Environmental Education Within Early Childhood

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Vignette (Part I)

Right before the winter break, Mrs. Clark's third-grade class was taking a nature walk near their elementary school that was situated close to a creek. The students were observing how the environment changes from season to season. This was their second walk of the year as they had observed the change from summer to fall in September. They had brought their journals they had started on the previous walk that contained pictures, poems, stories, data on animal tracks, water depth and speed, soil erosion, etc. The students broke into groups and began observing the creek for changes from the previous walk. Students added more data and information to their journals on water depth and speed, erosion of soil, and animal tracks. They concluded that compared to their September walk, there was less water in the creek and the flow had slowed down, more soil had fallen from the sides of the creek, and there were fewer animal tracks – especially bird tracks.

Conclusions were drawn from the data that focused on seasonal information such as less rainfall, animals hibernating or migrating to warmer places, etc. Each of the students had planted a tree during the fall trip and had tagged each one with the tree name and student's name on a protective laminated card. The students returned to their tree to take height measurements and to look at overall quality. They recorded data and their observations in their journals.

Water samples from the creek were taken back to the classroom. Using droppers and slide protectors, the students viewed the creek water with large-screen microscopes. They were very interested to see if there were any active organisms in the water. Terms such as organism, macroinvertebrates, mayfly larva, stonefly larva, and dragonfly nymph were introduced during the viewing of the water and students were asked to include the terms when talking about the water samples. As this water was mainly runoff from local homes, no live organisms were found.

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[Safety precautions were taken as students wore latex gloves and eye protection. They were also told not to drink the water.] It was interesting to note that the students felt the water was clean because it was clear and they did not see anything living in the water samples. This became a "teachable moment" to discuss chemical point and nonpoint source pollution and how life cannot be sustained in this type of environment. Knowing that the water was not going to have much life in it, Mrs. Clark had sample slides of the larva and insects for them to view. [We will take a look at Mrs. Clark's classroom later in the chapter.]

Goals and Objectives of This Chapter

The goal of this chapter is for the reader to gain a better understanding of how environmental education (EE) can play an important role in early childhood education in preschool through primary classrooms with children of ages 4–8. Based on research of adult environmental activists, Chawla (1998) found that environmental experiences early in life were precursors to their activism later in life. This implies that children can learn to make a difference about the environment and that these learning experiences will carry into adulthood.

The objectives of this chapter emphasize early childhood education and include the following:

- Defining environmental education
- Explaining how EE can be incorporated into the early childhood curriculum
- Describing how EE can contribute to other subject areas within early childhood
- Supporting students in acquiring knowledge about the environment
- Assisting students in developing an environmental ethic
- Adapting EE activities to promote the inclusion of students with special needs
- Developing authentic assessment techniques that encompass EE within early childhood

Definition of Environmental Education

Much of what we do within both EE and science relates to the processes of human and animal life, how nature works, and how technology impacts the world. Interweaving EE and science makes sense, as the knowledge, skills, and attitudes being used in both areas overlap. For example, students develop scientific knowledge by studying the interdependence of environmental systems. When investigating water quality they are developing skills in data collection and analysis, and communicating results.

The following definition of EE is included in this chapter in part because it contains a reference to making decisions about environmental issues based on

"scientifically sound information" (US Environmental Protection Agency (EPA) 2008, ¶ 2). When helping children understand environmental issues, it is important that what is being discussed is supported with reliable scientific evidence. The US EPA Office of Environmental Education defines EE as:

> [i]ncreasing public awareness and knowledge about environmental issues and providing the skills necessary to make informed decisions and taking responsible actions. It is based on objective and scientifically sound information. It does not advocate a particular viewpoint or course of action. It teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decision making skills.
> (US EPA 2008, ¶ 2)

Incorporation of EE into Early Childhood Curriculum

In a National Environmental Education and Training Foundation Report (2001), 95% of Americans supported the inclusion of EE in K-12 schools. Schools have been answering the call with over half of the nation's schools including some type of environmental teaching throughout the school year.

Promoting EE in early childhood involves the intrinsic motivations of the students. Children are naturally curious about their surroundings and teachers can use this curiosity to highlight the natural world (Chalufour and Worth 2003). Part of helping children to see the beauty and wonder of the world is that they begin to better understand themselves in the process (Davis and Elliott 2003).

Wilson (1999) created guidelines for developing and implementing an EE program within early childhood based on the understanding of how children learn:

- Begin with simple experiences.
- Keep children actively involved.
- Provide pleasant, memorable experiences.
- Emphasize experience versus teaching.
- Involve full use of the senses.
- Provide multimodal (learning through more than one avenue of information) learning experiences.
- Focus on relationships.
- Demonstrate a personal interest in and enjoyment of the natural world, and model caring for the natural environment.
- Maintain a warm, accepting, and nurturing atmosphere.
- Introduce multicultural experiences and perspectives.
- Focus on the beauty and wonder of nature.
- Go outside whenever possible.
- Infuse EE into all aspects of an early childhood program.

The above guidelines should be promoted as part of an overall emphasis on EE within the early childhood classroom. Using supplemental materials, including the *Project* curricula that support EE knowledge and skills, can also be successfully

incorporated into early childhood classrooms. The activities in these curriculum materials integrate numerous subject areas so they can be used in either theme-based (all subjects are taught under an umbrella topic such as the "water cycle" or "living things" that offers an organizing framework for the implementation of an interrelated series of lessons) or more traditional classrooms where subjects are taught separately. *Project WET* (2010), *Project Learning Tree* (2006), *Project WILD* (2000), and *Windows on the Wild: Biodiversity Basics* (World Wildlife Fund 1999) are examples of EE supplemental curricula. In addition, the Council on Environmental Education recently developed a curriculum guide specifically for early childhood, *Growing Up WILD* (2009).

Contribution of EE to Other Subject Areas

Learning about the environment involves "knowledge and skills from all disciplines" (Grant and Littlejohn 2005, p. xi). Research has found that using the environment as an integrating context for learning is the most effective way to teach EE (Lieberman and Hoody 1998; Lonning et al. 1998).

Science

"Doing science" instead of "learning about science" has become the theme for many educators. Students are naturally fascinated with the outdoors and will ask questions that are often quite complex. Environmental investigations that focus on the students' surroundings can reinforce science process skills such as observing, measuring, predicting, and describing. The students can begin to problem solve by refining the question to be studied. For example, they might ask whether earthworms prefer light or dark areas. They might begin with generating a hypothesis that states what the students initially believe, such as "the earthworms like to be in dark places because they live in soil." The students can then set up an experiment by placing earthworms in a box with half of it covered by black construction paper and the other half open to the light. The earthworms can be observed and data taken on the earthworms' movements. For example, the students could create a checklist with two columns (light/dark) with 5-min intervals. They could check off which side the earthworms prefer over a 1-h period. Finally, the students can communicate their results through graphs, journal writings, poems, or presentations.

This investigation could be expanded to decide on the best environment for earthworms. This might include a study into soil types: sand, gravel, soil, or clay to discover earthworms' preferred habitat. The students can observe worms outside in their natural environment as well. They might further their investigation by asking what would happen to birds if earthworms were no longer around. The important point is that the investigative ideas come from the students with the educator acting as a facilitator throughout the process.

Mathematics

Measurement, traditionally a mathematics topic, is a natural tool used to study the environment. For example, when focusing on weather, students can measure temperature, precipitation, humidity, and wind velocity (Engleson and Yockers 1994). Estimations can be made when trying to find tree height, width of rivers, or depth of a lake. In the vignette, Mrs. Clark's class estimates the amount of soil erosion along the creek bank. When studying plant development, students can measure growth in relation to days, weeks, and months. Time can also be studied in relation to animal movement, for instance, how long it takes a turtle to eat a small handful of berries.

Geometry also has clear connections to the natural world. Objects in nature have geometric shapes that can be explored and classified. These objects can be two- and three-dimensional with properties such as round, square, large, small, curved, etc. Students can also find simple patterns of symmetry in the environment such as the wings of a butterfly or certain tree leaves.

Arithmetic, such as addition, subtraction, multiplication, and division of whole numbers, can be used when counting the number of flowers on a plant, estimating the number of trees in a wooded area, or amount of fruit being produced by a grove of apple trees. Gathering data by measuring, counting, or performing simple experiments will help students gain skills in statistical analysis. These exercises can be kept simple, for instance, students can count the number of different birds that come to a birdfeeder. These data can be used to construct a bar graph or pictogram that highlights bird type and number of birds eating a particular food.

Language Arts

Emphasizing communication through writing, speaking, listening, and reading is crucial to a successful language arts curriculum. The purposes of communication which includes informing, expressing, transmitting feeling, and persuading contribute nicely to EE (Engleson and Yockers 1994; NSTA 2003). Students can express their feelings through stories, songs, or poems, keep a journal for recording EE investigations, write letters to companies and elected officials, or put on a play for another group of students.

Observation of plants and animals can help in the development of visual discrimination that supports emergent readers. For instance, naming items on a hike for each letter in the alphabet, counting a particular species of plants, classifying, or sequencing can assist in the development of beginning readers. Reading nonfiction and fiction books that highlight the environment can introduce students to different ecosystems such as a mangrove swamp, rainforest, or coral reef. Students might then act out different scenarios from the ecosystems, such as rain providing water to dried-out plants or fish swimming amongst the reefs. Students who can write and are beginning to read for understanding could select an object from the environment and list descriptive words that highlight this object without showing anyone. Peers can then attempt to identify the object through the descriptive clues.

Social Studies

Relating EE to the students' daily lives allows them to develop a deeper, more meaningful understanding of geography, history, economics, sociology, and political systems. They see the interrelationships and connections made between individuals and communities when they have the chance to apply their knowledge to real-world settings. For example, students could help a local farmer plant crops such as corn, tomatoes, or watermelon. They could also weed around the plants, keep records on amount of rainfall, pick the fruit and vegetables, sell them in a market, and eat them. This process would help them to better understand economics through pricing and competition, geography through land use and weather, and natural resources through soil quality.

The ultimate goal of social studies is to help students become effective citizens in a democratic society. To do this, students need to be informed, committed, and involved in their local community. There are many different types of EE projects that can be developed that encompass the different parts of social science. For instance, students might petition the local government to create a green space in a vacant lot. The students will need to understand how government functions to know whom to contact. They will also need to know about environmental justice issues and understand economics to find funding to support their project. Once the project has been developed, they will need to focus on stewardship of the space as well as sustainability after they no longer can care for it themselves (possibly placing the care of the lot with a neighborhood nature organization).

Music

Using the sounds of nature such as crashing waves on the shore, the hammering of a woodpecker, the songs of birds, or the wind rustling tree leaves will help students to see music as something broader than the music created by humans with musical instruments. The students can use natural objects such as rocks, sticks, sand, or seedpods to create different musical sounds. Providing numerous materials (i.e., natural objects and materials for the containers: paper towel holders, plastic bowls with lids, etc.) and allowing the students to decide what to create will help to keep this activity student-directed. They can combine the sounds to create a concert. Different orchestral instruments mimic sounds of nature (flute = bird, harp = flowing water, maracas = water hitting rocks). The students can experiment to see which instruments mimic sounds in nature or they can create new instruments that relate to the ocean, birds singing, or backyard sounds.

Expressive dance or movement can be combined with nature sounds. Each student can move to express the way they feel about what is being played. This exercise can also be done outdoors where there are nature sounds. After studying an environmental topic such as the water cycle or plant growth, the teacher can choose a common tune and have the students rewrite the lyrics to relate what they just learned.

Art

Teachers can focus on texture, color, lines, shapes, spaces, balance, contrast, rhythm, movement, and repetition while viewing the environment (Engleson and Yockers 1994). Students can focus on individual senses such as touch or sight to explore their surroundings. For example, touching tree bark, stones, leaves, flowers, soil, or twigs can show students the diversity of the natural world. The students can go outdoors when there are leaves on the trees and discuss the different greens they see. Students can use different shades of green to capture the variations. Students can also observe the attraction of insects to the bright colors of flowers. They can watch as the insects move from flower to flower which helps the pollination process. Color is important to animals as well. The class can visit a nature center or a zoo so the students can observe how animals use color to attract a mate, hide from predators, regulate temperature, etc.

Watching a line of ants as they take bits of leaves back to their colony or following a butterflies' path from flower to flower can promote a sense of wonder of the outdoors (Wilson 2000). Verbalizing what the students see can also help to internalize an appreciation for nature. Some of the projects that students can complete include the creation of dioramas, pictures, collages, poems, and stories that highlight the aesthetics (beauty), interdependency, and change within the environment.

Physical Education

Developing physical skills that children can use throughout their lives is an important part of EE. Paddling a canoe, safely traversing a creek, taking a hike with needed supplies in a backpack, digging a hole to plant a tree, are all desired skills that can be a part of the physical education curriculum. These needed skills can also be accompanied by discussions on how to support a quality environment through putting trash in a receptacle, keeping a vegetable garden, or creating green space in urban areas.

Health

There are two ways to look at health education, through the physical health of human beings and through the health of the environment. Many people would say that human health is intertwined with the quality of our environment. The air quality in a wooded park can be compared to the air near a highway busy with cars. Foods with chemical additives can be compared to organic foods. Students can keep a record of the types of foods they consume over the course of a day. They can then study ingredients and food labels to get an idea of how healthy they are eating. The health of a community is tied to proper waste and sewage disposal that for primary grade students can be highlighted through excess packaging of toys and landfill problems.

Vignette (Part II)

On the students' third walk to the creek in early spring, their attention turned to the small buds on the trees. The trees were still bare, but they could see that in a week or two the leaves would be out. Pushing away the rotting leaves on the ground they also saw that there were plants beginning to break through the soil. The students worked in small groups to record how many plants were budding in a 2 ft^2 area. They concluded that the areas closer to the creek had more budding plants because there was a ready supply of water.

As the students were keeping track of the soil erosion by the creek, they again measured the width of the creek in the same area as the previous two trips. Not much erosion had taken place since the winter trip. The students thought that little water had flowed during the winter so little soil erosion took place. Water speed was picking up since their last trip and the students hypothesized that the next time they came to the creek it would be much deeper with spring rains coming soon. They found more animal tracks and took a plaster cast of them so they could find out what types of animals were around.

The students also went back to the trees they had planted to observe changes. They again measured tree height and the beginning buds. They wrote an additional journal entry about their observations. This was a time for the students to use their sense of sight, smell, and sound to further their understanding of nature.

Acquiring Knowledge About the Environment

Research has shown that humans learn mainly from their own direct experiences by using their senses, interacting with others, as well as manipulating and observing materials (Barratt-Hacking et al. 2007; Etkina and Mestre 2004; Littledyke 2008). At younger ages, students need more concrete, hands-on experiences and less abstract experiences. Abstract experiences, that emphasize the use of textbooks, visual or verbal symbols, may be used because content can be compressed into a shorter amount of time than when utilizing concrete experiences. Teachers though, should not make the mistake of selecting abstract experiences solely for the purpose of "covering" material since this does not allow the learner time to meaningfully relate to the knowledge being emphasized.

Students must first begin to construct knowledge by observing objects and events (Piaget 1983; Vygotsky 1978). To further the process of observation, students can use skills such as sequencing, measuring, predicting, or interpreting. They will begin to process and internalize knowledge by having numerous direct experiences that relate to a particular idea. These ideas are emphasized in the Science, Technology, and Society (STS) approach to teaching that promotes using higher-order thinking skills such as evaluation, synthesis, and analysis (Krathwohl et al. 1973), using student-generated questions, and accentuating real-world problems

(Yager 2007). For example, when focusing on the concept of landfills and waste removal, students can:

1. Observe the composition breakdown of different materials such as an apple, plastic, wood, and metal over time
2. View a video on how landfills manage waste and how certain materials are recycled
3. Keep track of the amount of garbage they create over several days and discuss what can and cannot be recycled
4. Reduce their garbage by not buying items with wasteful packaging, reuse items, or begin a recycling campaign at the school or in their neighborhood

The more direct and concrete the experiences, the more permanent and complete the learning.

Developing an Environmental Ethic

The development of knowledge of the environment cannot be separated from attitude development. A student's feelings and emotions are tied to their content understanding. Promoting positive environmental experiences in the early grades supports both cognitive (knowledge) and affective (attitudes) domains (Hammond 1997). Teachers need to take into consideration what values and ethics are being promoted when dealing with environmental issues. The emphasis should not be placed on passing judgment or promoting a particular point of view, but on providing a process through which learners can actively engage in and better understand the world around them.

At the primary level, students may go for a nature walk observing the natural area through the use of their senses (such as looking around them, feeling objects, or smelling a flower). They could record sounds, write a description of the area, create a leaf print, or collect samples of items for further observation in the classroom. If there are negative impacts such as trash, neglect, or vandalism, students might attempt to correct the situation or record information for further study. Once back in the classroom, students can discuss their experience by thinking about what a squirrel or a tree might think of the area. Would they want to live in this area? Would people want to come and visit this place? How could it be improved? What good experiences have we had in this area? Students could then write to someone who has never seen this site and describe their experiences. These types of activities help students to value nature and give them the opportunity to view the outdoors from different perspectives.

Adapting EE Activities for Inclusion of Students with Special Needs

Focusing on what is of interest to the students is the best way to incorporate nature into the classroom. Some children who may have attention problems in the classroom find the outdoors exciting and interesting. These children look under rocks

for bugs or observe the rushing water in a stream. If the students are outside to observe birds but find the squirrels more interesting, do not feel compelled to force them back to bird-watching. Highlight the teachable moment by having them ask questions and closely observe the squirrels' behavior. Their excitement may carry over into the classroom where books and journaling can be emphasized.

Children who are visually impaired can be guided by others and can use other senses to relate to nature. They can lie in the grass and feel the warmth of the sun on their face, bury their hand in sand or soil, feel the texture of bark on different trees, or compare two flowers by feeling the size difference in petals or sepals. Children who are hearing-impaired can use their sense of touch and sight to observe nature. This can include throwing leaves up in the air and watching them glide to the ground; viewing a hummingbird feed on sugar water at a feeder outside the classroom window; or touching items in different bags such as soil, bark, leaves, and fruit, that relate to a particular tree.

Children with severe physical disabilities will need support with planting seeds or plants, using tools or utensils. This does not mean that the students should not participate, but may need guidance and/or adaptations of equipment. Most park trails can accommodate a wheelchair, but if possible the children should also be lifted out of the chair to have direct experiences with nature such as lying in the grass or on a pile of leaves. Items should be brought close to the wheelchair and they should be allowed the opportunity to hold animals or feel their fur.

Some children may have certain fears of nature including spiders, snakes, thunderstorms, darkness, and others. Do not underemphasize or belittle these concerns. Try to find out specifically what causes the fear so it can be addressed. The more the students know about what they fear, such as snakes, the more likely they are to value its part in nature. Some activities to do before the introduction of an animal include viewing pictures and hearing stories, creating a play, and pretending to be a particular animal. Observation of an animal can start indirectly by watching others' interactions. It is always best to invite trained naturalists into the classroom when introducing animals as they know the animals and can give detailed information about habitats and niches.

Vignette (Part III)

On the students' fourth and final walk to the creek right before the end of the school year, they found that all of the trees and plants had leaves and many were in full bloom. Mrs. Clark asked them to use their senses to observe the area. The students quietly walked around watching butterflies, feeling the bark of different trees and listening to the birds and wind rustling the leaves. In one part of the creek, the students could see that a large tree branch had fallen and the water had become pretty deep in that area. There was still water getting by the branch, but it had stopped some of the creek flow. There had been a fair amount of spring rain and the students could see that by the fallen branch a fair amount of soil

erosion had taken place. They decided that the branch falling had quickened the erosion since the deeper water was now higher on the creek bank.

The animal tracks were still around the creek. Since they had investigated the tracks in the winter they knew that raccoons, white-tailed deer, squirrels, cardinals, robins, and other birds frequented the creek area.

The trees that the students had planted had grown and produced leaves. They took height measurements and fertilized each tree. Many students said they wanted to continue coming to the creek next year and said they were going to ask their fourth-grade teacher to include the walks when possible. They sat next to their trees and wrote their final journal entry about their nature walks to the creek.

Assessing Environmental Education

Assessment should be tied to measurable learning objectives that are part of a well-designed curricular plan (Tierney 2006). Using authentic assessment allows the teacher to focus on individual learning styles and rates of growth. It also provides the flexibility for multiple approaches to problem solving within investigations. Incorporating actual authentic assessment techniques might also provide for a learning experience. Some examples of authentic assessments include observation, rubrics, checklists, interviews, performances, portfolios, projects, oral or pictorial responses, self-reports, journals, and presentations (Enger and Yager 2001).

It is important to involve the students as much as possible in their own self-assessment. They can assess their progress through interviews or self-reports. The teacher should make sure that expectations are clearly communicated to the students prior to the assessment activity. This might include handing out rubrics that focus on learning outcomes or providing journal-writing tasks that will be a compilation of their investigations during an environmental project. Using a diversity of assessment types that highlight the complexity of learning will help with understanding how far students have progressed over time.

Throughout this chapter, Mrs. Clark's third-grade class has been taking trips to a creek to observe soil erosion, water depth, and plant growth. During their investigation they wrote in their journals about the different observations. Table 1 is an example of a scoring guideline that clarifies Mrs. Clark's expectations for these journal entries.

Summary

This chapter focused on how to incorporate environmental education into either a theme-based or traditional preschool through primary (ages 4–8) classrooms. Environmental education is a topic that easily fits with other subject areas and promotes both knowledge and skill development in relation to the outdoors. Allowing

Table 1 Scoring guideline for journal entries

	Level 1	Level 2	Level 3	Level 4
Journal Writing:	Unacceptable performance	Approaching acceptable performance	Acceptable performance	Exceeds acceptable performance
Content and Organization	Did not define the idea	Defined but not thoroughly developed the topic	Mostly a developed topic	Developed topic
	Supporting details are missing	Supporting details are minimal	Supporting details are relevant but limited	Supporting details are relevant and provide important information about the topic.
	No organization, may be a brief list of items	Little organization to topic idea	Organization is appropriate, but may falter in logic	Develops the topic in a logical, organized way
	Ideas are unconnected	Ideas are not connected to the specified purpose	Ideas are connected	Connects ideas to the specified purpose
Style and Fluency	Writing is unreadable or messy	Portions are unreadable or messy	Writing is mostly readable and neat	Writing is readable and neat
	Word choice or vocabulary is inappropriate	Selects words that are not accurate or appropriate	Mostly selects words that are accurate or appropriate	Selects words that are accurate and appropriate and may use a variety of sentence structures
	Errors severely impede communication	Errors may impede communication	A few errors, but doesn't impede communication	Nearly error free
Effort	No effort was made to write	Little effort was made to write	Effort was made to write	A great deal of effort was made to write

student interest to drive the environmental investigations will promote learning that is internalized and valued by the students. Specifically:

- EE should be defined in the context of the environment where the students live, as this will be where it is the most meaningful.
- EE is important to include in the early childhood curriculum because it emphasizes children's natural curiosity of the world around them and promotes the foundation for their future experiences with the outdoors.
- Integrating EE into all subject areas and relating it to the real world is the most effective way to help students develop knowledge and skills in relation to the environment.
- When students have direct, concrete experiences with the environment their learning is more permanent and complete.
- Knowledge and attitude develop simultaneously and promoting positive environmental experiences in the early grades supports both cognitive (knowledge) and affective (attitudes) domains.

- Adapting EE activities to promote the inclusion of students with special needs is crucial. Students should be allowed and encouraged to participate in outdoor experiences. They can use different senses such as touch, smell, sight, or hearing to experience nature.
- There are numerous examples of authentic assessment techniques that can be utilized with EE activities. Focusing on individual learning styles and rates of growth should be the main factors in deciding what assessment strategies should be used.

References

Barratt-Hacking, E., Scott, W., & Barratt, R. (2007). Children's research into their local environment: Stevenson's gap, and possibilities for the curriculum. *Environmental Education Research, 13*(2), 225–244.

Chalufour, I., & Worth, K. (2003). *Discovering nature with young children*. St. Paul, MN: Redleaf Press.

Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of environmental sensitivity. *Environmental Education Research, 4*(4), 369–383.

Davis, J., & Elliott, S. (2003). *Early childhood environmental education: Making it mainstream*. Australia: Early Childhood Australia.

Enger, S. K., & Yager, R. E. (2001). *Assessing student understanding in science*. Thousand Oaks, CA: Corwin Press.

Engleson, D. C., & Yockers, D. H. (1994). *A guide to curriculum planning in environmental education*. Madison, WI: Wisconsin Department of Public Instruction.

Etkina, E., & Mestre, J. (2004). *Implications of learning research for teaching science to non-science majors*. Harrisburg, PA: National Science Foundation, SENCER. (Grant DUE-0088753)

Grant, T., & Littlejohn, G. (Eds.). (2005). *Teaching green: The elementary years*. Toronto, Canada: Green Teacher.

Hammond, W. F. (1997). Educating for action: A framework for thinking about the place of action in environmental education. *Green Teacher, 50*, 6–14.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1973). *Taxonomy of educational objectives, the classification of educational goals. Handbook II: Affective domain*. New York: David McKay.

Lieberman, G. A., & Hoody, L. L. (1998). *Closing the achievement gap: Using the environment as an integrating context for learning*. San Diego, CA: State Education and Environment Roundtable and The Pew Charitable Trusts.

Littledyke, M. (2008). Science education for environmental awareness: Approaches to integrating cognitive and affective domains. *Journal of Environmental Education Research, 14*(1), 1–17.

Lonning, R. A., DeFranco, T. C., & Weinland, T. P. (1998). Development of theme-based, interdisciplinary, integrated curriculum: A theoretical model. *School Science and Mathematics, 97*(6), 312–319.

National Environmental Education and Training Foundation. (2001). *Lessons from the environment*. Washington, DC: NEETF.

National Science Teachers Association. (2003). Retrieved March 16, 2008, from http://www.nsta.org/about/positions/environmental.aspx

Piaget, J. (1983). Piaget's theory. In P. Mussen (Ed.), *Handbook of child psychology* (4th ed.). New York: Wiley.

Project Learning Tree (PLT). (2006). *Project learning tree: PreK-8 environmental education activity guide* (6th ed.). Washington, DC: PLT/American Forest Foundation.

Project WET. (2010). *Project WET (water education for teachers): Curriculum and activity guide*. Bozeman, MT: The Watercourse and Western Regional Environmental Education Council.
Project Wild. (2000). *Project WILD: Curriculum and activity guide*. Houston, TX: Western Regional Environmental Education Council.
Project Wild. (2009). *Growing up WILD*. Houston, TX: Environmental Education Council.
Tierney, R. D. (2006). Changing practices: Influences on classroom assessment. *Assessment in Education, 13*(3), 239–264.
U.S. Environmental Protection Agency Office of Environmental Education. (2008). Retrieved September 2, 2008, from http://www.epa.gov/enviroed/basic.html
Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.
Wilson, R. (1999). *Starting early: Environmental education during the early childhood years*. Columbus, OH: ERIC Clearinghouse for Science Mathematics and Environmental Education.
Wilson, R. (2000). The wonders of nature: Honoring children's ways of knowing. *Early Childhood News*, pp. 6–9, 16–19.
World Wildlife Fund. (1999). *Windows on the wild: Biodiversity basics*. Tustin, CA: Acorn Naturalists.
Yager, R. E. (2007). STS requires changes in teaching. *Bulletin of Science, Technology & Society, 27*(5), 386–390.