students to complete (because of multiple choices for each question instead of yes or no).

CHAPTER 4

CONCLUSION

Using ecological principles to guide the creation of a succinct list of general nonformal EE standards would help to bring unity to EE. Not only would it assist students in their understanding of the interconnectedness of the biotic and abiotic components of their everyday environments, but it also would help educators relate specific lessons to the "big picture". The ability to relate general ecological principles to an understanding of the environment and other areas can be easily accomplished through EE. The implications of our EE program survey results should simply reinforce what we already know—that ecological understanding is a common theme among existing EE guidelines and basic principles of ecology are prevalent in both widely used and locally adapted EE programs. If environmental educators recognize these two commonalities, then EE would build much strength for years to come. Knowing that the necessary tools are already present, it is now up to environmental educators to look for these principles in their own EE programs, and use them to build unity in dynamic field of EE.

The results of our pilot study of EUGENE have provided us with information that will assist in the revision of the evaluation instrument, and evidence that will help us gain other participants for future pilot studies. While this study only provides a small amount of information about the EUGENE evaluation instrument as a learning tool for environmental educators, the knowledge of the logistical success of EUGENE can be used as a foundation on which to construct a highly adaptable evaluation tool for nonformal EE. If EE centers had access to an easy-to-use and highly adaptable evaluation form, the benefits would be enormous; EE program administrators would be able to show accountability, and identify areas of program

weakness. Ultimately, the improvement of EE programs as a whole would assist in accomplishing the long-standing goal of EE, environmental sustainability.

Appendix A – Original Questionnaire

No._____

Please answer the following statements!
Circle T for true or F for false.

T	F	Desert plants could live in a rainforest.
T	F	Some living things do not grow at all.
T	F	Thirst is connected with your body's need for water.
T	F	Heat is a form of energy.
T	F	Some animals cooperate with each other to increase their chances of survival.
T	F	Even though they get tired, most animals never go to sleep.
T	F	Animals can become sick or die if there is enough pollution where they live.
T	F	Oak trees are the only kind of trees we really need.
T	F	Humans could live without the sun's energy.
T	F	Polar bears became white by accident.
T	F	An ant colony is nothing more than a bunch of individual ants crawling around.
T	F	The healthiest forests have a lot of different kinds of plants and animals.
T	F	The ocean's temperature could continue to rise without hurting any of the fish.
T	F	Humans are always learning something new.
T	F	A living thing may stop changing.
T	F	It would be better if all animals looked alike and acted the same way.
T	F	Chocolate milk is different from the chocolate by itself and the milk by itself.
T	F	When things grow, they change.
T	F	Hunger is a warning sign that helps to keep animals alive.
T	F	It takes energy to recycle aluminum cans.

T F When a dog is rewarded for doing something, he probably will not do it again.

T F Fish that live in caves probably became blind because it is too dark to see in caves.

T F An adult giraffe can do things that it could not do as a baby giraffe.

T F A forest is more than the individual trees, plants, and animals that live there.

T F A single basketball player acts the same way practicing alone or practicing with a team.

T F When an acorn falls from a tree, the energy in that acorn is destroyed.

T F A person could live for many weeks without water.

T F Because there are so many different kinds of insects, insects can survive in a lot of different conditions.

T F Some animals compete with each other to increase their chances of survival.

T F Dogs pant to keep cool in hot weather, but they could live in hot weather without panting.

T F Sharks have nothing to do with the number of other fish in the ocean.

T F All plants and animals continue to change over hundreds and thousands of years.

Are you a BOY or a GIRL (circle one) How old are you?_____

Thank you!!!!

Appendix B – Eco-Questionnaire

Group Number:_____ FS Number:_____
Student Number:_____

Eco-Questionnaire

We need your help! We want to know what you think about plants, animals and people. Please answer the following questions by circling "yes" or "no". At the end of the questionnaire, complete the information about yourself. Thank you!

Yes No 1. Can desert plants grow in a rainforest?

Yes No 2. Do all living things grow?

Yes No 3. Is thirst connected with your body's need for water?

Yes No 4. Is heat a form of energy?

Yes No 5. Do you think some animals cooperate with each other to increase their chances of survival?

Yes No 6. Do most animals go to sleep when they are tired?

Yes No 7. Can animals become sick or even die if there is too much pollution where they live?

Yes No 8. Are oak trees the only kind of tree we really need?

Yes No 9. Can humans live without the sun's energy?

Yes No 10. Do you think polar bears became white by accident?

Yes No 11. Is an ant colony kind of like a small city?

Yes No 12. Do the healthiest forests have a lot of different kinds of plants and animals?

Yes No 13. If the temperature of the ocean increased, would it hurt any of the fish?

Yes No 14. Are humans always learning something new?

Yes No 15. Do living things stop changing?

Yes No 16. Would it be better if all animals looked alike and acted the same way?

Yes No 17. Is chocolate milk different from the chocolate by itself and the milk by itself?

Yes No 18. Is the feeling of being hungry a warning sign that helps keep animals alive?

Yes No 19. When things grow, do they change?

Yes No 20. Does it take energy to recycle an aluminum can?

Yes No 21. If a dog is rewarded for doing something, do you think he will do it again?

Yes No 22. If some fish that live in caves are blind, do you think they became blind because it is too dark to see in caves?

Yes No 23. Can an adult giraffe do things that it could not do when it was a baby giraffe?

Yes No 24. Is a forest more than the individual trees, plants and animals that live there?

Yes No 25. Does one basketball player act the same way while practicing alone and while practicing with a team?

Yes No 26. When an acorn falls from a tree, is the energy in that acorn destroyed?

Yes No 27. Can a person live for many weeks without water? 

Yes No 28. Since there are so many different kinds of insects, do you think insects can be found in many different environments?

Yes No 29. Do some animals compete with each other to increase their chances of survival?

Yes No 30. If dogs pant to stay cool in hot weather, then could they survive in hot weather without panting?

Yes No 31. Do sharks have anything to do with the number of other fish in the ocean?

Yes No 32. Do all kinds of plants and animals continue to change over hundreds and thousands of years?

Circle one.

Are you a: boy or girl ?
How old are you? 9 10 11 12

Appendix C - Instructions for Eco-Questionnaire Administration

It is very important to administer both the pre- and post-questionnaire using the same method. In order to obtain a valid evaluation, the following instructions must be followed exactly:

BEFORE the students arrive:

1. Determine an appropriate location to administer the questionnaire. If possible, find an area with few distractions.
2. Make enough copies of the eco-questionnaire (marked PRE in the upper right-hand corner) so that each student will have one copy. You may want to go ahead and copy the same number of the eco-questionnaire marked POST in the upper right-hand corner – these will be used at the end of the program.
3. Make sure that there are enough pencils for every student.

WHEN the students arrive:

1. During your introduction to the center or lesson, read the following statement to the students:

   "To get you thinking about the environment and what you will be learning during this program, we want you to answer some questions for us. I am about to hand out a questionnaire to each of you. Please do not write anything on the questionnaire until I tell you to do so."

2. Hand out the pencils and questionnaires. Once all of the students have a questionnaire, read the following to the students:

   "At the top of the questionnaire where it says 'What are your initials?', write your initials, the first letter of your first name, the first letter of your middle name (if you have one), and the first letter of your last name."

   Hold up the questionnaire and show the students where to write this information.

   "Now, at the top of the page where it says 'When is your birthday? (month and day)', write the month and day of your birthday, using only numbers. For example, if your birthday is May 15, you would write....(let the students answer)."

   "Do NOT write anything in the two blanks in the upper right-hand corner of the page."

3. Now read the following:

"Listen carefully to these instructions so that you will know how to complete this questionnaire. I will read each question aloud to you. To the left of the question, you will circle either yes or no to answer each question – circle the first answer that comes to mind. At the end of the questionnaire, you will circle whether you are a boy or a girl and write your age – the age you are today."

"If you have a question while I am reading, please raise your hand."

4. Read the statement at the top of the eco-questionnaire and then begin reading the questions. Do not give any hints. Give the students about five seconds to answer after you have read each of the questions.

5. Collect the questionnaires. Place a rubber band around them or clip them together.

6. At the end of the program, repeat the steps above. This time, have the post-tests ready (they are marked POST in the upper right-hand corner of the first page). Read the following to the students:

   "Now that you have spent some time with us, we would like you to complete the eco-questionnaire again. As soon as you get the questionnaire, complete the area at the top of the page with your initials and birthday, just as you did before."

7. Collect the questionnaires, and place a rubber band around them or clip them together.

8. Send the questionnaires to:

   Holly E. Rutledge
   USDA Forest Service
   320 Green Street
   Athens, GA 30602-2044

   Thank you!

   Holly E. Rutledge, University of Georgia
   Office phone: 706-559-4244
   Email: her6552@owl.forestry.uga.edu

   Babs Mcdonald, USDA Forest Service
   Office phone: 706-559-4224
   Email: bmcdonald@fs.fed.us