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Ecological Principles—A Unifying Theme in Environmental Education

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Abstract: Using ecological principles to form the basis of a succinct list of general environmental education (EE) standards will bring unity and strength to EE. Environmental education literature supports the importance of understanding general ecological principles, 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 NSES (National Science Education Standards) and NAAEE Guidelines for Excellence. This article presents an analysis of the frequency of ecological references in several EE programs and discusses the implications of general ecological principles as a common thread in EE.

Introduction—Unifying Themes in Environmental Education

Education programming, referred to as information and education (I&E) programs (Shepard 1999), is an important component of the extension mission. Environmental programs are widely used by extension faculty to educate adults and youth about our natural world. Lawrence, Schuknecht, and Lally (2006) phrased the concept as —teaching people to fish rather than giving them a fish." Explaining how the environment works using simple unifying themes could enhance understanding and retention of environmental knowledge rather than expecting participants to remember facts.

We, as Extension professionals, commonly use programs such as Project Learning Tree (PLT) (Broussard & Jones, 2001), Project WET, and Project WILD to instruct students in 4-H, FFA, scouts, and other organizations about the natural world. Understanding the similarities and differences among these programs

will assist teachers in choosing the program most closely matched to their teaching goals.

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 (Barrett, Peles, & Odum, 1997). These are:

1. Adaptation,
2. Behavior,
3. Diversity,
4. Emergent properties,
5. Energy flow,
6. Growth and development,
7. Limits,
8. Regulation.

Table 1 contains a brief description of each principle.

Table 1.
Descriptions of the Eight Ecological Principles and Associated Concepts

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 stress can be tolerated by living systems.	Sustainability, Conservation, Disease, Natural Disaster, Agriculture, Pollution
Regulation	Energy is spent if a signal is sent to increase or decrease some function to maintain balance.	Feedback Loops, Organismal Systems, Cybernetics

The identification of these eight ecological principles helped to guide the USDA Forest Service's nonformal environmental education evaluation efforts. The focus of our study was to determine if the eight ecological principles were appropriate to use as the basis of general EE standards. We analyzed the extent to which five popular EE programs incorporate these eight transcending principles.

Rutledge (2005) reviewed the history of Environmental Education (EE) evaluation and found that evaluation of nonformal 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 takes place is often outside a classroom, and
- The length of EE programs varies as well.

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 in 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.

Several national and international conferences held in the 1970s and 1980s led to the creation of an EE framework (Archie & McCrea, 1996). Fortunately, the push for education reform that began in the 1980s led to the development of national education standards (NAAEE, 1999). In 1999, a set of standards were created for EE and published in *Excellence in EE—Guidelines for Learning (K-12)* (NAAEE, 1999).

Evaluating Existing EE Program Activities

The main objective of our review was to assess how frequently the transcending ecological principles are referred to in what we considered some of the most widely used EE programs. Three EE programs that we felt represented a range of widely (nationally) used programs were selected for the study: Project Wild, Project Wet, and Project Learning Tree.

In addition, these three EE programs were identified in *The Biodiversity Collection*, a collection of EE materials considered to be an exemplary resource (World Wildlife Fund, 1998). Two additional EE programs used in this study were Ecosystem Matters and Sewee Earth Stewards.

We chose Ecosystem Matters for the survey to determine if an EE publication of the USDA Forest Service had incorporated the eight ecological principles into its major EE activity resource guide. Sewee Earth Stewards was the final EE program guide chosen for the survey. Because Sewee Earth Stewards was written specifically for one EE Center, it gave us the opportunity to survey a site-specific program and compare its frequency of references to the eight principles to those of more widely used programs. In addition, the Sewee Center is involved in pilot studies for the ongoing EE evaluation project mentioned earlier.

After obtaining the curriculum guide for each of the five selected EE programs, we used a three-step procedure to randomly select activities in each program guide to assess the level of incorporation of the transcending principles.

- Step One—We numbered each of the individual activities in the five programs.
- Step Two—We randomly selected 25% of the activities for further analysis.
- Step Three—We evaluated each activity for both explicit and implicit reference to the eight principles. We defined explicit as clearly stated and leaving nothing implied, definite. We defined implicit as suggested or thought to be understood though not plainly expressed. Explicit references to a principal were easily identified. If the word "diversity" was specifically stated, then that particular activity had an explicit reference to the ecological principle of diversity. Implicit reference to an ecological principle was identified by words or phrases included in the activity that imply a specific principle through an analogy to the principle.

Further details of our methods are available in Rutledge (2005).

Survey Results

We surveyed 94 activities from the five EE programs. There were 1,260 explicit references to the ecological principles and 814 implicit references to the ecological principles. 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

Project Wild

Project Wild contained 113 activities (28 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 fewer 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

Project Wet contained 91 total activities (23 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

This program contained 128 activities (32 were surveyed). Twenty of the surveyed activities contained four or more references to the ecological principles. Once the activities that included fewer than four references to the ecological principles (12 activities) were reexamined, we found that five of the 12 activities had either a language arts or social sciences focus.

The remaining seven had a strong ecology focus, but they 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

This program contained 30 activities (eight were surveyed). Seven of the eight activities included references to four or more transcending principles. The only activity that had fewer 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.

Sewee Earth Stewards

The Sewee Earth Stewards program contained only 11 activities (three were surveyed). All three of these activities included references to four or more transcending principles. A summary of all results are presented in Table 2.

Table 2.

Total Number of Explicit and Implicit References in EE Programs Surveyed and 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 Including Four or More Principles	% of Surveyed Activities Including One or More Principles
Project Wild (28)	345	269	614	78%	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)

Discussion

By reexamining all activities that included references to fewer than four ecological principles, we found that all of the activities could be revised to include additional transcending principles. Rutledge (2005) gives examples of suggested revisions.

Our results show that ecological principles are evident in most of the activities surveyed. In fact, 97.9% included references to at least one of the eight ecological principles, and 73% included references to four or more of the eight ecological principles.

Our results demonstrate that general ecological principles are already being integrated into some of the most widely used EE programs. Perhaps this is in 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 remember that the findings of the study reported here in no way suggest that environmental educators should not be correlating programs to NAAEE guidelines for learning and national science education standards (NSES). 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.

Because general ecological principles are already prevalent in many popular EE programs, 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, Wölfing, & Fuhrer, 1999).

Although our investigation 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 were 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 our review, 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. In this example, it would be important to ensure that all participating educators have a similar knowledge base.

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 this unity 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 combine broad ecological knowledge with an understanding of the environment and the human role in the environment 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
- That 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 to use them to build unity in the dynamic field of EE.

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