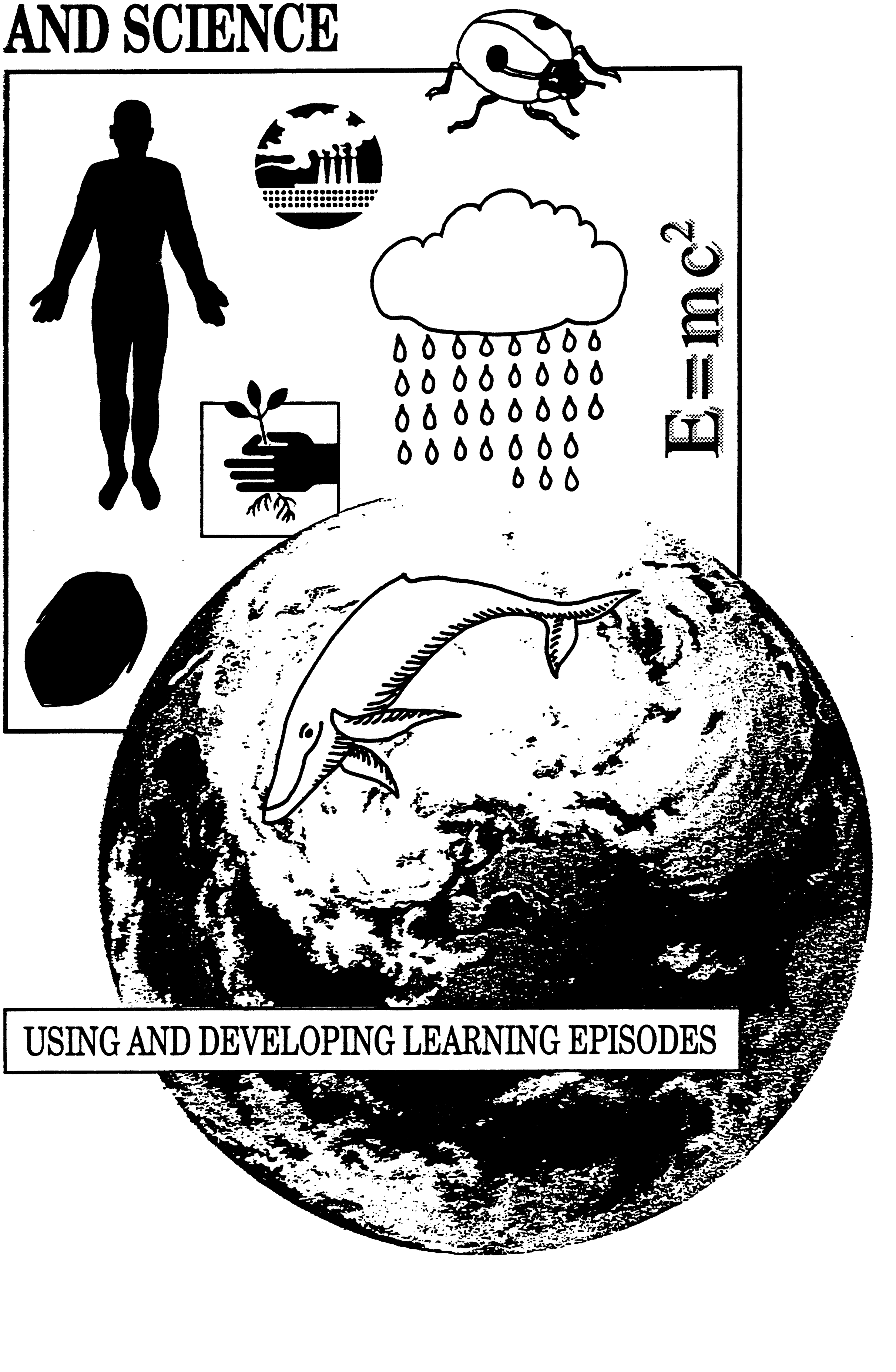
INTEGRATING ENVIRONMENTAL EDUCATION AND SCIENCE



USING AND DEVELOPING LEARNING EPISODES

COLLABORATING ORGANIZATIONS

Environmental Education Council of Ohio (EECO)

[Formerly the Ohio Conservation and Outdoor Education Association (OCOEA)]

EECO is a statewide, professional organization dedicated to promoting environmental education which nurtures knowledge, attitudes and behaviors that foster global stewardship. Teachers, naturalists, camp staff, youth leaders, university students, agency personnel and others join EECO to meet other environmental educators and to share ideas, materials, and teaching techniques. EECO sponsors statewide and regional conferences and workshops, distributes an informative newsletter, provides consulting services, serves as a liaison with other organizations concerned about environmental education, and gives annual awards recognizing outstanding achievements in the field of environmental education. For more information, contact EECO Executive Director, 121 Beckett Court, St. Clairsville, OH 43950.

Ohio Department of Natural Resources (ODNR)

The Ohio Department of Natural Resources is responsible for the preservation, management and wise utilization of the state's natural assets. ODNR helps Ohioans protect and enjoy our fish and wildlife, waterways, forest lands, state parks, nature preserves and recreational areas. At the same time, the agency works to conserve valuable soil, water and mineral resources, and to promote recycling and the use of recycled products. One of the largest and most diverse agencies in state government, ODNR is at work in each of Ohio's 88 counties, making a strong, positive impact on the social, recreational and economic well being of all Ohioans. For more information contact ODNR Public Information Center, 1952 Belcher Drive C-1, Columbus OH 43224.

Continued on inside back cover.

Science Education Council of Ohio (SECO)

SECO is the state chapter of the National Science Teachers Association (NSTA). Membership is comprised of elementary, secondary and college/university teachers and administrators who desire to improve science instruction in Ohio schools. SECO's goal is to increase, through education, the understanding of the nature of science, its methods, its technology and its future prospects among Ohio students, their families and the general public. SECO publishes the *AGORA*, a journal with professional articles by and for science educators, and a newsletter with science developments and events of interest to science teachers. SECO holds an annual meeting for its membership and is a channel of communication with all segments of the educational community for the common goal of improving science at all educational levels. For membership information contact SECO Membership, The University of Dayton, Dayton OH 45469-0512.

Ohio Department of Education (ODE)

For over fifty years the Ohio Department of Education has had a staff member engaged in improving and extending environmental education programs in Ohio's elementary and secondary schools. There has also been a concurrent effort to provide high quality environmental education programs for inservice and preservice teachers. These two efforts have substantially improved the education of Ohio's young people. One of the important aspects of this effort is the fine cooperation there has been among several state agencies, state professional organizations, profit and non profit organizations, all levels of government, and philanthropic foundations. These collaborative efforts have resulted in innovative and successful programs in every part of Ohio. As Ohio's elementary and secondary education curricula continue to move toward a more integrated, interdisciplinary mode, environmental education will be needed as a unifying focus of learning. For more information contact Professional Development Work Cluster, Ohio Departments Building - Room 1005, 65 South Front Street, Columbus OH 43266-0308.

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INTEGRATING ENVIRONMENTAL EDUCATION AND SCIENCE

Using and Developing Learning Episodes

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ATTENTION!!! ATTENTION!!!

This publication is DIFFERENT—at least we hope you think so. At first glance you may think that it is one more activity book. And yes, we hope that you find some teaching ideas that you can use immediately.

More importantly, it is a "how to" guide:

- **how to organize curriculum in a way that synthesizes all the different educational reform ideas and**
- **how to design learning opportunities that carry out these reform ideas.**

The Advisory Board used the old adage, "give people a fish and they will eat for a day; teach people to fish and they will eat for a lifetime" as the guiding principle for the publication.

Yes, we hope you find
some good fish.

But,
we really hope you
practice your fishing.

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ACKNOWLEDGMENTS

The Environmental Education Council of Ohio (EECO), along with the other project collaborators, would like to thank the many individuals and organizations that contributed their expertise to this project. A special thanks is also given to Diane Cantrell who was the lead writer for major sections of this publication, including the models of curriculum organization on pages 3-10.

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PREFACE

Seven collaborators representing statewide organizations, agencies and constituencies worked together on this project. We share in common a commitment to promoting quality education and encouraging the development of environmental and scientific literacy in learners. We are excited by the potential that Ohio's *Model Competency-Based Science Program* (State Board of Education, 1994) holds for reforming science education in the state. Consequently, we have elicited the assistance of Ohio educators in developing this document which illustrates how environmental education can serve as a vehicle for implementing the new model. We are enthused by the learning opportunities suggested by the contributors and even more so by the unlimited possibilities that we believe these ideas will spark.

FOREWORD

Elementary and secondary education is in the midst of a major effort to restructure its educational programs so learners will be prepared for the dramatic global changes which continue to occur at accelerating rates. Science education, as part of this restructuring, is receiving much attention both nationally and within Ohio. One of the eight national goals for education states that American students will be first in the world in science and mathematics achievement by the year 2000.

As a nation, we are spurred by media attention on American students' low science test scores, concerned over our ability to compete in a global market place without well prepared scientists and engineers, and compelled to have a more scientifically literate general population. Consequently, several national organizations have initiated science education reform efforts. These include *Project 2061* spearheaded by the American Association for the Advancement of Science, *Scope, Sequence and Coordination* by the National Science Teachers Association, and *National Science Education Standards* by the National Research Council (see Appendix D-2).

Building upon these and other national initiatives, Ohio continues to strive for educational excellence. Grounded in the belief that all students can learn, Ohio is promoting educational reform through the development of standards, model curricula, and accountability measures.

The seven collaborators who developed this project share these national concerns and support Ohio's educational reform effort. We believe that the recent adoption and implementation of Ohio's *Model Competency-Based Science Program* (see Appendix A) provides a timely opportunity to refocus our thinking about science education and how to continue to improve educational practice.

To meet the spirit and intent of the science model, we know that school districts will be searching for and choosing appropriate curriculum materials that match their newly designed and/or redesigned science programs. This selection process will be more difficult than in the past because educational reform efforts, and specifically science education, call for new and expanded ways of constructing the curriculum. Curriculum materials need to reflect a broad range of instructional objectives, thematic organizations, and interdisciplinary approaches.

Since many existing educational curriculum materials are not designed to support this multi-dimensional approach, we believe that there is a compelling need for a publication that clearly describes how this can be addressed. This document which focuses on environmental education serves as a vehicle to model this approach for several reasons:

- Environmental topics facilitate the development of process and higher level thinking skills while engaging learners in the construction and application of knowledge.
- Environmental education is issue-oriented; therefore, it provides a multi-dimensional approach across the disciplines of science (i.e., life, earth/space, physical) and across other disciplines (e.g., technology, mathematics, social sciences).

- More importantly, environmental issues are of a real life, problem solving nature which is a critical element emphasized in many reform efforts.

As stated previously, the impetus behind this project was to promote the implementation of Ohio's *Model Competency-Based Science Program* through environmental education. However, the ideas and learning activities presented here not only reflect the Ohio Model Science Program but also other educational reform efforts. For Ohio, the ideas in the document:

- are consistent with the premises, rationale, and objectives found in Ohio's elementary and secondary standards and in all of the associated competency models and
- reflect the priorities and characteristics addressed by the Environmental Education Council of Ohio "Guidelines for Environmental Education Activities" and by the Ohio Environmental Education Fund "Grant Guidelines for Educational Projects" (Ohio EPA).

Since all of the above are based upon national reform efforts, we believe that the information and materials in this document have broad-based support and applicability.

In addition, we believe that leaders from groups and organizations that are not required to follow state education guidelines will find these materials fully consistent with their own organization's understandings about what constitutes "good" education.

INTRODUCTION: ABOUT THIS DOCUMENT

Purpose

The purposes of this document are twofold. **First**, it is designed to encourage environmental literacy and responsible environmental behavior through the implementation of the Ohio Model Science Program. By focusing on environmental topics, themes and issues, the learning episodes demonstrate how to develop similar experiences that will help learners become more environmentally literate and make evidence-based decisions about the environment.

Second, this document is designed to assist curriculum developers and leaders of learners in reflecting about and designing/redesigning their curriculum. By providing sample learning episodes, this document demonstrates a variety of ways to address the multi-dimensional characteristics of curriculum advocated by national reform initiatives as well as by the Ohio Model Science Program.

Key Terms

This document contains sample **learning episodes** which exemplify how the science model and key educational reform ideas are translated into practice (see Getting Started). A learning episode presents a rich description of a learning experience, capturing the multifaceted aspects of teaching and the conditions necessary for effective learning to take place. The term episode was selected because it can be defined to meet innovative educational approaches without the connotations of terms such as lesson or unit.

In a similar vein, the term **leaders of learners** is used interchangeably with teachers or educators as is the term **learners** for students. This is done throughout the document to move away from the connotations of the traditional roles of teachers and students. These terms emphasize the role of the leader as facilitator and the role of the learner as self-initiator.

Who Should Use This Document

This publication is intended for two audiences. The first is individuals and groups who are responsible for writing curriculum. This may be a district curriculum committee charged with revising the local course of study. Or it may be a classroom teacher designing and organizing the overall curriculum to translate the course of study into practice.

The second audience is the leaders of learners who bring this curriculum to life by developing and implementing appropriate learning episodes.

How to Use This Document

This publication is divided into three main sections: one which presents the thinking behind the document, one which illustrates what these ideas can look like in practice, and one which motivates leaders of learners to try out their own ideas.

The Big Picture: Building Blocks and Models discusses the goals for environmental education and science education. It identifies key elements that comprise the content of curriculum and suggests a range of ways to organize the curriculum. Use this section to:

- reflect about the content of your curriculum and how you organize it,
- identify important key elements to include in your curriculum, and
- redesign your curriculum to include these elements in a way which accomplishes your vision for educational practice.

In addition, the first part briefly discusses key educational ideas related to instruction and how learners learn content. These key ideas are reflected in the example learning episodes contained in the second part. Use this brief overview to:

- reflect about your current practices,
- consider how they relate to environmental education and science education, and
- create a vision for your future practice.

This is a section to read, reread and revisit often as you reflect and try out different ideas.

Getting Started: Sample Learning Episodes fully defines what is meant by the term **learning episode** and provides samples. Some of the examples illustrate how existing curriculum materials can be modified to include more of the ideas discussed in the first part. Some model a specific educational strategy, technique or approach. Others depict multi-dimensional learning opportunities. These learning episodes are provided to:

- be used with learners as written,
- be modified or extended to meet your educational purposes,
- serve as a model for writing other learning episodes to meet your educational needs, and
- stimulate thinking about other approaches.

Branching Out: Developing Your Own Episodes provides some general guidelines for developing your own learning episodes. It suggests different approaches to use as starting points. Use this section to:

- write up your modification of one of the episodes provided in section two,
- adapt a favorite activity that you have used in the past to include more of the building blocks discussed in section one,
- develop your own learning episode from "scratch," or
- web new learning episodes based upon one of the models from section one.

Appendices extend the information discussed in the body of the document and suggest additional resources. They include an outline of the science model; guidelines for environmental education activities; helpful lists, samples and tips; curricular and professional resources; overview of the learning episodes; ninth grade proficiency outcomes; and "blank" models and webs.

THE BIG PICTURE: BUILDING BLOCKS AND MODELS

The Big Picture: Building Blocks and Models

Environmental Education and Science Education Goals

According to *Science For All Americans* (1990, p. v), "Education has no higher purpose than preparing people to lead personally fulfilling and responsible lives." Both environmental education and science education use the term "literacy" to describe the understandings and lifelong skills which learners need to achieve this goal.

As an outgrowth of an effort to set national standards for environmental education, Roth (1992) has written a monograph on environmental literacy. According to this work:

- Environmental literacy is essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems;
- Developing environmental literacy [involves] fostering productive and responsible citizens of this planet and of our society. (p. 1)

In Ohio's *Model Competency-Based Science Program* (1994), similar ideas are captured with this definition:

> At its most basic level, scientific literacy is the capacity of a person to be able to ask questions, collect information, and make evidence-based decisions about scientific and technical issues in their own life. (p. 23)

If environmental literacy and scientific literacy are accepted as worthy goals of education, then these definitions can be used to determine the content of the curriculum and suggest how the curriculum should be organized.

Components of Curriculum

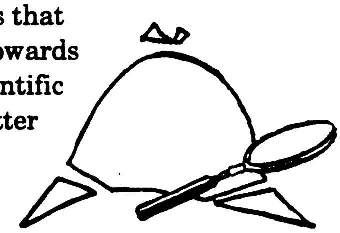
This discussion of environmental and scientific literacy indicates that the content of the curriculum must reach beyond mere content knowledge to also include the skills, attitudes and behaviors necessary for people to function responsibly in society. Specifically, Roth identifies four strands that should be considered: knowledge, affect, skill, and behavior.

All four of these are captured by the four major curriculum strands identified by the Ohio Model Science Program. These are briefly discussed below.

Curriculum Strands

Inquiry

The scientific inquiry strand combines two of Roth's strands—affect and skill. The former relates to the attitudes and dispositions that learners have towards science and scientific inquiry. The latter relates to the cognitive and physical skills which learners must develop in order to conduct inquiry (see Appendix C-1). This strand addresses the manner in which learners do science and guides how they interact with the natural world and others.



Knowledge

The scientific knowledge strand identifies the big ideas from life, earth/ space and physical sciences which should be the focus of inquiry by learners. These include major concepts, principles, laws and theories. The more powerful and relevant these ideas are to the learner and the more they emphasize the interconnections among the disciplines, the more easily learners are able to understand them and use them to construct meaning about the natural world.

Conditions for Learning

The premise behind this strand is that all children will learn if the condi-

tions for learning are right. While the elements represented by this strand are not typically identified as part of the content of curriculum, they are included in the science model because learning related to the other three strands cannot occur otherwise. This strand addresses the strategies and activities necessary to support learning. These include providing adequate time for learners to construct knowledge, using diverse teaching strategies and settings, and promoting learner interactions and communications.

Applications

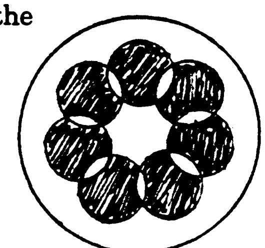
The application strand is a critical component in the development of scientific literacy. It provides age-appropriate, real-life situations in which learners use their skills and knowledge to solve problems and make decisions. Through their behaviors and actions, learners apply what they learned in a context that is relevant and engaging.

These strands represent the components of the curriculum which must be carefully considered when writing instructional objectives for a school science program or selecting instructional materials. Objectives, individually and/or collectively, should integrate all four components.

In addition to the strands, two other curricular elements need to be fully considered: integrated approaches and thematic ideas.

Integrated Approaches

The importance of recognizing and emphasizing the interconnections among the disciplines was mentioned under the knowledge strand. Science is not "a" science but many sciences, each different yet an integral part of the whole. *Science for All Americans* (1990) elaborates on this point by stating:



> [All the disciplines] are equally scientific and together make up the same scientific endeavor. The advantages of having disciplines is that they provide a conceptual structure for organizing research and research findings. The

disadvantage is that their divisions do not necessarily match the way the world works, and they can make communication difficult. In any case, scientific disciplines do not have fixed borders. (p. 10)

The world works holistically, without artificial boundaries, and may best be studied from the whole to the part, not the part to the whole. This is true not only regarding scientific investigations but also regarding all the other disciplines.

Integrated approaches to teaching and learning may include the following:

- Multidisciplinary—making connection across the boundaries of disciplines,
- Interdisciplinary—blurring the boundaries among disciplines, and
- Transdisciplinary—eliminating the boundaries among disciplines.

For scientific inquiry, these integrated approaches can cross the disciplines of science (i.e., life, earth/space, physical) and they can cross other disciplines as well (e.g., technology, mathematics, social sciences).

The study of topics or issues related to science, technology and society (STS) is one example of an integrated approach. As learners investigate real-life situations, they draw upon the different disciplines to understand the complexity of STS topics or issues. Many of these relate to environmental education—energy, population and food, human engineering, air and water quality, utilization of natural resources, and human health.

Thematic Ideas

Thematic ideas, or organizing concepts, provide learners with an overarching scheme for categorizing, sorting, ordering and otherwise making sense out of what they are learning. These themes are transdisciplinary in nature and provide an infrastructure for learning when reinforced from year to year across all disciplines (see Appendix C-2).

Based upon *Science For All Americans,* the Ohio Model Science Program suggests five themes:

- Systems,
- Models,
- Constancy,
- Patterns of change, and
- Scale and complexity.

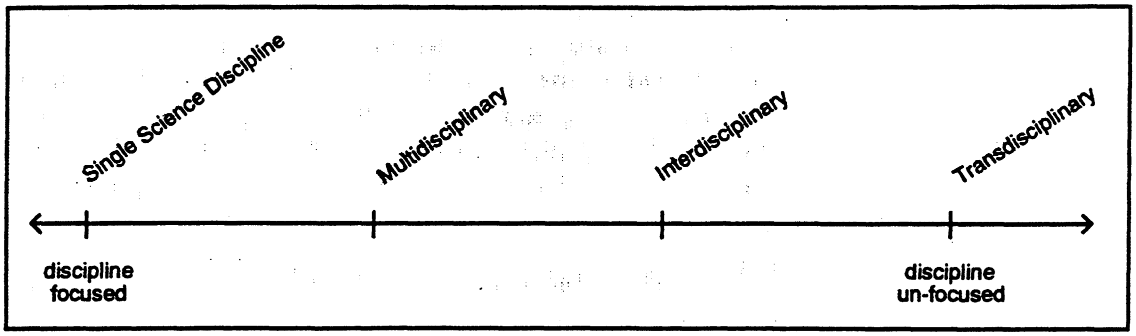
Environmental education also encourages the use of themes. For example, *Project Learning Tree* (1993, p. ii-iii) is organized around the following five themes:

- Diversity,
- Interrelationships,
- Systems,
- Structure and scale, and
- Patterns of change.

When designing or redesigning the curriculum, integrated approaches and thematic ideas need to be considered along with the four strands.

Models of Curriculum Organization

How the curriculum is organized depends upon which strands, integrated approaches and themes will be included and what emphasis they will receive. Several variations are possible, ranging from relatively simple to more complex. One organizing scheme may provide a single discipline approach while another uses an interdisciplinary or transdisciplinary approach. One may focus on



a single thematic idea while another integrates several themes throughout the curriculum. One may focus on a fairly narrow topic while another uses an integrated STS topic or issue.

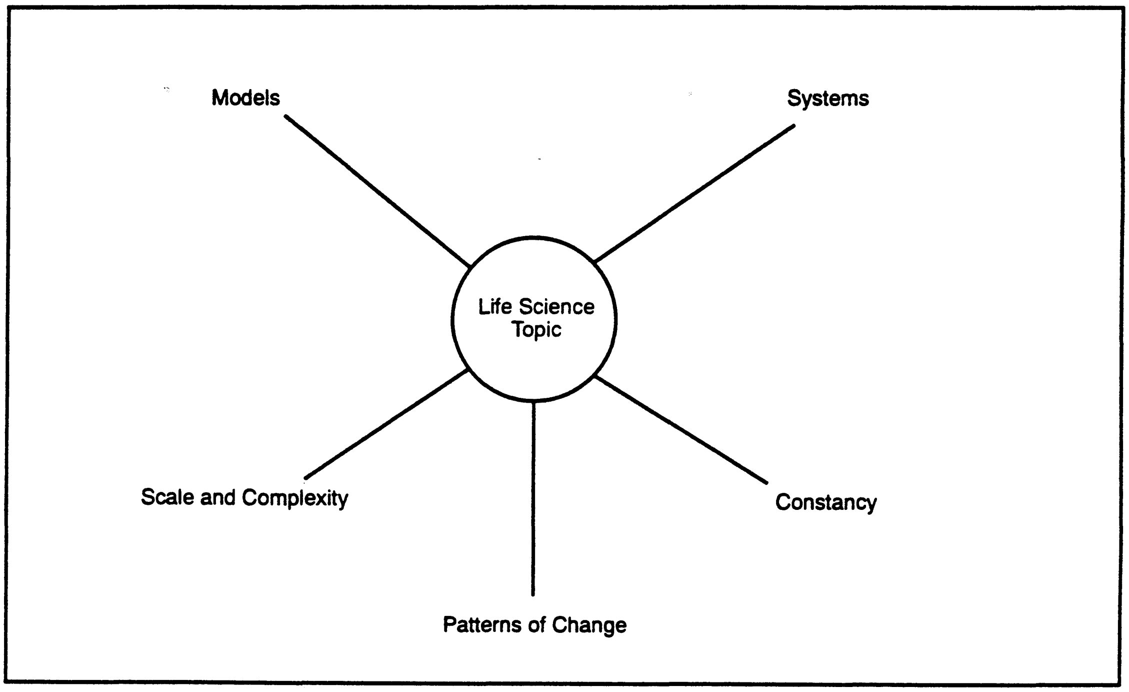
Sample Models

The following examples (pp. 5-9) illustrate some basic models using the components of curriculum in increasingly more complex arrangements. Each one represents a different point along a continuum which ranges from "discipline focused" to "discipline un-focused." That is, each one is progressively more **integrated** than the previous one.

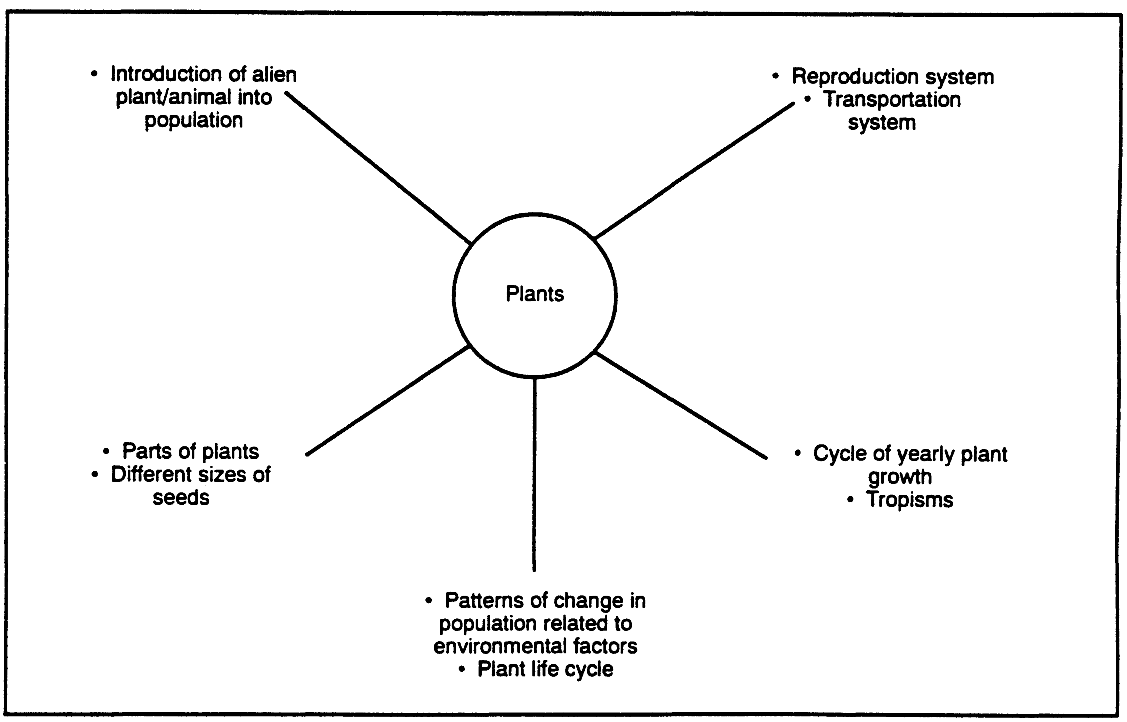
In addition, the models show a variety of ways in which "themes" can be incorporated—as subcategories under a topic or issue, as the central focus of the investigation, or as integrally woven throughout all aspects of a topic or issue. Each of the following models represents one conception of how to organize the curriculum. An example is given to illustrate how the model might translate into practice. None of the examples of models represent a year-long science program but rather a segment within it. The same organization and scheme could be used throughout the year or several schemes could be combined. These models are intended to stimulate further thinking about the many possibilities rather than delineate a set number of ways to organize the curriculum.

Model 1. Single Science Discipline: Topic —This curriculum organization emphasizes a specific topic from one of the sciences and investigates it through thematic ideas. Typically many topics as well as a variety of topics are included in a year-long science study.

MODEL

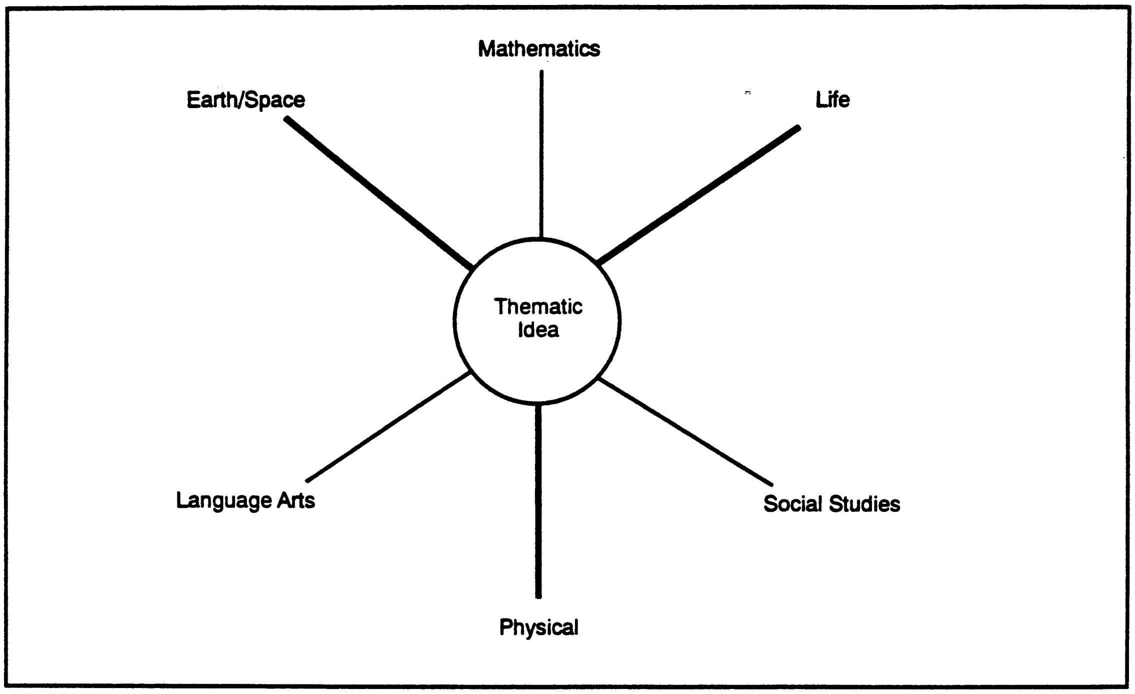


EXAMPLE



Model 2. Multidisciplinary: Thematic Idea—This curriculum organization emphasizes a single thematic idea and explores how concepts, principles or topics from life, earth/space and physical science, as well as other disciplines, exemplify the theme (thick line indicates primary emphasis; all lines could be equal). Typically only a few themes are addressed in a year-long study.

MODEL



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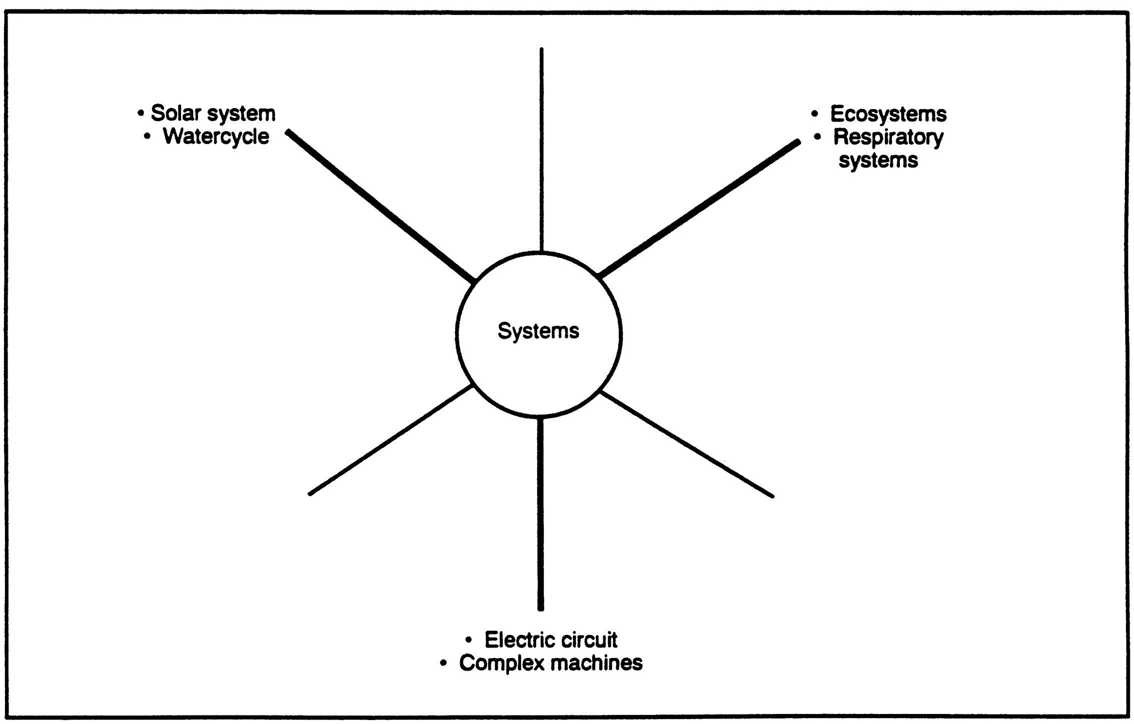
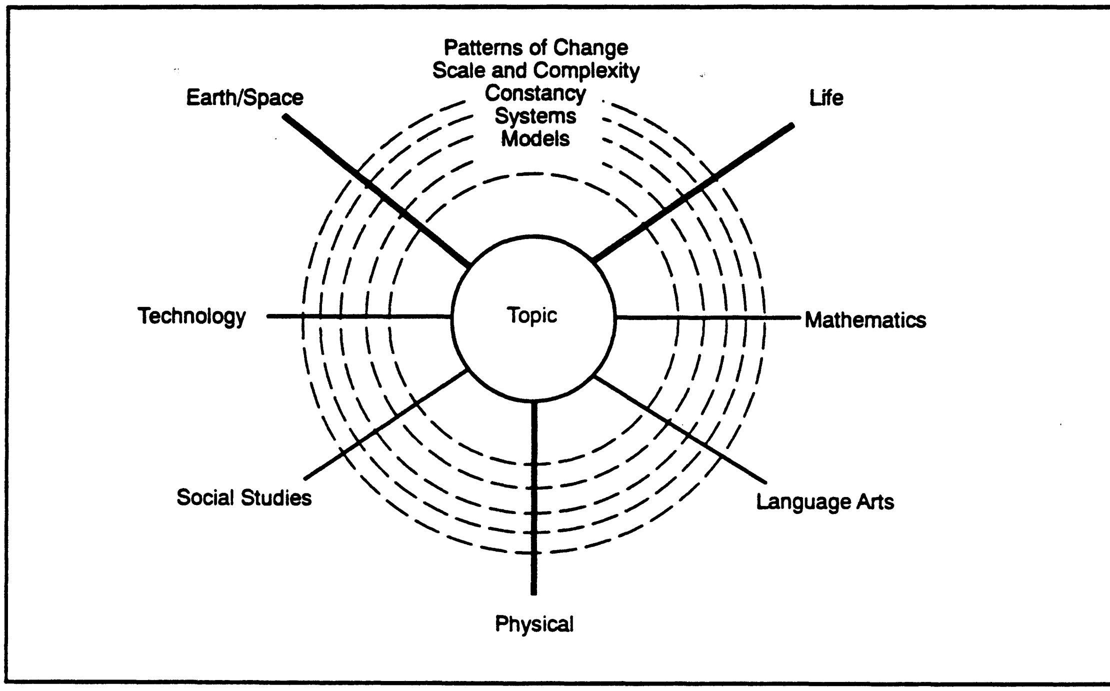


Model 3. Multidisciplinary: Topic—This curriculum organization emphasizes a specific topic and how it relates to different disciplines within science (i.e., life, earth/space, physical) and, if desired, to other disciplines (e.g., social studies, technology, math, language arts, music). The connections among these disciplines may not be evident to learners if the topic is taught in isolation in the various disciplines. This organization also integrates the thematic ideas throughout the investigations of the topic within each of the disciplines. (The dashed circles show the "themes" woven throughout). Typically fewer topics are included within a year-long study using this organization than #1 above because each topic is investigated in greater depth.

MODEL



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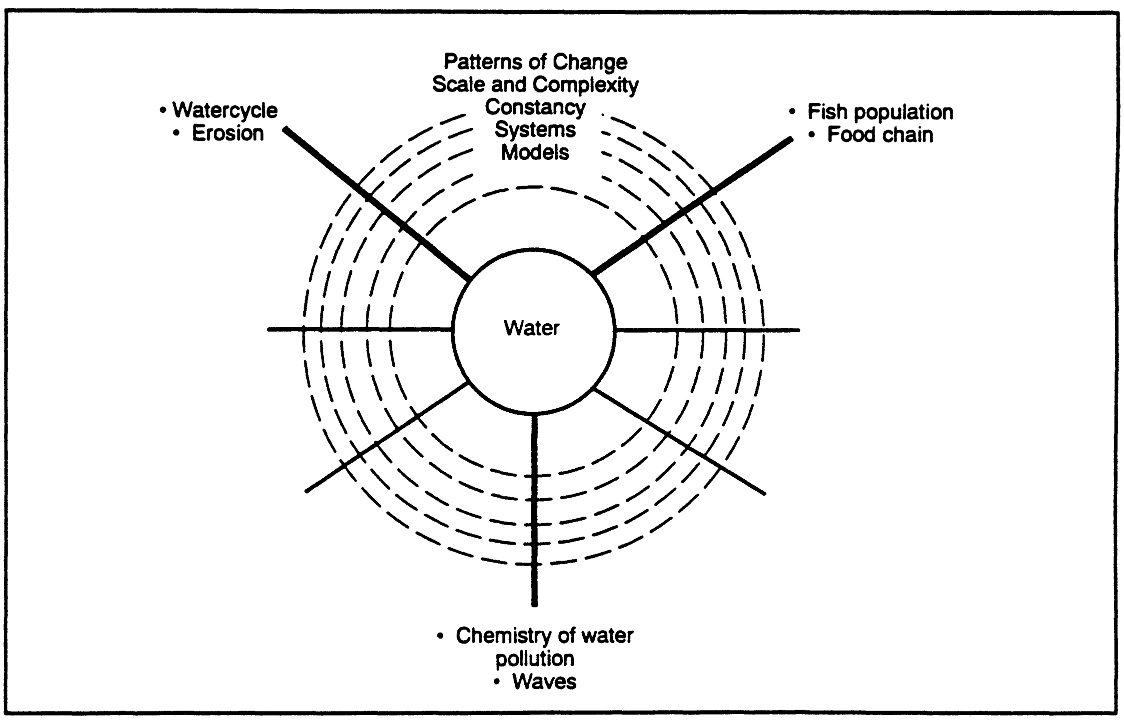
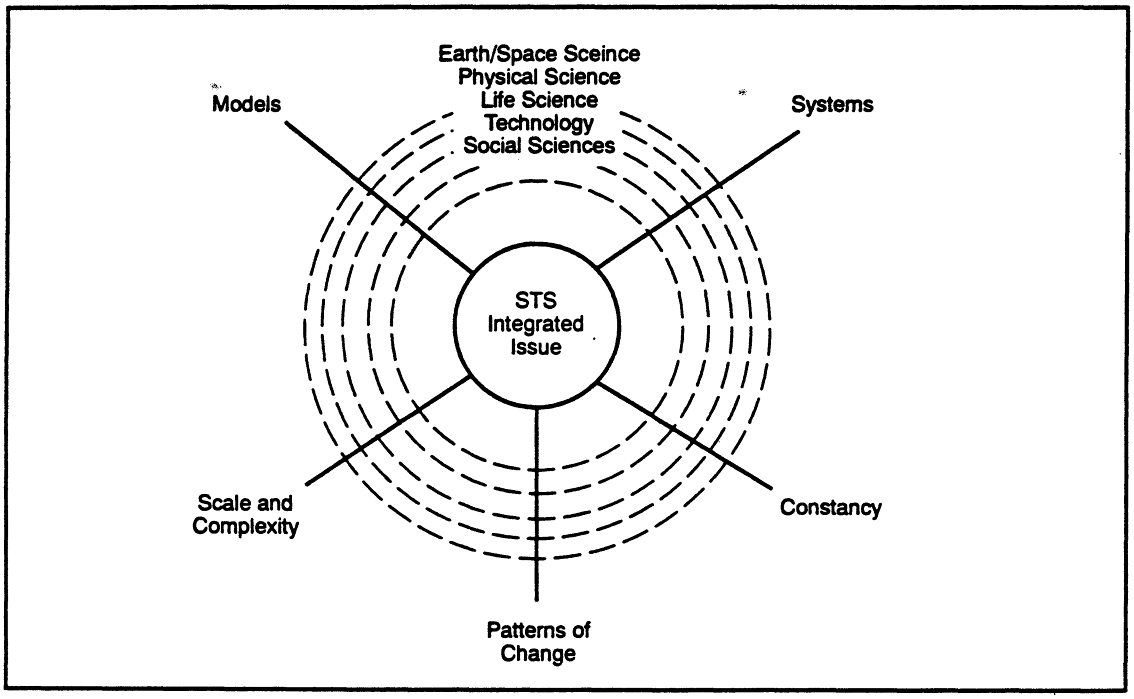
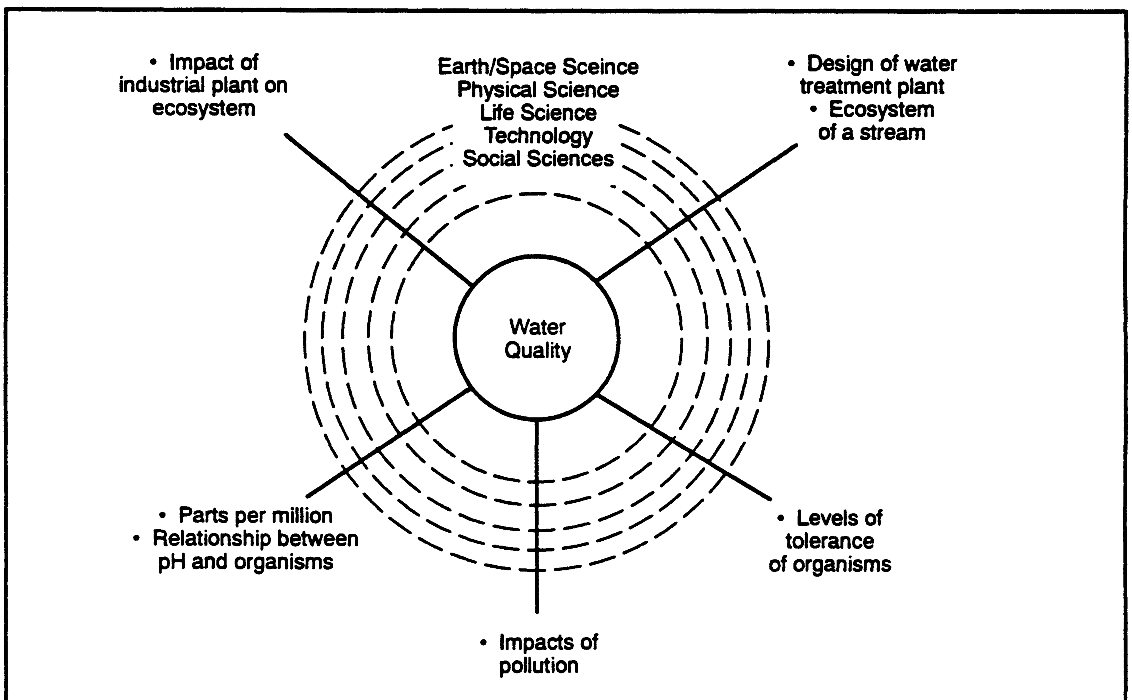


Model 4. Interdisciplinary: Science/Technology/Society (STS) Issue—This curriculum organization emphasizes an interdisciplinary STS topic or issue and investigates it through thematic ideas. It integrates all of the sciences with technology and society (social sciences) and offers rich opportunities to integrate across other disciplines—blurring the disciplinary boundaries. In this integrated approach, learners make connections—among the disciplines, to the broad thematic ideas, and to real-life issues which are relevant to them. Because of their richness and complexity, a limited number of STS topics or issues would be explored each year.

MODEL

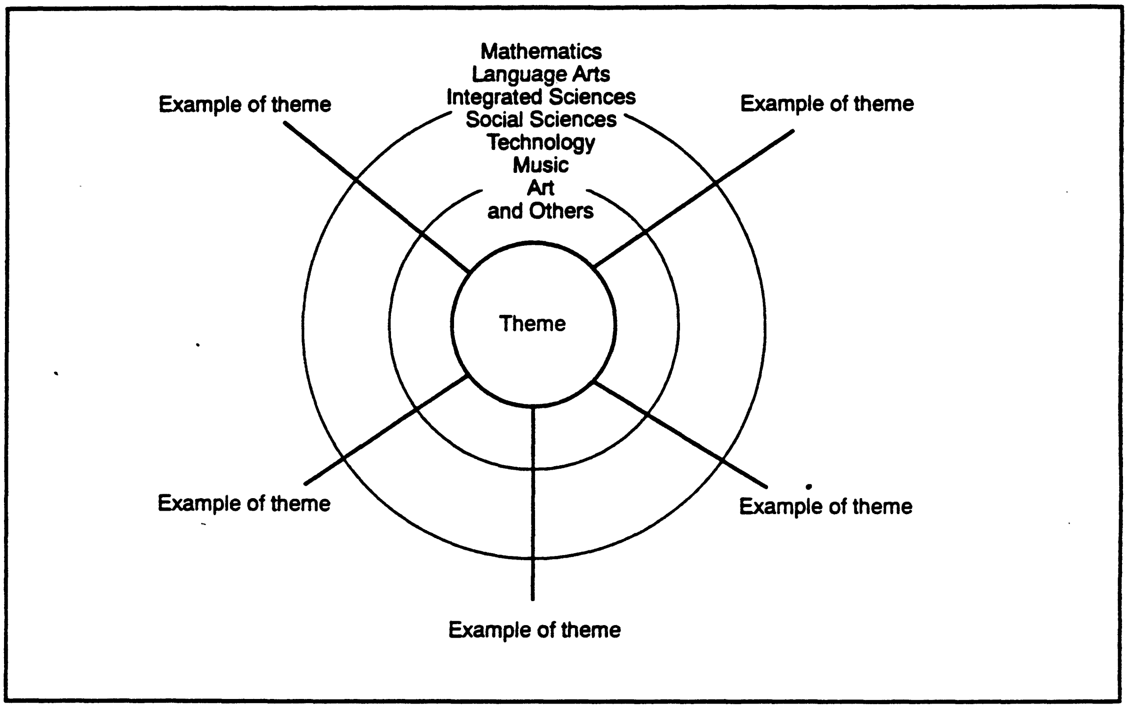


EXAMPLE



Model 5. Transdisciplinary: Theme-Based—This curriculum organization emphasizes a thematic approach where learners investigate broad areas of interest which exemplify the theme. Learners draw upon an appropriate mix of disciplines, melding the disciplines together and eliminating the boundaries. Each year may focus on only one theme or few.

MODEL



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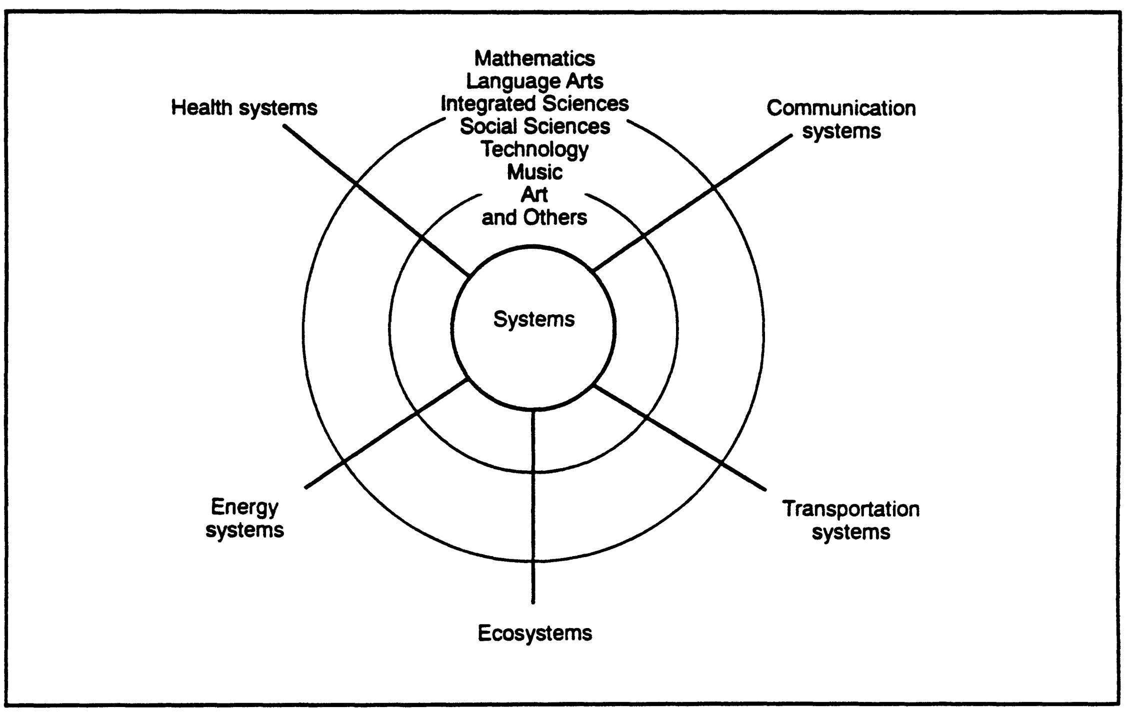


From Models to Learning Episodes

The previously described models suggest a range of possibilities for organizing the curriculum. Each model is translated into practice through the development and use of learning episodes. The sample learning episodes in this document were not designed specifically to match any particular model but to show a wide range of possibilities. In practice, some episodes would only represent a part of the curriculum illustrated by one of these models. For example, "Observing Birds in Their Habitat" (pp. 61-62) might be used as one of several learning opportunities developed for a comprehensive investigation of birds and it could be used to enhance observation skills.

On the other hand, some of the sample episodes are well matched with the different types of curriculum organization illustrated in the models. The following gives one example for each model.

Single Science Discipline

(Model 1): "Everybody Needs a Home" (pp. 33-35) focuses on the life science topic "habitats." Through the episode, learners explore several themes:

- constancy—almost all living things share the same basic needs of food, water, shelter, space, light
- patterns of change—similarities and differences over time
- systems—ecosystems as habitats

Multidisciplinary: Thematic Idea

(Model 2): In "Wetlands and Waste Water" (pp. 99-101), learners examine the theme of systems by investigating and comparing different aspects of a wetland ecosystem and a waste water treatment system. As they conduct research and interpret their findings to others, learners draw upon different disciplines. Depending on the learning conditions, the disciplines may be stressed separately (multidisciplinary) or integrated (interdisciplinary).

Multidisciplinary: Topic

(Model 3): During "Birds in the School Yard" (pp. 21-24), learners investigate the topic of seed preference of birds. Life science, mathematics and language arts are stressed and have the potential to be integrated. The themes of patterns of change (e.g., seed preference, effect of temperature) and constancy (e.g., basic needs of birds) permeate the learning episode.

Interdisciplinary: STS Issue

(Model 4): "What's Going on with the Weather?" (pp. 113-118) involves learners in the investigation of different themes:

Directly
- Systems—earth, energy, economic, political
- Patterns of change—weather, climate
- Constancy—ways systems do not change

Indirectly (interwoven)
- Scale and complexity—effects of small and large changes on systems
- Models—predicting future trends

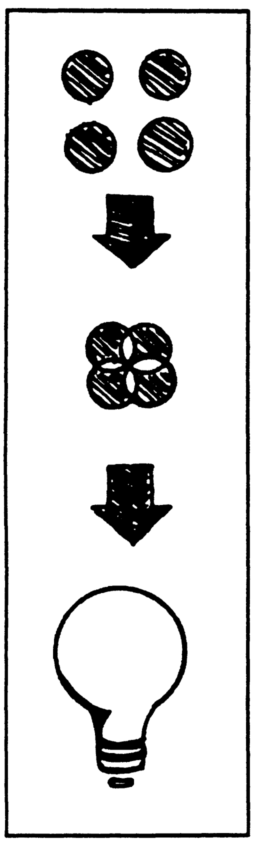
The investigations within the learning episode integrate the different disciplines with an emphasis on science, technology and society.

Transdisciplinary: Theme-Based

(Model 5): The theme of systems is the focus of "Let's Try Our Own Biosphere II" (pp. 53-56). This simulation of planet earth provides learners with diverse opportunities to research and investigate different systems and cycles including land, water, air, waste and recycling, communication, health, and social. The emphasis is on learner selected and directed investigations of systems, drawing as needed upon appropriate disciplines.

Instructional Considerations

No matter which approach to organizing the curriculum is used, it is effective instruction that brings the curriculum to life. Effective instruction depends on key ideas related to how learners learn, the role of learners and leaders of learners during instruction, and the selection of instructional methods. While these instructional considerations were previously discussed as "conditions for learning" under the components of curriculum, they deserve further emphasis. The following briefly describes the key ideas which have been incorporated into the sample learning episodes in the next section, "Getting Started."



Constructivism

Constructivism is the idea that people learn by making sense out of information and relating this new knowledge to their own experience (Lorsbach & Tobin, 1992). It holds that learning is active mental work for the learner, not merely passive reception of information. Thus the learner must search, rather than follow, in order to learn. This explains why learners learn different things from the same lesson and how previous knowledge, even if it is incorrect, shapes what is learned.

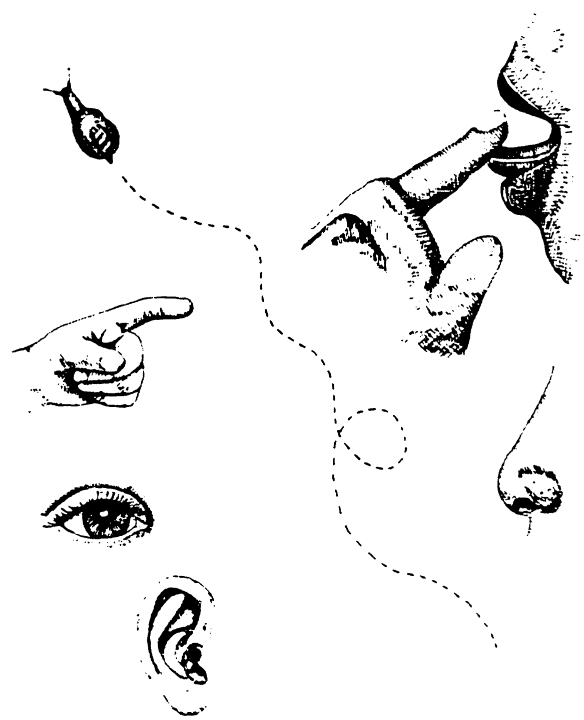
Constructivism challenges educators to rediscover the student in teaching (Woolfolk, 1993). Instead of giving information and managing behavior, the constructivist leader of learners takes on the role as a mediator of learners and the environment. Tasks are framed which require learners to classify, analyze, predict, and create using raw data and manipulatives. Learners are encouraged to dialogue among themselves, and to develop connections among the ideas and concepts they are learning. The responses and experiences of learners are powerful and are used by the constructivist leader to drive lessons, shift instructional strategies, and modify content (Brooks & Brooks, 1993).

Other people also play important roles during the learning process. They provide support, challenge the learner's thinking, and serve as coaches and models of inquiry thinking and learning. Learners are encouraged to collaborate and to thoughtfully question each other. Learners "try out" ideas and work toward understanding with feedback from peers or others for the learners themselves are the key to learning. A comparison between traditional classrooms and constructivist classrooms is presented in Appendix C-3.

Active Learning

The idea that the learner is an active participant in the learning process is at the heart of constructivism and is supported by what is known about how people learn.

Leaders of learners help in the process by putting learners in the most

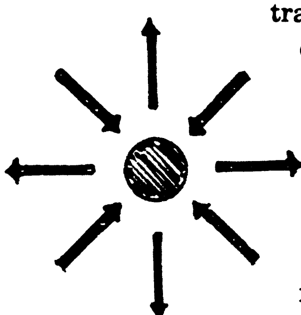


active role possible during learning activities, realizing that ultimately learners will make sense out of the experience in their own way (Eggan & Kauchak, 1994). During active learning, learners physically interact with real objects and the real environment. Active learning also involves mental interaction with ideas, concepts, or questions that do not make sense to the learners and which stimulate them to ask further questions and to manipulate the new information until it makes sense with their own experience.

This active physical and mental interaction helps learners build a rich repertoire of experience and understanding, and to move from lower to higher levels of thinking and learning (Lowery, 1993-94; Willis, 1993).

Learner-Centered Approach

Constructivist leaders of learners use a learner-centered approach during instruction. This approach treats the learner, rather than the content, as the central focus of the instructional process. The tightly regulated structure in a traditional teacher-centered approach gives way to a flexible, evolving instructional plan with the learner-centered approach. During instruction, the leader of learners functions as a guide and facilitator. The leader provides a learning environment conducive to exploration and interaction. Subject areas are integrated and lessons are driven by real-world applications or questions which arise from the students. In addition, the emphasis of the learner-centered approach moves from the product or outcome to the process which the learner goes through in search of those answers.



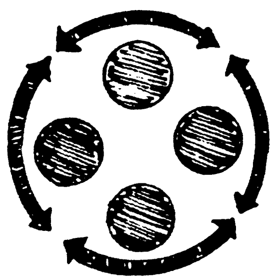
Alternative / Authentic Assessment

When a leader of learners moves away from traditional ideas about what learning is and how it is accomplished, new approaches to assessing learning are also required. While traditional multiple choice and fill-in-the-blank tests may be effective in determining how much content a student has learned, they are ineffective in measuring learners' on-going progress, higher levels of thinking, and ability to solve problems and make connections among concepts and ideas. Alternative forms of assessment aimed at providing more authentic information about the learner throughout the learning process are more appropriate for this.

Assessment involves collecting, synthesizing, and interpreting information to aid in classroom decision making, including information gathered about the learners, instruction, and instructional environment (Airasian, 1994). In contrast with traditional assessment, authentic assessment uses worthwhile, meaningful tasks which stimulate learners to apply the knowledge and skills they have learned to real-life problems (Woolfolk, 1993). These assessment tasks are embedded in the instructional process instead of administered all at the end. This enables the leader to give learners meaningful feedback on their performance throughout the learning process. Authentic assessment also uses multiple indicators of the learners' performance to reflect the complexity of learning, including leader observations, professional judgments, and student self-evaluation. Specific assessment methods might include portfolios, checklists, interviews, self reports, essays, journals, group work, long-term projects, performances, and oral, written or pictorial responses. As with all effective assessment, these techniques must be tied to clear goals which are communicated to students prior to instruction. (see Appendix C-4)

Cooperative Learning

According to Johnson and Johnson (1991), many schools have evolved into competitive arenas where one learner's success is frequently at the expense of another learner's progress. Further, assignments are common in which individuals are evaluated against each other or against a rigid set of standards. An alternative strategy which leads toward a collaborative environment in which active learning is enriched is cooperative learning.



Cooperative learning is not just placing learners in groups. Rather, it is an arrangement in which students work in mixed-ability groups and are rewarded on the basis of the success of the group in addition to their individual level of knowledge and expertise (Woolfolk, 1993). Leaders must structure lessons and groups to focus on important goals and reinforce interdependence among learners. Several studies have shown that when the task involves complex learning and problem-solving skills, cooperative learning leads to higher achievement than a competitive arrangement, especially for low-ability learners (Johnson & Johnson, 1985). Further, cooperative learning experiences lead to stronger interpersonal and negotiation skills, higher self-esteem, stronger motivation, and greater acceptance of others in today's diverse classrooms. (see Appendix C-5)

Diversity Among Learners

Leaders of learners readily acknowledge that learners are different because of their background, experiences, natural abilities, and level of development. In order to meet this diversity among learners, instruction must encompass a wide variety of teaching and learning strategies. (see Appendix C-6)

Howard Gardner (1983) presents the idea of multiple forms of intelligence which helps to explain some of the diversity among learners. He discusses seven different types of intelligence:

- Linguistic
- Musical
- Logical-Mathematical
- Spatial-Visual
- Bodily-Kinesthetic
- Intrapersonal (understanding self)
- Interpersonal (understanding others)

In addition, learners differ developmentally based on their age and experience. While this diversity presents a challenge for traditional instructional approaches, it enriches instruction, assessment, and learning from a constructivist perspective.

The recent emphasis on inclusion in today's schools focuses attention on learners with special social or learning needs. Proponents of inclusion support the practice of placing special education students in regular classrooms with additional help and support. Assistance can be provided by special education teachers, regular teachers who have had this special preparation, or a combination of the two. Used appropriately, the sample learning episodes in "Getting Started" can lead to meaningful instruction and student learning for all students in today's diverse classrooms.

Multicultural Education

Multicultural education is a process, an idea and a reform. It involves ongoing planning and efforts to make appropriate changes in the entire school and school community. A multicultural science education program must incorporate the building of knowledge, the expansion of instructional strategies and the infusion of information about the history, culture and perspectives of groups now largely excluded from the curriculum and materials. It is through such an approach, which incorporates the perspectives of different gender, cultural and racial groups, that we can promote high self esteem and enhanced achievement for all our students while inviting them to be critical thinkers and problem solvers. Environmental education is a natural vehicle for multicultural education because of its integrated approach and emphasis on a global perspective. (see Appendix C-7)

GETTING STARTED: SAMPLE LEARNING EPISODES

Getting Started: Sample Learning Episodes

This section is significant for curriculum writers and classroom teachers because it translates the educational ideas discussed previously into concrete examples. Following an expanded explanation of what is a **learning episode**, the section presents 24 samples of learning episodes designed to show how Ohio's *Model Competency-Based Science Program* (1994) can be implemented using environmental education as a vehicle. These are offered as a starting point and as a stimulus for further thinking.

Description of Learning Episodes

A learning episode presents a rich description of a learning experience, capturing the multifaceted aspects of teaching and the conditions necessary for effective learning to take place. It can occur over a short duration of time involving minutes or hours or it may transpire over weeks, months, a semester or year. The term "episode" was selected because it can be defined to meet new educational trends without the existing connotations implied by terms such as "lesson" or "unit."

The learning episodes in this section vary both in format and detail to meet the needs of a wide variety of leaders of learners. The episodes can be used as they are written or as the basis for a modified episode that meets the characteristics of the leaders and learners who will be involved. If a particular episode represents more of a change from current practice than is comfortable for the leader and/or learners, it can be revised to fit their needs.

Characteristics

The variety of episodes included in this document are based largely upon actual ones which have been used under normal learning conditions. Since they do vary in format and emphasize different aspects of the multi-dimensional curriculum, reading several episodes will help a leader get a feel for the spirit they are meant to convey.

In addition, the following list of general characteristics is offered to help stimulate thinking about the overall essence of learning episodes and how they may be planned and carried out:

- Place more responsibility for goal setting, planning, designing, implementing and evaluating learning activities on the learner.
- Make a major effort to utilize the extensive existing knowledge and skills of the learners.
- Incorporate a variety of teaching and learning strategies to best meet the individual needs of all learners.
- Allow, with help, learners to take responsibility for their own behavior (health and safety should also be a conscious concern for the learners rather than only the leaders).
- Allow a wide latitude for learners to guess, speculate, surmise, contemplate, needle around, construct meaning, and question.
- Make a special effort to discern individual interest and proficiencies that can be used for future individual pursuits or for peer teaching opportunities.

- Place more emphasis on an interdisciplinary or transdisciplinary (theme-based) approach rather than discipline specific.

When the general characteristics have been considered, then the specific instructional objectives of the episode need to be reviewed for their consistency with the leader's intentions.

Instructional Objectives

As a leader of learners works with students to plan and carry out these or other episodes, several sources of instructional objectives should be used. For school personnel, the primary source would be the instructional objectives found in school district-developed courses of study with the primary source being the science course of study. The episodes in this document use some instructional objectives from Ohio's *Model Competency-Based Science Program* (1994). Other sources of objectives may be state standards, a school district's philosophy or mission statements, educational literature, or informal educational programs.

As previously discussed, the objectives chosen should include a balance among process, content, and application while at the same time work toward more general objectives associated with the characteristics of lifelong learners such as tenacity, honesty, initiative, self-reliance, and more.

Components

While the sample episodes vary in style, the following components are identified for each:

- Title
- Overview
- Grade level range
- Illustrative instructional objective (based upon Ohio Model Science Program)
- Background
- Procedure
- Assessment
- Materials
- References

The following 24 learning episodes were written by many practicing Ohio educators. Some illustrate how existing curriculum materials can be modified to include innovative educational approaches. Some model a specific educational strategy or technique. Others depict multi-dimensional learning opportunities. All of them are designed to show how the Ohio Model Science Program can be implemented.

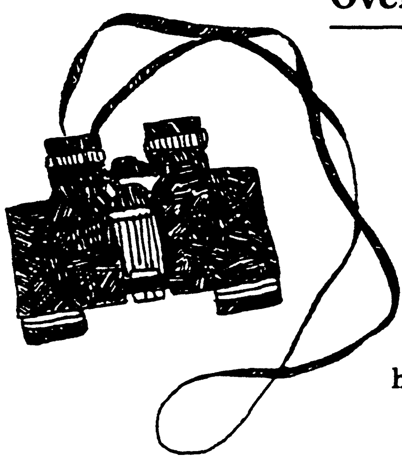
Because the writers of the episodes approached both the components of the curriculum and instructional considerations from a variety of angles and emphases, they addressed these to varying degrees. We encourage you to modify the episodes not only to meet your needs but also to further enhance them based upon the ideas discussed in the first section "The Big Picture: Building Blocks and Models."

The following learning episodes are arranged in **alphabetical order.** Two appendices are provided to assist you in selecting episodes to use:

- **Appendix E** is a chart which gives a quick **overview** of all of the episodes in terms of:
  - time factor (short-term/long term),
  - approximate grade level range,
  - main focus of the content (topic),
  - environmental issues addressed, and
  - predominant location of learning site.

- **Appendix F** lists the **ninth grade proficiency test outcomes** and identifies for each outcome the learning episodes which will contribute to building the foundation of experiences that will most likely lead to a high degree of success on the test.

BIRDS IN THE SCHOOL YARD



Overview

The episode builds on a Cornell University national study of seed preference that involved observers from all parts of the country. Students follow Cornell's basic experimental design, but encounter and solve problems as they actually plan and carry out the experiment at school and at their homes.

Grade Level Range

Intermediate, Middle School

Illustrative Instructional Objective

Learners will investigate patterns in nature by maintaining journals of observations over long periods of time, report findings on the variability of observations accurately and ethically, and then compare their results to commonly held perceptions.

Background

During the winter of 1993-94, the Laboratory of Ornithology at Cornell University conducted a National Science Experiment—Seed Preference Test to determine if wintering birds have a preference for black-oil sunflower seed, white millet, or red milo.

For this experiment, which was conducted across the United States and Canada, Cornell Lab developed the hypothesis. They observed that some birds seemed to like to eat red milo, which went against "conventional wisdom." This was especially true for ground-feeding birds in the Southwest. The hypothesis was stated in the form of two questions:

1. What kinds of seeds do ground-feeding birds like best?
2. Do seed preferences vary from region to region throughout the USA and Canada?

The participants in this experiment followed the same scientific procedures. To minimize error, additional information was given to all participants to help control variables, such as interruptions of bird feeding by other animals. To conduct the experiment, participants laid out one half cup each of black-oil sun-flower seed, white millet, and red milo on a separate pieces of cardboard. They then placed the seed an equal distance apart on the ground and observed the number of visits by birds. The bird species and visits were recorded, tallied, and sent to Cornell Lab.

The data from around the nation was analyzed by Cornell Lab and the results published in their newsletter. Instructions were also available by request so the participants could analyze their own data.

This learning episode centers on the learners doing the real science that was required to be a part of the Cornell Research Team. What began as a science lesson rapidly expanded into other areas of the curriculum and became interdisciplinary.

Additional learner outcomes for the episode might include:

- accurate and ethical reporting of findings on the variability of observations in the feeding habits of winter birds.

- investigating and recording the diversity of methods by which wintering birds meet their needs for food, shelter, protection and water.
- maintaining a complete and accurate journal of investigations into the seed preferences of wintering birds over a 12-week period.
- exploring the impact of human feeding of wintering birds on the population and migration of the species observed.

Procedure

The following is a description of the participation of one class in the project.

Mr. Peterson, a fifth grade teacher with an interest in ornithology, decided that his fifth grade class would participate in the National Science Experiment. He ordered the materials from the Cornell Lab of Ornithology with $10 he had received because he had the most parents at the PTA meeting. He told his students that they were going to be part of one of the largest research teams ever called together for one scientific experiment. Instead of reading about science, watching science demonstrations, and doing hands-on lessons, the class would become scientists and do "real" science for the next two grading periods.

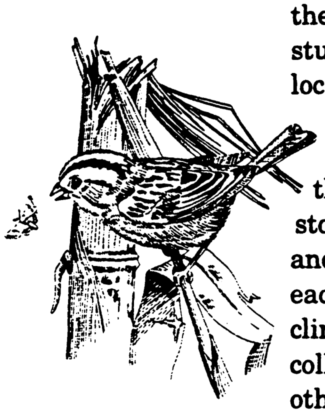
When the packet of materials was delivered from Cornell, Mr. Peterson turned the project over to the class. He told the students that they were responsible for following the instructions, organizing the experiment, recording and reporting the data and solving any problems they encountered. He said he would serve as a resource person to assist them, but that most questions the students came to him with would be answered with another question. Mr. Peterson explained to the class that their grades for this project would be based on how well they followed instructions and completed their study.

After completing an overnight assignment of reading the 12-page *Seed Preference Test Instruction Booklet*, the students decided to divide the responsibility for planning the science experiment into six groups. (Note: Mr. Peterson's class was accustomed to cooperative learning and breaking large jobs into smaller tasks. A class with no experience in this learning strategy would need to spend time discussing group roles such as leader, recorder, equipment manager, observer, etc.) The six groups were responsible for organizing different aspects of the study:

1. oversight—bring the work of all the other groups together, make additional assignments and schedule the experiments, data collection, and reporting;
2. site selection and gaining permission;
3. bird identification skill development;
4. equipment preparation and birdseed acquisition;
5. data collection—preparation and duplication of forms; and
6. quality control—make sure experiment procedures are being followed and bias in the experiment is being minimized.

As the groups made preparations for the experiments, a number of questions came up which required that decisions be made by the class. For instance, the site selection team first thought about using the school site for all data collection. After talking with the data collection group, they realized that more data could be collected if each member of the class collected data at home. This created a question for the equipment acquisition team, "How much of the three types of seed do we need?" One cup of each seed type was required for each observation. If 10 observations were made at the school site, only a small amount of seed would need to be purchased. If all 24 students completed 10 observations at home, a large amount of seed would be needed.

Through the planning process, Mr. Peterson offered suggestions and asked lots of questions. When the birdseed acquisition team asked where they should get the birdseed, Mr. Peterson pointed out that a source and costs were included in the instructions. He then asked the students if they could secure the seeds locally at a cheaper cost and handed the students a telephone book. After several phone calls, the students found that a local agricultural feed supply store had all three types of seed in stock and was willing to donate 25 pounds of each seed type for the project. That clinched the decision to have each student collect data at their home, but it created other questions. Did each student have access to the necessary site requirements at home and did they have a way to measure the seed, time the watch and measure the temperature? Each student was asked to check at home (the oversight committee developed a checksheet) to see if they had everything that was needed.



After two weeks of planning, organizing, and gathering materials and supplies, the class was ready to start. The quality control team had become concerned that variations in data collection and identification might occur so they had suggested that the school site be used as one site with the entire class participating in the initial data collection episode as a means of being sure everyone used exactly the same procedure. The bird identification training team had made color copies of the identification poster included in the packet from Cornell so each student had their own identification poster. The ID team had also secured copies of several field guides, *The Audubon Encyclopedia of North American Birds*, and *The Birder's Handbook* for reference material in the classroom. The *Encyclopedia* and *Handbook* were checked out of the local public library since they were not available in the school library.

The data collection continued for 10 weeks. Some students had more success than others in being able to ID and count birds. The quality control group decided that more information was needed about each data collection site to try to understand the differences in results. They devised a questionnaire that each student completed listing such items as distance to nearest wooded area, distance to nearest full-time bird feeding station, presence of house pets, availability of water, etc. The class's science time during this period was devoted primarily to compiling data, making tables and graphs of results, and discussing the data. Two students recorded large numbers of evening grosbeaks at their feeding stations. Both students observed that there were approximately 3 females for every male that was counted. Mr. Peterson asked for explanations of this observation. Numerous hypotheses were put forth and after 20 minutes of discussion, arguing and no consensus, Mr. Peterson asked each group to research this phenomenon using the resources in the classroom, visits to the library and even interviews with local bird watching experts.

The National Science Experiment—Seed Preference Test concluded with completion and mailing to Cornell of all the reporting forms. Students then shared and compared their findings through E-mail with those of several other schools participating in the experiment. Two presentations of the results were also made locally. The first presentation was to the local PTA at their March meeting. The students shared their results in graphs and tabular form and presented a slide show on bird identification of winter feeding birds. (Note: the slides came from the Ohio Department of Natural Resources slide set "Birds of Ohio"). The second presentation was done for a high school biology class in the same school district. The high school students were asked to form a scientific review panel and evaluate the work done by the fifth grade class.

As Mr. Peterson's students studied Bird Seed Preference, they encountered other curriculum areas:

- mathematics in ordering supplies and analyzing data,
- cultural geography in understanding changes in migration behavior caused by human activity,
- physical science in measuring weather conditions and setting up the experiment,
- language arts in writing plans, individual journals and reports, and
- social studies in understanding how groups of people (organizations) work together.

The students in Mr. Peterson's class decided that they wanted their class to continue performing scientific studies. In discussing other possible science experiments, Mr. Peterson pointed out that a field bounded on three sides by cattail-clogged drainage ditches would soon be the nesting territory for a number of red-winged blackbirds. He suggested that a study of territorial behavior in blackbirds might be possible.

The Cornell Lab of Ornithology has several ongoing national experiment programs, such as Project Feeder Watch, which are similar to the Seed Preference Test.

Assessment

- ❑ Mr. Peterson made a weekly assessment of each student's involvement in the Seed Preference Experiment by recording observations on a checklist when students completed tasks in their work group, submitted completed data reporting forms, and participated in class discussion activities.
- ❑ Each student's journal, completed data forms, and graphs/tables were peer reviewed, much like a scientific report would be peer reviewed for publication in a journal. Each student served on three review groups of other student's work. Each student's own work was thus examined by three students. The peer review was done using criteria developed by the quality control group and included: completeness of observations, thoroughness of data form entries, and quality of graphs/tables.
- ❑ Each student received a team grade for the work of their four member group.
- ❑ Each student completed a self-evaluation of their participation in the experiment, including knowledge gained, skills learned, and contributions to their team.
- ❑ Mr. Peterson gave two exams - a bird identification test using slides and a paper and pencil, multiple choice/short essay test covering ecology of wintering birds, scientific method and data interpretation.

Materials

- Cornell Seed Preference Test packet
- Three types of birdseed
- Other materials as determined by the learners

References

National Science Experiment - Seed Preference Test. Cornell Lab of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY 14850, (607) 254-2440.

DAY AT THE CREEK

FIELD
T • R • I • P

Overview

This learning episode models good field trip planning, execution and follow-up. Although the trip described is to a local stream, many of the planning and follow-up components could be applied to any field trip. "A Day At The Creek" is a field trip planned with the learners to meet their specific needs. Activities include investigating the creek for its importance to the ecosystem, monitoring water quality, determining human impact on the stream, and experiencing part of the water cycle.

Grade Level Range

Primary, Intermediate, Middle School, High School

Illustrative Instructional Objective

Learners will participate in choosing, planning and taking a field trip during which they will select and explore the use and accuracy of several measuring devices to investigate chemical, physical and biological attributes and then use various communication methods to describe the results of the exploration.

Background

Site & Curriculum Considerations

- Secure a site along a creek or river for the group to visit. Possible locations include parks, camps, or even a teacher's house along the banks of a stream.
- Enlist the help of area "experts" who may be knowledgeable in:
    - aquatic animals and plants
    - diversity of streams
    - stream monitoring
    - nonpoint source pollution

Local experts may be from the state department of natural resources, park rangers, parents, farmers, environmentalists or scientists who explore or monitor streams on a regular basis. Also consider contacting local groups such as the Audubon Society or Sierra Club.

Safety & Transportation Considerations

- Discuss all safety concerns and permission slips with learners. Design the slip to include an invitation for parents to chaperone. Chaperones need not always be parents. Other relatives and community people can be included. However, don't expect any one person to take on several roles, (i.e., chaperone and fish expert). Check the school district policy concerning volunteers.

  To alleviate some parental anxiety, one of the chaperones might be certified in first aid or nursing. Having a portable phone, school walkie talkie, or other accessible communication should also be considered.

- Determine how learners will be transported from the school to the site. If the class will walk to the creek, review the route and reinforce safety rules.
- Additionally, if the trip requires payment from learners for admission or other costs, make arrangements for those who cannot afford

the price. Check with administrators or the building parent organization for needed financial support.

- Visit the stream a few times before taking the group. This will help assure that stream-appropriate activities are developed. Leaders will also want to visit the site a day or two ahead of time to check the water levels in the creek because water levels can change rapidly, especially in the spring.

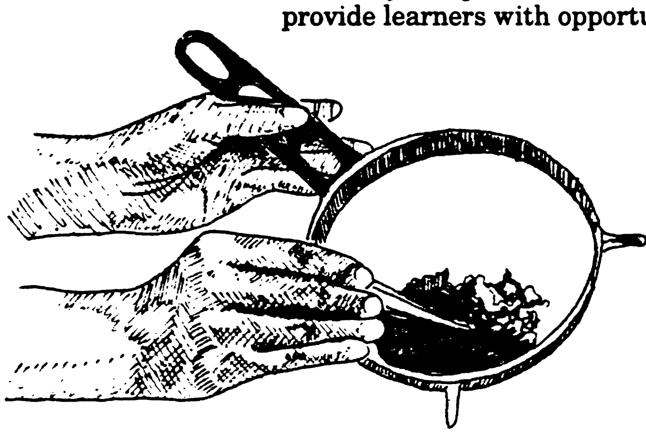
Safety is always a concern when visiting any waterway. Leaders should be prepared and know the stream. If possible, the leader should walk in the creek ahead of time checking for currents and/or changes in the creek bottom. The temperature of the air and water on the day of the visit should also be taken into consideration. A good "rule of thumb" is that the water temperature plus the air temperature should equal 120 degrees before learners are permitted to enter the water.

Procedure

Data Gathering & Documentation

- Help learners plan ahead for gathering data. Tablets of paper with pens or pencils attached to clipboards and magnifying lenses on strings for wearing around the neck are examples of ways to provide for effective learning out of doors.

- Make plans for documenting the field trip. Disposable cameras are relatively inexpensive and can provide learners with opportunities to take some memorable pictures. Learners might contact people who are interested in sharing the good news about learners and education. Think ahead about getting publicity through your local newspaper or television station. Alert them to the time of the trip and the activities that will occur. The school newspaper or newsletter could also help share the events of your trip.



Learner Preparation

- Leaders should make plans so every learner can attend and fully participate in the field trip. Provisions and necessary adjustments should be developed by leaders to enable participation by learners who have disabilities. Behavioral and emotional problems might surface on the field trip because learners are not in their regular classroom. Leaders should be prepared for these challenges and establish clear guidelines.

- Leaders and learners should brainstorm expectations for the trip to the creek. For younger learners, this might include practicing teacher hand signals for various actions and practicing listening skills by playing "Simon Says" with the teacher as leader. For older learners, each should know clearly the goals and objectives of the field trip and channel their energies toward reaching those ends.

- With the learners, reinforce plans for appropriate dress, acceptable behavior, eating, and waste disposal. Be sure to check on restrooms and parking! If possible, set a rain/snow date.

- Learners should be actively involved in planning their stream site investigations. Learner investigations should be dependent upon the age of the learner, the learner's interests, and the relationship of the investigations to the school's curriculum.

Listed below are suggestions for "setting the stage":

a. Brainstorm current beliefs that learners have about waterways.

b. Use webbing or mapping to develop specific learner interests.

c. As a group, establish goals and/or outcomes that relate to a stream visit.

d. Design maps specific to student interests. (Map locations of animals indigenous to stream, local trees, stream currents and rate changes, etc.)

e. Trace the history of the stream and its development.

Suggestions for in-depth areas of study

- Investigate the importance of the stream upon area plants, animals, economy, and lifestyles.
- Compare one stream to another or compare parts of the same stream.
- Explore how the stream fits into the watershed.
- Document the location of possible point and nonpoint pollution sources and whether they are adequately controlled so the uses of the stream are maintained.
- Develop a plan of action to protect the stream from pollution or from being further polluted, or enhancing stream uses (e.g., fish habitat).
- Consider the resulting negative and positive impacts when a stream is artificially contained. Causes for this change could be filling in the stream, diverting its path, putting in a concrete culvert, damming the stream, using pipes or tiles for underground water movement, etc. How would the aquatic life, recreation, agricultural, industrial, human health, or wildlife uses change? Which users would benefit and which would not?
- Measure the water quality of the stream during the trip and at other times during the year.
- Explore food chains, food webs, and the interdependence of all living things around the stream.
- Using field guides, name, locate, and/or label trees, animals, macro invertebrates, tracks, and plants living within the creek area.
- Study the water cycle and its relationship to the stream.

There are many ways to organize the day at the creek. Leaders might consider keeping their group together, dividing the group into sections which rotate to specific stations, and/or investigating in small, chaperoned groups all day.

Investigations should be centered around the goals developed by the class during the brainstorming sessions. All learners should have a plan or project to complete at the creek that is appropriate for their area of study, age, and skills. Learners may want to incorporate stream tests developed by the Department of Natural Resources, such as stream monitoring for invertebrates and chemical tests for nonpoint pollutants, into their investigation plan. Learners will also want to record any data gathered for later use.

Assessment

Learners should be given ample time to process and organize information gathered on their day at the creek. Projects should be completed and then shared with others. The group should return to the goals set prior to the trip and evaluate how well each goal was met. The findings of the group can be summarized and more goals or questions relating to the stream could be developed for further investigations and enrichment.

Learners can brainstorm and web possible real-life uses for the information that they have gathered. Ideas may include hanging posters, presenting plays or skits for parents and students, making "info-mercials," and/or writing a book about the investigation for the local library or school library.

Materials

Listed below are items to consider taking on the creek adventure. Many of the items needed will greatly depend upon the site that is chosen.

- first aid kit
- trash bags
- sack lunches
- change of clothes
- clipboards, paper, etc.
- meter stick
- magnifying lenses
- drinking water
- toilet paper
- permission slips & medical information
- nets, bowls, thermometers
- fine mesh kitchen strainers
- portable phone
- field guides
- cameras
- blankets or drop cloths

References

American Forest Institute. (1993). Project Learning Tree. Washington, D.C.

Western Regional Environmental Education Council. (1992). Aquatic Project WILD. Bethesda, MD.

Western Regional Environmental Education Council. (1992). Project WILD. Bethesda, MD.

ENVIRONMENTAL YOUTH CONGRESS: SOLVING ENVIRONMENTAL PROBLEMS

Overview

This learning episode is designed to provide youth with the opportunity to actively participate in the democratic process while being exposed to important environmental issues. The Environmental Youth Congress (EYC) is composed of delegates and an advisor from each participating school. A committee of educators and other professionals in the fields of natural resources and youth services, along with selected youth delegates, provides guidance for the EYC and interprets environmental issues for the youth delegates. EYC enables youth to understand local, regional and international environmental issues and to involve their peers in the formulation of solutions to these problems.

Background

The Environmental Youth Congress is a year-long convening of student delegates which enables young people to discover natural processes and the problems created when those processes are disrupted. It empowers young people to help friends and classmates understand local, regional and international environmental issues and to involve their classmates in formulating solutions to these problems. The EYC encourages positive youth role models by promoting youth delegates to serve as congress chairs and to become active members of the EYC planning committee. Adults who serve on the EYC planning committee are there to advise youth, but it is the responsibility of the delegates to initiate action.

Grade Level Range

Intermediate, Middle School, High School

Illustrative Instructional Objective

Learners will gain experience in choosing, planning, and actively implementing a solution to an environmental problem which is relevant to their lives and will learn the skills of self evaluation.

EYC enables students to have a greater understanding of the legislative process and parliamentary procedure. When the EYC convenes near Earth Day, the delegates discuss environmental concerns by sharing their views and by giving suggestions to other delegates. As a result of this experience, the young people are better educated and have been empowered to make a difference in the community. EYC delegates participate in a variety of activities which increase their level of environmental awareness as well as assist in leadership development.

Perceptions held by youth regarding environmental issues are profoundly influenced by the way in which these issues are presented. The EYC described in this episode has been held for four years and youth delegates have consistently received positive responses from their schools. These delegates have assumed a leadership role in their community to solve environmental problems. Instead of giving youth delegates a pessimistic report on the state of the environment, the EYC process gives delegates skills to analyze and solve environmental concerns.

Procedure

The following outlines the logistical steps for organizing and holding an EYC.

1. The EYC Committee

A committee is necessary to provide guidance for the EYC and to interpret environmental issues for the youth delegates. Members are recruited for the committee from school systems (teachers and students), soil and water conservation districts, Boy Scouts and Girl Scouts, park districts, litter control and solid waste agencies, local National Audubon Society chapters, and local museums and nature centers. The committee meets regularly to establish the format of the EYC and plan a variety of activities for the delegates.

2. Identification of Delegates

EYC delegates are identified for an entire school year and participate in various activities which culminate in a reporting meeting (the Congress) near Earth Day. The EYC committee establishes a timeline for activities, and then generates information about registration and sends permission forms to schools. Each school may designate a delegation of no more than four students from each school. In the EYC being described students in grades 5-8 participated but other grade level configurations could be used. Each school must have at least one adult who will act as advisor for the delegations. Participation in the year-long EYC is both an honor and responsibility. Past EYC delegates may apply to chair the EYC. Chair applications are submitted to the EYC committee and the committee interviews candidates. Selection of delegates may be based on following criteria:

- Completion of an application form designed by the EYC committee.
- Composition of an essay on local issues.
- Interview with applicants on local issues.
- Creation of a poster on a local issue.
- Completion of a project on a local issue.
- Recommendation by parent and/or teacher.

3. Background for Delegates

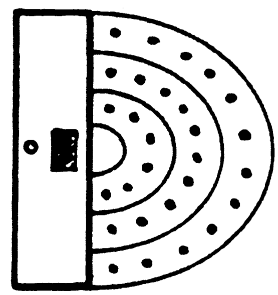
A workshop is organized for the advisors who assist delegates with activities at their schools. The committee also organizes an overnight workshop for advisors and delegates to explore activities which will help identify and solve environmental problems at the schools. Delegates learn hands-on teaching techniques for environmental issues. Delegates participate in group cooperation activities to learn to trust and communicate with each other. The keynote event for the overnight workshop is a simulation activity which evaluates community reaction to a proposed highway construction project in the county. Delegates divide into groups representing various interest groups—production agriculture, environment, business, regional planning, engineering and government. Each group works with an adult mentor who is familiar with this area of the community. The purpose of the simulation is to place delegates in the role of reviewing a community project from a variety of perspectives and weighing the impact of their decisions on threatened ecosystems. After attending the overnight workshop, delegates conduct surveys with their peers and share activities which focus on local environmental issues and possible steps toward solutions.

4. Field Trips

The EYC committee plans field trips which enable delegates and advisors to visit areas which are impacted by environmental concerns. Delegates investigate local environmental issues by visiting threatened habitats in their community. At the conclusion of the field trips, delegates write environmental resolutions based upon their discoveries and desire to solve these problems.

5. Resolutions and Action

The EYC committee records the resolutions and sends them to the participating schools. This document is a compelling statement by youth to other youth and adults about perceptions of the state of the environment and what should be done. The process does not stop with this document, it provides another jumping-off point for further actions by the delegates and their peers. Armed with resolutions, delegates lead their schools and communities to action for the improvement of the environment.



6. Holding the Congress

In April, on or near Earth Day, EYC delegates convene the formal congress, discuss how their schools reacted to the resolutions, and report on their schools' initiatives to solve issues. Delegates are seated by school district. The EYC Chair opens the EYC and recognizes delegations to speak. A state legislative leader welcomes and commends the delegates for their hard work. The following are examples of schools' initiatives which have been presented at the Congress:

- Purchasing and planting seedlings
- Purchasing one acre of wetlands and building a boardwalk through it
- Building blue bird boxes and placing them on a monitored trail
- Adopting an animal at a raptor rehabilitation center
- Undertaking an effort to stop the use of hair spray in locker rooms
- Numerous recycling efforts, including starting a school club to collect trash from the woods and creek for recycling
- Action to stop the use of styrofoam in the school cafeteria

Assessment

This learning episode should be evaluated by the following groups of people:

- The EYC committee
- The EYC delegates
- The EYC advisors
- Participants in the environmental action projects.

The evaluation should consider:

1. Did participants like the Environmental Youth Congress? This may be determined by using questionnaires and/or interviews.

2. Did participants learn the desired knowledge, skills, and/or attitudes as described in the learning objectives or determined by the project? This may be determined by observing skills demonstrations, observing and/or monitoring progress on tasks, using self-reports, and/or interviews.

3. Do participants use the skills acquired/enhanced through the learning episode? This may be determined by using follow-up surveys, task-performance evaluations by self or others, journals and project record/logs, and/or peer interviews.

References

Developed by Aullwood Audobon Center & Farm in cooperation with Miami Valley Earth Central. For more information contact Miami Valley Earth Central P.O. Box 401, Spring Valley, OH 45370.

EVERYBODY NEEDS A HOME

Overview

Learners explore various aspects of a habitat for animals and for themselves. This learning episode also models how to adapt an activity from an existing environmental education program. (In this case, the activity was adapted from Project WILD).

Grade Level Range

Primary

Illustrative Instructional Objective

Learners will seek information from many different sources to explore the varied needs of living things and the different ways in which living things meet their needs, and then construct models of homes while working in small and large groups.

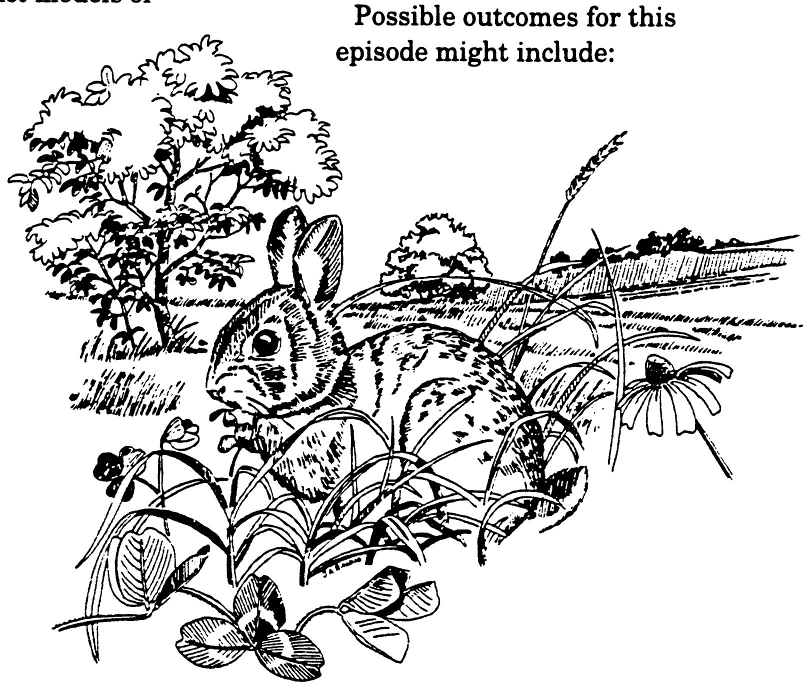
Background

Humans, other animals and plants have basic needs in order to live: food, water, shelter, space and usually light. Every living thing needs a home but that home is not just a "house." Homes for animals are often big areas and are outdoors; plant "homes" are places that provide the right amount of light, water, space, and food. A "home" has everything an animal or plant needs to live. It is also called a habitat. The main purpose of this activity is for learners to understand that every living thing needs a home or habitat.

One part of a habitat is the actual place something lives. Humans build houses, apartments, trailers, and other kinds of shelter in which to live. Animals don't need a home that looks like a house but they do need some kind of shelter. Animal shelters might be underground, in a bush, among rocks, or inside the bark of a tree.

A home or habitat is more than a "house" (shelter) and includes an entire area within which all the plant's or animal's needs can be met. Perhaps the concept of "neighborhood" could help the learners understand the idea. Care should be taken to help the learners equate *home* or *neighborhood* with habitat and *house* with shelter.

Possible outcomes for this episode might include:



1. Learners develop an understanding that all living things need a "home" and that there are usually several necessary conditions that need to be present in order for a living thing to survive in that home.

2. Learners observe similarities and differences among the characteristics of various plant and animal homes.

3. Learners further develop the idea that a "whole" is made up of "parts."

4. Learners improve verbal communication skills through the sharing of their observations.

Procedure

1. Share a story about one animal in its habitat and discuss how it satisfies its needs for food, water, shelter, space and light.

2. Ask learners to collect pictures of plant and animal (including human) homes.

3. Lead a class discussion about homes or habitats, houses, and the needs of plants and animals. This should generate a list of what they already know and a list of what they would like to find out.

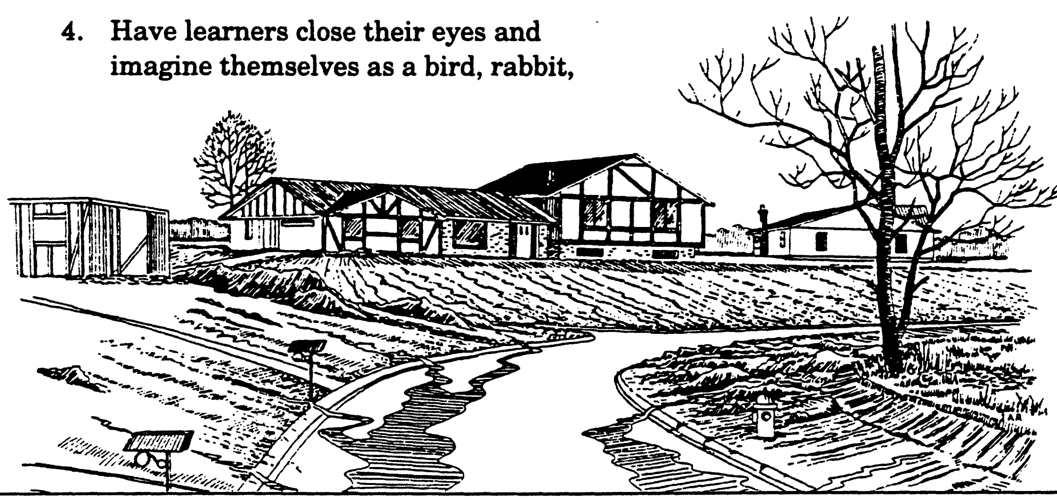
4. Have learners close their eyes and imagine themselves as a bird, rabbit, turtle or some other animal and visualize their "home" (habitat) and the kinds of activity they might engage in: food gathering, drinking water, keeping away from prey, family building activities. This can be repeated several times over a period of time and should include animals, plants and humans.

5. Ask learners to point out similarities and differences among the animal, plant, and human homes (habitats) they have envisioned. They can do this in small groups. The groups can also discuss what living things need (food, water, shelter, space and light).

6. Have the learners share the pictures they collected of different places where people, other animals and plants live. Can they point out or describe the required needs of a plant or animal? Compare neighborhoods to a habitat.

7. Ask learners to draw a picture of where they live. Have them include in their drawings all they need to survive (where do they sleep, keep food, play, etc.)

8. Lead a discussion about how the school building and the school grounds provide all their needs during the day: food, water, shelter, space for learning, recreation, exercise, and light.



9. With learners, plan for trips to nearby places to visit (school yard, local park, woods, etc.) to take a closer look at habitats of other living things.

10. Extensions: Teach songs about habitats and homes, for example "The Habitat Song" by Bill Oliver. Make clay models of animal homes. Draw pictures, create a skit, write a story. Verbally communicate about a habitat.

Assessment

1. Choose several "habitat" pictures and ask learners to point out where the inhabitant would find food, water, shelter, space and light.

2. Have learners sort the habitat pictures according to different components of habitat (e.g., which habitats have the most water, greatest amount of light, best shelter, etc.)

3. Allow groups of learners to create shopping lists of items needed for their habitat, with each group representing a different plant or animal.

4. Have learners create a collage of items needed to provide adequate habitat for a certain plant or animal.

5. Draw a rough map of the school yard or nearby park and have learners identify possible sites that could provide adequate habitat for specific plants or animals. Pictures of the plants or animals could be drawn on the map to show where they would be most likely to live.

Materials

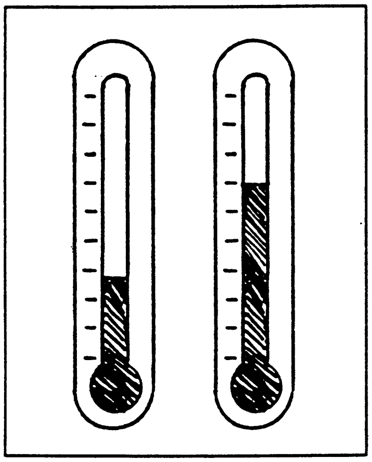
- Pictures of homes
- Drawing paper

References

Adapted from:

"Everybody Needs a Home," Project WILD, (1992), Western Regional Environmental Education Council, Boulder CO.

HABITAT HIGH-LOW



Overview

This episode engages learners in investigating and comparing the physical factors of a habitat (i.e., light, moisture, heat, wind, etc.). Learners think about the factors that make a place comfortable to them and then use their senses to measure the intensity of those factors in various areas around their school grounds. The episode also demonstrates how an activity from existing environmental education programs can be adapted and extended.

Grade Level Range

Primary

Illustrative Instructional Objective

Learners will recognize the limitations and variability of human senses to describe physical factors, discuss factors that affect change in organisms, describe and use instruments to extend the senses, and tell stories about animal preferences.

Background

Habitats can be divided into two parts: the things that are alive and growing like animals and plants, and physical features like sunlight, moisture, heat, and wind. Although the living aspects of a habitat certainly affect an organism, this activity focuses on the nonliving, or physical factors, of habitats. Physical factors of a habitat include the amount of light, moisture, heat, and wind found in a specific area. These factors greatly influence the suitability of an area for particular organisms.

Humans employ devices like light meters, thermometers, and anemometers (wind speed instruments) to help improve the accuracy of their senses. By having learners use their own senses to determine differences in light, moisture, heat, and wind, this activity will help learners be more sensitive to the physical factors that influence habitats.

The following is the major outcome of the episode: Given five study sites, learners will indicate which sites have the most and least amount of sunlight, moisture, heat, and wind as a way to describe differences among the sites.

Procedure

Ask learners "If you could live anywhere, where would you live?" They can draw a picture of their dream place. Have a group discussion about physical factors that make a place desirable in which to live. Ask what they like about the place they chose. Which of the things they like are living? Non-living? Have learners share their drawings with one another and note what things are similar, different (e.g., sunlight, wind, temperatures, moisture, living things). Have learners discuss and map areas around the school grounds to look at and measure for differences (least & most).

As a group, select and mark the boundaries of five areas to investigate.

The areas should be different (one windy, one sunny, one dry, etc.).

1. The learners can work in teams with each team having a different factor (wet/dry, hot/cold, etc.) to investigate in all five areas.
2. Each team should make a "most" and "least" sign for their factor to place in each area.
3. Review if necessary, terms used by comparing in the classroom (i.e., hottest near the radiator).

Teams are now ready for the High-Low Hunt. Each team will explore the five areas and choose the extreme "high" and "low" place for their factor in each area. Once they have chosen the places in each area (most/least) for their factor they can mark them with their cards.

When all teams are through, go back as a class and see how many markers of each type are in particular places in each area. What senses were used? What place in the areas would they most like to be? Have each pick their "spot." Would they choose that spot on a "rainy" day or warmer day? Where were the animal "spots" in their areas. Do animals have spots they prefer (e.g., sowbugs under logs, cats in the sun)? Are there animals that like the same places you do? What non-living (physical) factors made their "spot" special (sunny, shady, etc.). Additional questions: What do they think are the most important factors? Do animals prefer one factor over another?

Assessment

1. Have learners draw a picture of their spot including all the physical highs/lows. Seasonal pictures could be drawn to show how habitat changes with the seasons.
2. Make a 5" x 7" card for each of the five areas, and have learners sort the cards in order of highs and lows for each of the physical factors.
3. Have learners tell a short story as though they were an animal living in one of the specific five study sites, bringing in how the physical features help or challenge them to survive.
4. Ask learners to complete this sentence. "I would like to live in the forest (or desert, ocean, pond, wetland, etc.) because ...."
5. Using arts and crafts supplies, allow learners to design an ideal habitat and discuss the physical features that make it special to them.

Materials

- Drawing paper
- High/Low markers
- Boundary markers

References

Adapted from:

Outdoor Biology Instructional Strategies (OBIS), "High and Low Hunt." Delta Education, Nashua NH.

A HANDFUL OF MUD

Overview

A literary excerpt is used as an introduction to soil erosion. Learners relate the experience of a boy in India to soil erosion and conservation practices in their own culture. The story becomes a springboard for investigations in the classroom or field.

Grade Level Range

Intermediate, Middle School

Illustrative Instructional Objective

Learners will utilize the mud story as an analogy to understand how soil erosion occurs in other environments, investigate soil as a nonrenewable resource and strategies for managing it, visit sites where erosion occurs, and then design, build, and test working models which reduce erosion.

Procedure

Share the following excerpt from "A Handful of Mud" by Paul W. Brand with the learners.

I grew up in the mountains of South India. My parents were missionaries to the tribal people of the hills. Our own life was about as simple as it could be, and as happy. There were no roads. We never saw a wheeled vehicle except on our annual visit to the plains. There were no stores, and we had no electricity and no plumbing. My sister and I ran barefoot, and we made up our own games with the trees and sticks and stones around us.

Our playmates were the Indian boys and girls, and our life was much the same as theirs. We absorbed a great deal of their outlook and philosophy, even while our parents were teaching them to read and write and to use some of the tools from the West.

The villagers grew everything that they ate, and rice was an important food for all of us. The problem was that rice needs flooded fields in the early stages of growth, and there was no level ground for wet cultivation. So rice was grown all along the course of streams that ran down gentle slopes. These slopes had been patiently terraced hundreds of years before, and now every terrace was perfectly level and bordered at its lower margin by an earthen dam covered with grass. Each narrow dam served as a footpath across the line of terraces, with a level field of mud and water six inches below its upper edge and another level terrace two feet below.

There were no steep or high drop-offs, so there was little danger of collapse. If the land sloped steeply in one area, then the terraces would be very narrow — perhaps only three of four feet wide. In other areas where the land sloped very little, the terraces would be very broad. Every one of the narrow earth dams followed exactly the line of the contours of the slope.

Every few feet along each grassy path were little channels cut across the top of the dam for water to trickle over to the fields below. These channels were lined with grass and were blocked by a grassy sod that the farmer could easily adjust with his foot to regulate the flow of water.

Since each terrace was usually owned by a different family, it was important to have some senior village elder who would decide whether one farmer was getting too much or too little of the precious water supply.

Those rice paddies were a rich soup of life. When there was plenty of water, there would be a lot of frogs and little fish. Herons and egrets would stalk through the paddy fields on their long legs and enjoy the feast of little wrigglers that they caught with unerring plunges of their long beaks. Kingfishers would swoop down with a flash of color and carry off a fish

from under the beak of a heron. And not only the birds enjoyed the life of the paddies — we boys did too. It was there that I learned my first lesson on conservation.

One day I was playing in the mud of a rice field with a half-dozen other boys. We were catching frogs, racing to see who would be first to get there. It was a wonderful way to get dirty from head to foot in the shortest possible time. But suddenly we were all scrambling to get out of the paddy.

One of the boys had spotted an old man walking across the path toward us. We all knew him and called "Tata," meaning "Grandpa." He was the keeper of the dams. He walked slowly, stooped over a bit, as though he was always looking at the ground. Old age is very much respected in India, and we boys shuffled our feet and waited in silence for what we knew was going to be a rebuke.

He came over to us and asked us what we were doing. "Catching frogs," we answered. He stared down at the churned-up mud and flattened rice plants in the corner where we had been playing and I was expecting him to talk about the rice seedlings we had spoiled. Instead, he stooped and scooped up a handful of mud. "What is this?" he asked.

The biggest boy among us took the responsibility of answering for us all. "It's mud, Tata."

"Whose mud is it?" the old man asked.

"It's your mud, Tata. It's your field."

Then the old man turned and looked across the dam. "What do you see there in that channel?" he asked.

"That is water running over into the lower field," the biggest boy answered.

For the first time, Tata looked angry. "Come with me and I will show you water."

We followed him a few steps along the dam, and he pointed to the next channel, where clear water was running. "That is what water looks like," he said. Then he led us back to our nearest channel and said, "Is that water?"

We hung our heads. "No, Tata, that is mud—muddy water," the oldest boy answered. He had heard of all this before and did not want to prolong the question-and-answer session, so he hurried on. "And the mud from your field is being carried away to the field below, and it will never come back, because mud always runs downhill, never up again. We are sorry, Tata, and we will never do this again."

But Tata was not ready to stop his lesson as quickly as that, so he went on to tell us that just one handful of mud would grow enough rice for one meal for one person, and it would do it twice every year for years and years into the future.

"That mud flowing over the dam has given my family food every year from long before I was born, and before my grandfather was born. It would have given my grandchildren food, and then given their grandchildren food forever. Now it will never feed us again. When you see mud in the channels of water, you know that life is flowing away from the mountain."

The old man walked slowly back across the path, pausing a moment to adjust with his foot the grass clod in our muddy channel so that no more water flowed through it. We were silent and uncomfortable as we went off to find some other place to play. I had gotten a dose of traditional Indian folk education that would remain with me as long as I lived. Soil was my life, and every generation was responsible for preserving it for future generations.

Discussion: After reading this excerpt, learners generate questions raised by the excerpt and discuss them. Some possibilities include:

1. What are the mechanics of topsoil erosion?

2. What are the various implications of topsoil erosion (both on land and as a source of nonpoint water pollution)?

3. How does the South Indian culture's attitude toward topsoil compare or contrast with that of the learners' home culture?

4. Given the renewable/non-renewable nature of soil, what types of management strategies would be most effective?

Possible routes to take: Depending on the questions raised through the above discussion of the story, investigations such as the following could be designed to focus the learning experience:

- Through simulation or actual field observations, explore various situations where soil is being eroded. Look for similarities and differences in the situations.
- Design several tests to reflect actions described in the story that caused or prevented soil runoff (i.e., terracing, sodding, sedimentation).
- Use contour and other types of maps to identify watersheds and track where a drop of water in a stream near you can actually end up.
- Interview local agricultural leaders (i.e., farmers, soil conservationists, geologists or urban planners) to gather information about local attitudes toward soil conservation. Compare those attitudes to those expressed in the story.
- Plan and implement a service project to stop erosion at a local site (e.g., a park or school site).
- Learners from the small groups share with the class the information they have gathered from their initial investigations. Groups then design service projects based on their investigation and the feedback from their presentation.

Assessment

- ❑ A "visual" presentation of the group's plan for a service project to stop erosion at a local site.
- ❑ After implementation of the service project, evaluate the experience using questions such as the following:
  1. Do you believe your project was successful? Why?
  2. What would you do differently if you could repeat your project?

3. What have you learned about soil, erosion and nonpoint source pollution from the project?

4. What was the single most important thing that allowed you to complete the project? Why was that most important?

Materials

Will vary depending on activities chosen.

References

Grantberg-Michaelson, W. (1987). A handful of mud. In P.W. Brand (Ed.), Tending the garden. Grand Rapids, MI: Eerdmans Publishing. Co.

INVESTIGATING BROWNING EVERGREENS

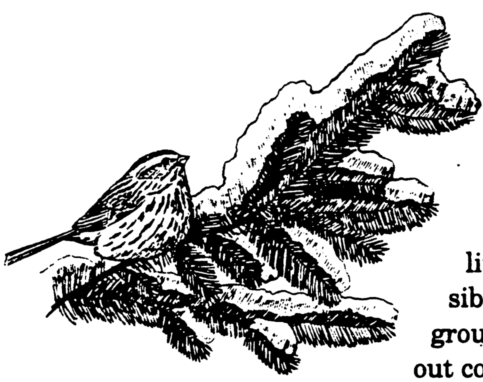
Overview

This learning episode examines a phenomenon commonly observed along Ohio's highways—dying evergreens. Through brainstorming, learners generate various possible reasons for this occurrence and then divide into teams to investigate the validity of those reasons. A final reporting by teams and synthesis of the information by the class can lead to further study or strategies for correcting the problem.

Grade Level Range

High School

Illustrative Instructional Objective



Learners will generate testable hypotheses, investigate physical and chemical changes in living and non-living systems, fulfill responsibilities as part of a research group, and propose and carry out courses of action based on scientific principles reviewed during the evergreen project.

Background

The purpose of this activity is for students to plan and complete an investigation of the causes for the browning of evergreens. The following areas can be addressed through the episode:

Biology Topics: plant life, soil
Chemistry Topics: salt and substitutes, fuels & exhaust, soil, asphalt
Physics Topics: temperature depression, splash distance, temperature & materials, friction
Earth Science Topics: highway cuts, weather, freeze - thaw tolerance, temperature changes

Procedure

Pose the challenge

Each spring as we drive along highways, we can see extensive browning of the needles on evergreen trees. There might be multiple causes for the browning of the trees and the task is for you to investigate possible causes and recommend actions to reduce the damage.

Planning the Study

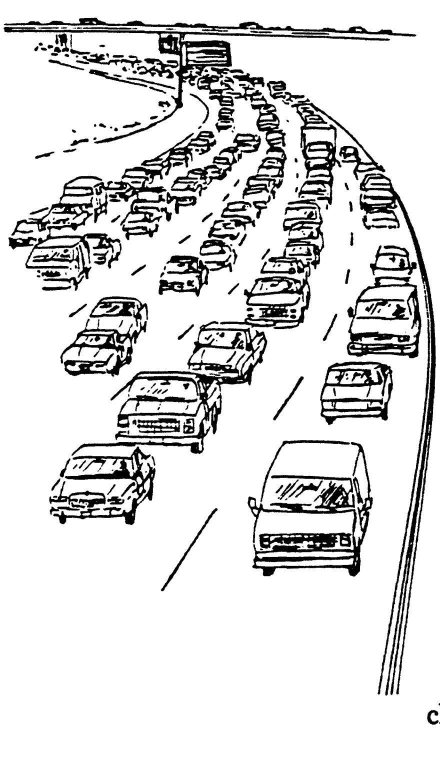
This learning episode provides a valuable opportunity for leaders and learners to practice divergent hypothesizing about a real-world problem. Initial discussions of conditions that may have caused browning should occur and be rich in ideas. Learners might suggest causes including: heavy highway traffic, nonpoint source pollutants in stormwater runoff, salting highways to reduce accidents, air pollution factors, plant growth, severity of weather temperatures, amounts of snow and ice during the winter, etc.

After a long list is generated, the class should devise a plan for taking and recording field observations and selecting observation sites. (Be sure to follow safety considerations noted later in this section.) The leader should again encourage divergent hypothesizing. Determine how to compare "normal" trees in the region to browned ones. Develop data collection sheets if appropriate.

Learners should decide what aspects concerning the browning evergreen needles to study. The following aspects might be included:

- Tree species involved
- Location (location of the tree & location on the tree)
- Extent of whole or part of the tree browning
- Observation of new growth and recovery
- Description of plant life near the tree

Next, learners should determine where additional information on this problem can be found and what experts can be contacted. (At some point the leader should consider inviting guest speakers such as experts on agriculture, nonpoint source pollution, botany, horticulture, forestry, highway maintenance and meteorology.) If conclusions and agreements about the cause of the browning emerge from the learners' studies, determine how and to whom the information should be reported. Does the class need to think about a second year study or third year study?



At this point, it should be clear that a thorough study will demand a great deal of work. Thus, the team approach should be suggested as one way to distribute the workload and responsibilities for data collection. This method is commonly used by scientists and the study of browning evergreens is an effective way to practice the method.

Discussion should also focus on how to compare observations by different teams and different individuals. Criteria for information to be shared by teams can be designed by the whole group or by individual teams. Suggestions may include oral reports which can use pictures, slides, evergreen needle samples, maps, interviews with experts, scientific reports, pamphlets from horticultural sources, etc. The leader and learners should also decide about any requirements for written reports.

Doing the Study

The leader or learners should decide on the make-up of teams and a timeline. Tasks should be determined by each team before the start of the project. Additionally, each team should review the group's ideas and suggestions and then design specific data collection activities which might be needed for their particular team. The review of activities and procedures within a team should be continuous. Evolution of original tasks and plans toward more interesting and efficient ones is expected, but an initial plan and any changes should be "cleared" by the leader.

Possible team tasks include:

Team One: Document normal appearance of evergreens in the spring as opposed to those appearing brown. Find the geographic range of certain evergreen species and other living conditions needed.

Team Two: Research weather patterns during the past winter. Include number of centimeters of snowfall, rain, ice, temperatures, winds, etc.

Team Three: Conduct traffic volume studies for a number of highways or streets where "damaged" trees are observed. What kinds of traffic? (truck, residential, business district, general, etc.).

Team Four: Study highway treatment—type (salt, ash, plowing, etc.) and frequency. Who is responsible (municipal, county, state)? Has there been community sentiment about the type and frequency of treatment or lack of it voiced in local newspapers?

Team Five: Search for and suggest possible factors not mentioned (soil erosion, nonpoint source pollutants contained in runoff from streets, elevation of trees, vehicle exhausts, acid rain,.....let students make suggestions and pursue them).

Team Six: Search areas away from highways to determine conditions of evergreen trees where human impact is minimal.

Additional notes to the leader:

- Safety is a concern if students need to examine browning evergreens along busy highways. Plan ahead for this problem depending on your location. Possible strategies might include:

  1. Find damaged trees along less heavily traveled roads and use those for the study.
  2. Focus as much as possible on lab research and connections with resource people such as urban foresters and do a minimum of field observation and testing.
  3. Bring small trees into the classroom to test for various factors.
  4. Involve students in setting parameters for appropriate safe behavior (including consequences for unsafe actions) prior to the field work, if study is to be conducted along a busy highway. The highway department or state highway patrol also might assist with safety.

- This episode will help students understand the long-term nature of some scientific research. It could be used as a year-to-year study with each successive class drawing conclusions possible at that point and building data and background for successive classes to use in their studies.

Reports and Summary

Showcase the team reports if possible and include an opportunity for a full group summary. Re-address earlier concerns about dissemination of findings and possible action by individuals and groups. Other questions include:

Is research being done to find more resistant species?

How should replacement, treatment, etc. of the evergreens be funded?

Are there alternatives to using evergreens near the highways?

Will damaged trees recover?

Recruit other classes to participate in a study on browning evergreens and share data through E-mail systems.

Assessment

Some or all of the following strategies might be used to assess the project.

Portfolio Assessment

Contents of portfolio might include:

1. Notes, calculations, references, tables, sketches, etc., from in-school activities
2. Notes, photos, drawings, videos, etc., from out-of-school activities (at field sites)
3. Collections/critiques of related articles
4. Collection of team's (and other teams') work

Performance Assessment

Possible areas to assess include:

1. Overall participation in groups
2. Level of appropriate questions, suggestions and contributions to the group in a variety of situations
3. Reports of research and findings brought in (oral, photos, video...)
4. Interactions with guest speakers, teachers, and other groups
5. Demonstration of creative thought for further scientific questions to ask or hypotheses to offer

Student Writings

Types of writing which might be used include:

1. Objective questions or problems on the topic as learned through the project that had been discussed/presented/studied in class or at field sites during the project study. (These questions might be written by the students themselves)
2. Progress reports and/or final conclusions of the project which could be submitted by groups or individuals at intervals throughout or at end of project—or both.
3. Open-ended questions to assess whether the students can express full understanding of the project as well as a vision for further study or solutions to the problem of browning evergreens.

Rubrics

For the progress report/conclusion part of the project, a possible rubric to help evaluate student achievement in the Investigating Browning Evergreen project follows. Other rubrics could be developed for other parts of the projects.

Materials

Will vary according to activities chosen.

PERFORMANCE OUTCOMES

Level of Achievement	Organization	Content/Information	Mechanics Usage Grammar Spelling
4 Expert	- meets all requirements - flow is exceptional - outstanding neatness, legible	- answered more than required questions precisely/ consisely (exceptional description) - variety of resources (beyond requirement)	- no errors
3 Proficient	- meets most of requirements in order - flow makes sense - neat, legible	- answered all required questions	- few errors
2 Apprentice	- meets some requirements - flow lacks continuity - is legible	- answered some of required questions - used some sources	- errors do not interfere with meaning
1 Novice	- does not flow - barely legible	- answered few or none of required questions - used no reference sources	- errors interfere with meaning
0 No "credit"	- no attempt	- no attempt	- no attempt

LAND RESOURCES

Overview

A hypothetical environmental dilemma is used to engage learners in an integrated, activity-based exploration of their local land environment and its resources. Learner-and leader-generated activities move the group toward solving the problem of a contaminated water well field. Although a specific issue is used in this episode, other issues from a variety of locations and situations could be substituted.

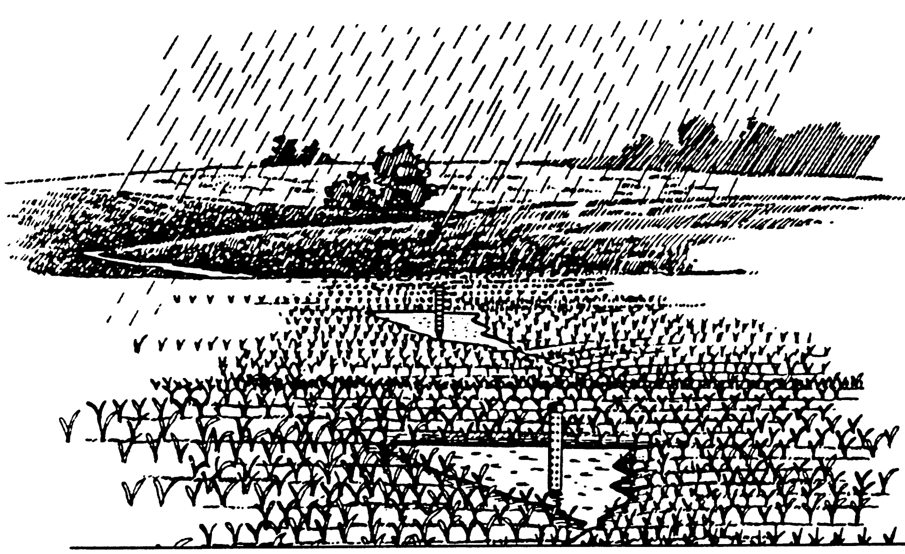
ASKING QUESTIONS

Grade Level Range

Middle School, High School

Illustrative Instructional Objective

Learners will discuss societal concerns, investigate ideas for short-term and long-term solutions, listen to and analyze evidence presented by others, and share ideas for resolving land use issues.



Procedure

Present the Dilemma:

Our town's water well field is contaminated with pollutants. This pollution is the result of our old landfill leaking. What can be done to correct the current problem and what actions are needed to prevent future contamination of the water well field?

Brainstorming and webbing session:

Following the introduction of the dilemma, a whole class brainstorming session is conducted. Typically, the leader can begin the process by prompting the learners with a question such as "What do we need to know to better understand and make decisions about this dilemma?" During this process, the leader should participate in a guidance capacity only. Through brainstorming and the subsequent webbing activity, learners will generate a subset of questions related to the main dilemma. The leader and learners may then link meaningful activities to the questions and thus move the learners towards a possible solution to the dilemma.

Learner Generated Questions/ Activities:

The following are examples of questions which were identified and possible learning activities used to help answer the questions. This set of questions has been arranged in a general-to-specific framework.

1. What is land and how were soil and rocks formed?

Activities:

- Take a soil sample and analyze its basic composition.
- Determine how the soil and geology of the area came into existence (weathering, glaciation, etc.).
- Make a soil/geology map of the local area.
- Utilize the county Soil and Water Conservation District representative as a resource (each county has a soil survey guide that is very useful).
- Determine the chemical and physical properties of earth/soil/geological layers. (This is an excellent place to explore basic science areas such as: elements, compounds, mixtures, the periodic table, reactivities, solubilities, metals, nonmetals, metalloid, conservation of matter, balancing equations, and basic mineralogy).
- Use topographic maps to determine the basic land forms of the local area as well as drainage patterns.
- Use land resource maps to determine the land resource of their local area. (This is an excellent place to discuss and explore natural resources and how we utilize them).
- Take a field trip to a strip mine. Many owners are more than happy to share the process of mining and the trip reinforces the concepts of land/soil/geology structure.

2. How do we get water in our community?

Activities:

- Learn about sub-surface hydrogeology.

  (This is an excellent place to teach learners about aquifers, ground water, water tables, springs, etc).
- Conduct investigations of porosity and permeability.
- Take a field trip to the local water treatment and sewage treatment plants.
- Conduct some simple chemical water testing (pH, alkalinity, iron, hardness, etc.).
- Explore sources of nonpoint water pollution and their effect on water resources.

3. What is a landfill?

Activities:

- Discuss historical, present and future management of different kinds of landfills.
- Determine what types of materials go into a landfill.
- Do a trash analysis, and compare the advantages of reducing, reusing, and recycling.
- Take an environmental shopping trip.
- Build landfills using two-liter bottles.
- Take a field trip to a local landfill. Most learners have no idea what happens to their trash.

  (Excellent resources for these activities are *Super-Saver Investigator* and *Investigating Solid Waste Issues* produced by the Ohio Department of Natural Resources.)

4. What processes go on in a landfill to change the materials chemically and physically?

Activities:

- Learn about decomposition by monitoring the 2-liter bottle landfills.

  (This is a good place to learn about decomposers, biodegradable vs. non-biodegradable, anaerobic vs. aerobic, chemical reactions, etc.)

5. What do we do with the old landfill?

Activities:

- Research how other communities have handled the problem (sealing vs. removing the materials) and present a position paper.
- Contact an environmental group, the EPA, and a local waste disposal company for technical and cost information. Compare and contrast the information from each source.

6. Where can we put a new landfill?

Activities:

- Determine a site for a new landfill based on soil profiles, land use, ground water, community perceptions, etc. Propose a design that is both cost effective and environmentally safe.
- Invite the Ohio EPA, Ohio Department of Natural Resources and a local waste disposal company to speak about the processes they go through to establish new landfills. Have them help evaluate the site designs proposed by the class.

  (This section could be used as a culminating activity.)

Assessment

As the primary assessment, learners present their landfill site designs to their peers and if possible, to a panel of EPA and/or ODNR staff. Additional evaluation activities could include developing real-life uses for the information they have collected, such as:

- ❑ Designing advertising campaigns to convince local citizens to move the damaging landfill.
- ❑ Identifying several ways that learners could change their daily habits to reduce the impact they have on landfills and the environment and then promoting these ideas schoolwide.
- ❑ Initiating recycling programs at school that stress the concepts of reducing and reusing.

Materials

Will vary depending on activities chosen.

References

Landis, D. (1994). Investigating Solid Waste Issues. Ohio Department of Natural Resources. Columbus OH.

Landis, D. (1990). Super Saver Investigators. Ohio Department of Natural Resources, Columbus OH.

LET'S TRY OUR OWN BIOSPHERE II

Overview

This episode simulates, on a classroom scale, the 1991-1993 Biosphere II experiment in Oracle, Arizona. A variety of possible activities is offered from which learners and leaders can construct a version of the Biosphere experiment that is tailored to their own situation.

Grade Level Range

Middle School, High School

Illustrative Instructional Objective

Learners will determine effectiveness of a model by identifying contributing and causal factors, and investigate strategies that can be used to improve more efficient interaction between the various components of systems.

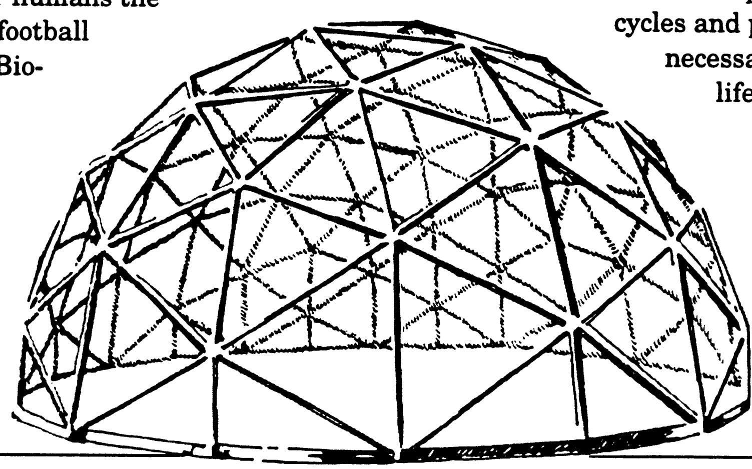
Background

At sunrise on September 26, 1991, four male and four female scientists enclosed themselves for two years in a terrarium for humans the size of three football fields called Biosphere II. Biosphere II was an attempt to model the systems and cycles on Biosphere I — the Earth. The self-sustaining geodesic dome became a sealed environment, isolating the scientists from the rest of the world.

Biosphere II was developed by Biosphere Space Ventures in Oracle, Arizona to help understand the complex interrelationships found on the planet (Biosphere I), and to gain the knowledge needed to design and build a self-sustained living environment for future space exploration and settlement. It has been called "the workshop for humanity's future."

This stationary ark cost over $150 million to build. It is intended to have a research life of 100 years. In it is a human habitat with computers, laboratories, videos, and a communication network linked to the rest of the world. Under a glass, Mayan-type pyramid is a rain forest with a 90-foot waterfall. The ocean is 25 feet deep and is complete with artificial tides. Like on Biosphere I, the marsh filters and cleans up wastes. The green grasses on the savanna contribute to oxygen production. The plants of the desert plains are valuable in this function during the dormancy of the savanna plants. The Biospherians have a farm to provide food.

The goal of the project is for the scientists to explore those cycles and processes necessary to sustain life and to gain information useful in maintaining life on Biosphere I.



Procedure

Based on the actual endeavor, students will assume the role of the Biospherians, researchers, biologists, systems technicians, Biosphere Space Ventures executives, publicity and promotion specialists, botanists and other support personnel as is decided upon by the learners. The eight original Biospherians were titled: Co-Captain; Technical Systems Manager; Terrestrial Biomes Manager; Marine Biomes Director; Medical Officer; Analytical Systems Manager; Communications Officer; and Intensive Agricultural Systems Manager. The educator may want to be the CEO of Biosphere Space Ventures.

Through the use of the video, "Biosphere II: The Human Experiment: (SBV, 1991) and/or *The Glass Ark: Story of Biosphere II* by Gentry and Karen Liptak (Viking), the educator will set the stage and announce that the class has been offered the opportunity to undertake the same experiment by simulating the experience using their own classroom in Ohio as Biosphere II. They will be working cooperatively to prepare and decide what needs to be done to make the project work. The simulation can go as far as the educator and learners wish.

It is suggested that with each of the roles available for adoption by each learner or learner group, the educator provide a set of prescribed and/or optional requirements. These may include, but are not limited to, research assignments, suggested readings, designs and inventions, and hands-on activities. These may be drawn from the sampling of activities below or maybe generated by the learners and leaders.

Sampling of student activities: The idea of eight humans living in a sealed, self-sustaining environment opens a realm of possibilities for classroom activities. Some are listed below.

1. Have class groups take the role of Director of Terrestrial Ecosystems or Director of Aquatic Ecosystems. The groups will assume the responsibility for designing the pod their biome occupies (create a scale model, drawing, or make a diorama) and "stock" it with all the plant and animal elements necessary for it to be self-sustaining. Learners will identify all the food webs/chains within each biome.

2. In preparation for their two-year stay in the biosphere, ask each scientist to keep track of what they use, need, eat, buy, etc., for one week. Have them multiply this consumption by 104 weeks. Limit the scientists to two suitcases. What will the students bring and what will they leave behind? Which items on their list could be harmful inside the biosphere? What will happen to each article that breaks or is no longer used? Have them design a recycling program that will be used in Biosphere II. Does the project recycling program accommodate everything they wish to bring?

3. What will each student have to do to arrange his or her "affairs" for a two-year absence from day-to-day living?

4. The cost of Biosphere II is expected to be offset by its value as a tourist attraction in the Tucson area. Design a promotional package to encourage tourists to visit the site. Be sure to have a bumper sticker and T-shirt designed for the gift shop. A self-guided interpretive brochure should be available for those tourists not wanting a guided tour. Of course, students need to develop interpretive dialogue to use in their new job as tour guides.

5. Learners can write a letter of application for one of the jobs available at Biosphere II including a resume which will give them the best qualifications for the job they want.

6. The idea of Biosphere II is controversial. Is it science or sensation? It has been dubbed by some as the prototype "fallout shelter" — protection for the wealthy against some future environmental disaster. Take a position on the issue and defend it.

7. Think of the potential inventions that may come from this big experiment. Design an invention useful in Biosphere II.

8. Design a prototype "recycled water/rain machine" for Biosphere II. Supplies needed are: clear plastic container with lid, ice cubes in a plastic bag, gooseneck table light and a cup. Place the cup in the plastic container and fill it with water. Put the lid on the container and turn on the lamp. Arrange the closed plastic system so the light is directly over the cup of water. Observe after two hours. Now put the bag of ice cubes on the lid of the plastic container at the end opposite the cup of water. What happens? On paper, design how you would adapt this to Biosphere II.

9. Set up a speaker symposium of resource people who can visit the classroom to talk about issues related to Biosphere II.

10. Design a send-off ceremony to showcase the day the Biospherians get sealed inside. Use it as a school assembly.

11. How will the students process garbage in Biosphere II?

    Set up a garbage rot experiment where learners can determine what factor best aids in the decomposition of garbage. Use four similar pieces of garbage, (such as lettuce leaf, banana or orange peel) and place each piece in a separate zip lock bag. To one add water, to another add microbe-laden soil, leave the next exposed to sunlight and the last one is the control with no light, water or soil. Label with the variable being tested. Place all bags but the one marked "light," in a dark place. Compare the bags weekly. Learners can use their findings to turn a 2-liter plastic soft drink bottle into a quick-rot chamber to speedily process food wastes.

12. Visit a water treatment plant or sewage treatment plant. Then design a water filtration plant for Biosphere II. Use a 2-liter bottle cut in half. Invert the top into the base to make a funnel for the filtered water collection system. Use "Water Purifiers" from *WOW! The Wonders of Wetlands* to explore natural and chemical/mechanical methods to purify polluted water. From the same source, use "Water We Have Here" to introduce the effects of salinity, temperature, dissolved oxygen and pH on a habitat.

13. Modify Project Learning Tree's Environmental Exchange Box activity to learn about other ecosystems through correspondence or telecommunications.

14. Learn how to test for CO_2 by mixing 100 ml. vinegar with 3 1/2 level teaspoons of baking soda in a bottle. Put a balloon over the bottle opening and shake the bottle. Test for CO_2 collected in the balloon with bromothymol blue.

15. Map where you would go on a collecting expedition to look for "stock" for your habitat. On paper, make travel arrangements and "pack" your suitcase.

16. Learn plant propagation techniques. Draw up a crop plan for the 1/2 acre intensive farming plot. Biospherians planted 156 species of food crops. What would you plant? What would sample meal preparations include? Use your classroom windows as a greenhouse. Duct tape zip lock bags with potting soil (or hydroponic solutions) onto the inside of the window. Experiment with growing plants in them.

17. Design a computer program to keep track of daily environmental conditions within the Biosphere. There are micro-climates within the school building. Observe and record these "weather" conditions.

18. Investigate how a usable air supply will be maintained in Biosphere II. Analyze the roles of plants, animals and micro-organisms. Will the supply have to be supplemented artificially?

19. Identify "green" products that could be used in constructing, decorating, furnishing, and stocking Biosphere II.

20. Study plants and animals of the 5 Biosphere II biomes. A local zoo could be used as a resource.

21. Use Biosphere II as an opportunity to communicate via E-mail with students in other parts of the country to get their views of the controversy associated with Biosphere II and to exchange ideas about Biosphere inventions.

Assessment

Fulfillment of contracts, journals, weekly progress reports, interviews, observations, and portfolios are a few of the tools that can be used to assess learning. As individuals or teams, students can showcase their learning by creating a video documentary about their version of Biosphere II. By using a variety of formats, each learner or group will be responsible for producing a segment directly related to their role in the Biosphere II experiment. To bring closure to the activity, the class might produce a Biosphere II newsletter for the school or take other classes on tours through their classroom mini-biosphere. Using a classroom with a self-contained bathroom (or other alternative solution), students can design a self-sustaining, 24-hour classroom simulation experience as the culminating activity for the learning episode.

Materials

Will vary depending on activities chosen.

References

Space Biosphere Ventures, P.O. Box 689, Oracle, AZ 85623.

WOW! The wonders of wetlands. Environmental Concerns, PO Box P, St. Michaels, MD 21663.

NOT IN OUR SCHOOL YARD

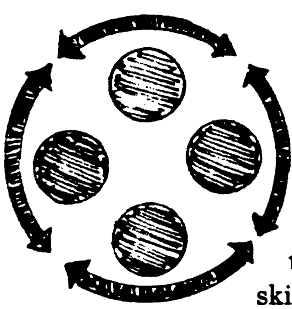
Overview

This episode begins with an inquiry about solid waste, what it is and where it goes. Learners may apply math skills to construct graphs to depict data that is collected regarding various solid waste materials and products. When it becomes apparent that most of our solid waste is put in landfills, the learners are prompted to consider if there is a place on the school property that would make a good location for a landfill and why or why not. The episode also leads learners to promote a reduce, reuse, recycle philosophy as an alternative to landfilling solid waste.

Grade Level Range

Intermediate, Middle School, High School

Illustrative Instructional Objective



Learners will improve their group learning skills, learn about the components of the waste stream, research the local landfill situation, and refine their skills of persuasive presentation of their findings.

Background

Each citizen of the United States, through his or her consumer habits, generates approximately 3-4 pounds of garbage or solid waste each day. Most of this material is buried in landfills, some is incinerated, and some is recycled. By recycling, incineration or purchase of goods that produce less waste, the need for landfill space is reduced. Finding a new location for landfills (siting landfills) is often difficult for communities because of public resistance (the NIMBY or "not in my back yard" syndrome) and because of stringent regulations for the construction of landfills that are designed to prevent pollution problems.

Two potential pollution problems at landfills are the generation of methane gas and a liquid that settles to the bottom called leachate. Various technologies exist to prevent both the problem of explosions as a result of the gas, and also the leaching of contaminated liquid into ground water.

Recycling and reduction practices have many beneficial effects, among which are the saving of natural resources and the land space to bury waste material. Recycling also prevents pollution associated with the mining of resources used in consumer products. Another incentive for recycling is the energy savings associated with using recycled instead of virgin materials in the making of certain products. This energy savings translates into cost savings for industry and energy resources savings for the earth.

Reduction practices, such as eliminating the use of household hazardous products whenever possible by finding alternatives and avoiding purchasing of overpackaged products also lessen the burden on land disposal of solid waste. Not purchasing an item at all should also be considered.

Procedure

Exploring Solid Waste

- Learners may begin by identifying and analyzing products and materials in the waste stream (stages the solid waste goes through from discarding to final destination).

Have students in groups generate their own categories after having made up a list of various consumer items that often end up in the waste stream. Or, various waste items can be collected and brought into class with collections of a variety of products and materials given to each group for observation prior to group categorizing.

Some possible *product* categories might be "durable goods" (appliances, furniture, tires, etc.); "nondurable goods" (newspapers, single serving cups, etc.); "containers and packaging" (bottles, cans, polyfoam clamshells, etc.); "food waste," "yard waste," and "miscellaneous items." Types of *materials* include products classified in the following categories: paper and paper board, metal (ferrous and nonferrous), glass, plastic, food waste, and yard waste.

Using two or more classification schemes, learners may make inferences about the relative percentages of *products* and types of *materials* in the waste stream.

Learners may make inferences about what part of the waste stream is composed of the various items they identified. They might then conduct research and collect data to determine what the literature on solid waste says about the relative percentages of materials in the waste stream.

After researching, learners may utilize various graphing techniques, including piecharts, to present data collected regarding the total waste stream.

Disposing of Solid Waste

- After presenting their waste stream graphs, learners may brainstorm questions and then discuss possible solutions as to the best ways to dispose of waste material which is not diverted from the waste stream through recycling or reduction. Based upon their knowledge of the waste stream, learners may use scientific procedures and information to make appropriate decisions about their solution to the waste stream problem.

Have each group create an experimental procedure that follows the solution brainstormed above (i.e., by making mini landfills) to determine the potential for waste material to change and the potential for pollution to be generated in the process. Learner groups should develop hypotheses, test them and eventually explain the results to the class. Have different types of soils on hand for use in constructing landfills, making provisions for drainage beneath the landfill model.

NOTE: This part of the activity may take several months involving digging up the materials and recording changes in them. To expedite the process, have prepared a mini-model landfill with items that have been buried for several months and unearth them. Have groups continue to monitor their own experiments throughout the year to compare their findings with the model findings, but proceed with the rest of the episode.

Learner groups may conduct research and collect data regarding their solution and make classroom presentations.

- Using the information and knowledge obtained so far, learners should determine if some place on school property would be a good location for a landfill for waste generated by the local community. After brainstorming a specific site, groups can investigate and prepare reports as to the problems and concerns about siting a landfill at this site (e.g., groundwater contamination, aesthetics, odor, litter).

- Learners may then explore an environmental-ethical inquiry. As a closing activity, debate the question: If not at this location on school property, then where should solid waste that is generated by each member of the class be disposed? How should we take responsibility for our own trash? Is the problem eliminated when it is shipped elsewhere?

Reduce, Reuse, Recycle

- Learners should become familiar with the philosophy of reduce, reuse, recycle as an alternative to disposal. Investigations could include conducting research, designing and giving a survey, and analyzing results about recycling and reduction as alternatives.

Learner groups might take a different material or product in the waste stream and research the potential for recycling or reducing this product to:

a. reduce the need to site disposal facilities,

b. save energy and resources, and/or

c. reduce the potential for nonpoint source pollution.

Following reports about findings, groups can create a community survey about solid waste information, including the benefits of recycling and reduction.

Each group's questions can be combined to construct a classroom questionnaire to be distributed by learners in their neighborhoods. Data then can be analyzed and represented using graphs.

- Given the knowledge gained so far, learners can take action by developing a publicity campaign promoting alternatives to disposal. Techniques could include writing persuasive essays, representing data, and constructing visual displays. A possible procedure is:

1. Have groups of learners develop and submit a publicity campaign for the school about the benefits of reduction and recycling as alternatives to waste disposal in the form of a "call to action" campaign. Focus on what all members of the school community can do to help ease the problems associated with the generation and disposal of large quantities of waste material. Each group should develop a persuasive essay in favor of their "call to action," use several forms of representing data, and construct a visual display for their "call to action." One member from each group joins an evaluation panel that assesses the strengths of each publicity campaign proposal.

2. Synthesize the good ideas from all the groups and, as a class, implement a school-wide publicity campaign, and, if possible, develop and implement a reduction and recycling plan for waste generated at the school.

Assessment

Give each learner a different piece of garbage or trash and have him or her construct a lifecycle diagram of this product and material with brief explanation of the various stages.

Each lifecycle diagram should include at least the following components:

a. the natural resource(s) used to make the item.

b. places (manufacturing, transportation, etc.) between extraction of the natural resource and consumption of the final product that require the use of energy.

c. what happens after consumers have finished using the product, indicating both disposal and recycling options.

d. a depiction of how recycling saves energy and resources and can reduce pollution.

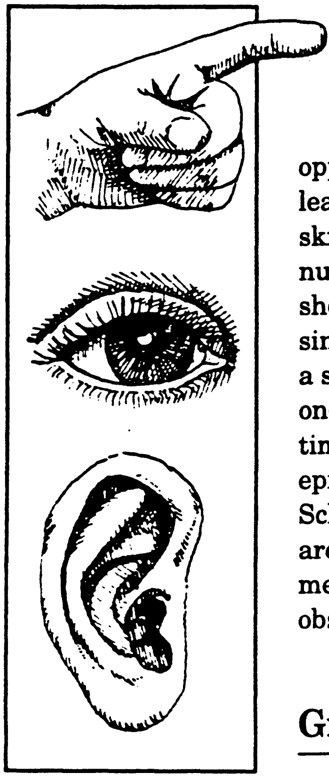
Materials

Tools for constructing graphs and charts; materials for constructing mini-landfills or incinerators including different types of soil, large containers, and various waste materials. Print resource materials (books, journals, etc.) about solid waste issues and recycling. Solid waste disposal regulations (can be obtained from the Ohio EPA or the Ohio Department of Natural Resources). Writing paper and an assortment of materials for constructing displays.

References

Landis, D. (1994). Investigating Solid Waste Issues. (A secondary, interdisciplinary, environmental studies activity guidebook about solid waste, natural resources, and environmental protection.) Ohio Department of Natural Resources. Columbus OH.

OBSERVING BIRDS IN THEIR HABITATS



Overview

In this learning episode, participants use bird observation as an opportunity to use and improve their learning skills in the outdoors. Since the skill development opportunities are numerous, the leader(s) and learners should select a few skills to emphasize in a single bird observation, or if there will be a series of observations, decide on which ones will receive attention during each time period. This is an ideal learning episode to take place in an urban area. School grounds, neighboring residential areas, nearby natural areas, or development sites are all suitable locations for observing birds in their habitats.

Grade Level Range

Primary, Intermediate, Middle School, High School

Illustrative Instructional Objective

Learners will gain confidence in learning on their own when they use observations, information, and procedures to learn how birds live; sharpen their observational skills; learn that birds have natural variations as do humans and other animals; and will improve their ability to use scientific methods to identify species.

Background

The general philosophical approach of the episode is for the learners and leader(s) to consciously concentrate on skill and attitude development. The content will result naturally from the activity. For example, the identification (naming) of a given number of birds may well be a result of the activity. A more important result of the activity might be the ability of learners to use their improved skills to identify an unknown bird on their own.

Procedure

The entire bird observation episode might include some or all of the following activities/outcomes:

- accurately judging the size of an unknown bird (comparing against known standards)
- describing patterns of color, walking, style, wing beat, flying mode (soaring, diving, undulating, hovering)
- carefully noting the birds' activity (feeding, mating, nest building, preening, singing)
- compile accurate written or pictorial notes for future use
- appreciating the predator-prey relationship (not usually seen)
- appreciating the beauty and majesty of birds
- understanding the difference between a drawing of a bird in which notable characteristics may have been emphasized and the observable characteristics of a real bird which may have some natural variation from the "average" or "best" specimen used by the artist (individuals of a species exhibit some variation)
- counting all birds in a group from one

species seen during the entire activity (estimation could also be used)
- use and introduction of new words and their meaning
- improve communications and cooperation skills between partners or among small group members as well as between the leader and each of the learners
- observe or speculate on the human impact on the habitats of birds - (their foods, shelter, water, and nesting sites) and management actions to minimize the effects
- how to use binoculars effectively

A culminating experience might be planned so that the leader(s) and learners can demonstrate and communicate to others the essence of the episode which should include the learned skills, knowledge, processes, and attitudes.

The leader(s) and learners need to jointly plan the activity if it is for a long term association group (classroom, nature club, youth group, etc.). If it is a one-time activity, the leader needs to share with the learners early in the activity what the purposes, actions and expectations are, so that the learners feel involved and can contribute to reaching the objectives.

When appropriate, learners should take responsibility for deciding what preparations will be necessary (with some guidance from the leader) and how to carry them out (permission to use site, parental permission, food, clothing, equipment, learning plans, grouping, safety, etc.). Since we are committed to helping learners to become lifelong learners, they must have numerous opportunities to actively engage in these preparatory activities.

In an overall view the following parameters should be followed as the episode is finalized:

- place more responsibility for planning, executing, and evaluating learning activities on the learner;

- make a major effort to utilize the extensive existing knowledge and skills of the learners;

- allow, with help, learners to take responsibility for their own behavior (health and safety should also be a conscious concern for the learners rather than only the leaders);

- allow wide latitude for learners to guess, speculate, summarize, contemplate, needle around, construct meaning, question;

- make a special effort to discern individual interest and proficiency that can be used for future individual pursuits or for peer teaching opportunities.

Assessment

The leader and the learners both must be aware that an assessment (evaluation) of the activity is needed. Questions can be framed beforehand, such as: Did we meet our objective? Did our objectives challenge us or were they too easy? What objectives were not met or were not addressed? What changes shall we make in our next episode planning session so we will be more successful? What specific objectives were fully met? Why were others less effectively met? What were the positive aspects of the episode? The negative? Did we enjoy the experience?

Materials

Will vary as appropriate to episode constructed by learners and leaders.

PARTNERING FOR ELEMENTARY ENVIRONMENTAL SCIENCE

ACTIVE LEARNING

Overview

This learning episode describes how educators are working in a collaborative partnership with resource professionals from the Ohio Department of Natural Resources (ODNR).

Partnering for Elementary Environmental Science focuses on using activity-based learning approaches and process skills to foster a general awareness of environmental issues. In addition, emphasis is placed on the development of an action plan outlining goals and activities for the school year which is developed by both the classroom teacher and the resource professional.

Grade Level Range

Primary, Intermediate

Illustrative Instructional Objective

Through interaction with a mining engineer, learners will describe the complex event of planning and conducting a blast at a mining site and will investigate the effect of the waves of the blast on the mine site and on the larger environment.

Background

Partnerships can encompass a variety of different relationships, whether they are formed between schools and the business community or between classroom educators and natural resource professionals. The partnership described in this episode embraces a reform-based partnership philosophy.

Generally, partners in a reform-based partnership collaboratively develop classroom goals for their partnership. These goals are based in part on the curriculum and in part on the environmental expertise of the ODNR partner. A year-long action plan is developed which includes the classroom goals and the activities to be undertaken in support of those goals. Team members then select and conduct hands-on activities. These activities support the classroom goals and tie the curriculum to real-world situations. Reform-based partnerships are more intensive and collaborative than other partnership models, where the educator-professional interaction may be much less in-depth. Reform-based partnerships strive to establish changes that become embedded in the educational system.

The first-year partnership described in this learning episode was between a sixth grade class and a combined fifth/sixth grade class in two different elementary schools, and two employees from the ODNR. The classes participated in joint activities, or had the same activity conducted in each classroom. Because the ODNR staff were from different technical backgrounds (litter prevention and recycling and industrial minerals mining and reclamation), the learners experienced two very different, yet interrelated, areas of study.

Procedure

The following narrative gives a brief overview of two natural resources professionals' adventure in partnering. Approximately 85 learners, three educators and two natural resource professionals participated in this first-year partnering experience.

After meeting with the educators with whom we would be partnered during the school year, we began to develop our action plan – a plan that outlined the goals and activities that our combined partnership would undertake. Our partner team chose the theme "Mining for Environmental Excellence" to guide our action plan. Corresponding activities were then discussed and selected.

The final action plan included four in-class sessions and one field trip. Most of the classroom sessions consisted of a brief presentation using visual aids, followed by a hands-on activity. Topics ranged from landfills and the importance of recycling to industrial minerals mining in Ohio and the technology of blasting.

One favorite classroom experience began with the reading of a poem about garbage followed by a brief slideshow on the transformation of a mining operation into a landfill. The learners were then challenged to construct their own simulated landfill. A pie crust represented the clay liner at the bottom of a sanitary landfill and materials such as licorice, bread crumbs, and green coconut were used to help learners identify with the concept of leachate tubes, sand and gravel filters, and grass cover. This activity concluded with a brief discussion of the importance of recycling to prevent the wasting of our natural resources.

During the field trip, the classes visited an active mining and processing site. Because we had discussed during the year different kinds of mining and reclamation, this really brought those ideas to life. We saw the quarry itself and watched a blast. We also watched rock being loaded onto crushers and saw the various stockpiles of different-sized rocks. We even weighed the bus that carried us to the site on the truck scales! Later in the morning, the learners searched through a rock pile for fossils – which they had also studied about earlier in the year. Every time one of the children found something, they ran to the reference books to identify it. They were really thrilled; everyone was involved in the search. Some of them had their bookbags so filled with rocks and fossils that they couldn't carry them! We weighed the bus again to see how much heavier it was with all those rocks.

This type of partnership holds great power. For educators, the opportunity to work alongside a resource professional broadens the educators' knowledge about environmental issues and gives them greater confidence in using hands-on activities to increase understanding and learning. Resource professionals tap the expertise of the teacher to translate complex ideas and applications into age-appropriate language and activities. Most importantly, learners not only have experiences which bring the curriculum to life, they also have consistent interactions with another positive adult role model. Through these interactions, stereotypes are eroded, and learners may begin to see themselves as possibly being able to become a resource professional. Their confidence in environmental science may increase, as does their awareness of environmental challenges and issues.

Assessment

The following questions were addressed:

1. Did the learner enjoy the hands-on activities?

The answer to this question was found in journals, other writing assignments and by conducting interviews.

2. Were the learners able to understand and interpret the ideas and concepts included in the activities and the field work?

This was determined by observations and discussions both during and following the activity and later, through test questions.

References

Science & Mathematics Network of Central Ohio. 445 King Avenue. Columbus, Ohio 43201. (For information on reform-based partnerships)

RESCUING THE RAIN FOREST

Overview

This episode describes one approach to a study of the tropical rainforest ecosystem and the human impact on that system. It also demonstrates how to address learning objectives from multiple disciplines holistically in one integrated unit, allowing students to see applications and connections.

Grade Level Range

Intermediate

Illustrative Instructional Objective

Learners will describe research findings and cite supporting evidence concerning the transmission and conservation of energy. They will collaboratively design, invent, and build a model of the rain forest ecosystem, and prepare for visitors who will benefit from the learners' effort.

Background

A fourth grade class spent two months doing an in-depth study of the tropical rain forest which integrated science, language arts, social studies and the applied arts. The unit of study was designed to educate and empower learners to understand tropical rain forests and take action for their preservation.
The objectives of this project were:

a. to introduce the diversity of plants, animals and native people of the tropical rain forest;
b. to show the contributions of the tropical rain forest in health, climate and to the well-being of all people;
c. to understand the consequences of deforestation of the rain forest;
d. to show the importance of protecting and preserving the rain forest;
e. to empower learners with ways that they can help to protect and preserve the tropical rain forest.

Procedure

The study began with an overview of the rain forests where learners read, wrote, discussed and gathered information from a variety of sources, keeping notebooks/journals of their findings. They were visited by a representative from Rain Forest Action who shared slides and expertise, as did another community member who had visited the rain forest.

Following their research, learners drew detailed sketches of the life in the various layers of the rain forest and in small groups, compared them with the drawings made by other students. The entire class also wrote and illustrated a book entitled *My Rain Forest Adventures* which they dedicated to the preservation of the rainforest.

For the major activity of the unit, the class divided into five groups which researched and constructed a 3-dimensional rain forest simulation which was placed in a conference room adjacent to their classroom. Each group captured the appearance of a particular layer of the rainforest through authentically constructed models of plants and animals from their layer. The environment was complete with dimmed lighting and realistic sound effects from a rainforest audio tape.

Learners then scripted a guided tour through their rainforest. Each group selected the most interesting or significant information from their research to incorporate into the script. A reading from the book The Great Kapok Tree and information about rainforest destruction and preservation efforts were also included.

The learners then practiced to become tour guides by learning the script and preparing to answer audience questions about their rainforest.

Led by rotating sets of 4th grade tour guides, over 350 people viewed the simulated rainforest, including students from other grade levels, parents, administrators and community members. The learners were interviewed by the newspaper, and radio and television stations and received extensive coverage in all the media.

The culminating activity for the unit was a work project at Arhaus Furniture, which has a policy of not selling furniture made from wood cut in the rain forest. The opportunity was provided for learners to receive $15.00 an hour for cleaning the store. A total of $390.00 was earned which learners decided to use to purchase approximately fifteen acres of the Amazon rain forest which will now be forever protected and preserved.

This project provided the learners with knowledge about the rain forest in a hands-on way, they learned to work together with their classmates and community and they learned how they can make a difference not only locally, but in a global way.

The following activities could be used as extensions to the episode. They could be completed by individual learners or the whole class.

Where in the World?—post a large world map and attach actual products or pictures where rain forest products grow.

Class Environmental Newsletter—include articles, interviews, drawings, cartoons, editorials, etc.

Flip Charts—select a topic and make a flip chart to use as a visual aid with an oral presentation.

Tropical Forest Prints—use potatoes to make tropical flower and animal prints to decorate booklets, notecards, etc.

Rain Forest Mural—research and draw plants, animals, etc., for individual forest layers.

Giant Class Collage—use pictures, wallpaper, feathers, foil, tissue paper, dried flowers etc. to construct a tropical collage.

Rain Forest Terrariums—make small terrariums using recycled two-liter bottles.

Creative Writing—publish shape books, rain forest adventure story, journals, poetry, etc.

Rescue the Rain Forest Poster Contest—establish guidelines, create posters, and display final products in school and community.

Tropical Trivia—research fun and interesting facts for class game.

Assessment

Authentic, holistic assessment can occur all through the unit

1. Periodically, the educator should meet with each cooperative learning group to evaluate progress, discuss strengths, weaknesses, brainstorm ways to improve and to re-evaluate group goals.

2. Learners can write an original story and create artwork for a classroom anthology. The stories can incorporate information learned about the rain forest biome. Peer and teacher editing can be included in this process, along with a narrative evaluation from the educator.

3. The learners' knowledge and communication skills can be evaluated as learners serve as tour guides and tell others about their rainforest.

4. An application oriented essay examination could also be given.

Materials

- Resource books about the rainforest
- Art materials for creating a simulated rainforest

References

Cherry, L. (1990). The Great Kapok Tree. Harcourt Brace Jovanovich.
Lewis, S. (1990). The Rain Forest Book. Living Plant Press.
National Wildlife Federation. Rain Forest: Tropical Treasures. Naturescope. Vol. 16.
Rain Forest Action Network. Rain Forest Action Guide. San Francisco, CA
Rain Forest Allinace. Rain Forest Curriculum Packet. New York, NY.

RESIDENT ENVIRONMENTAL EDUCATION EXPERIENCES

Overview

This learning episode explores some of the benefits of resident environmental education programs. Because of the setting and length of the programs, they provide a unique opportunity for interdisciplinary, hands-on learning experiences. Activities are included to assist leaders in using the newer educational approaches, such as theme-based and learner-directed education in resident programs.

Grade Level Range

Intermediate, Middle School, High School

Illustrative Instructional Objective

Learners will design and conduct a range of investigations associated with everyday experiences at a river, investigate inferences about this large system based on observations of a smaller system, collaborate to prepare presentations, and gain insight into their own situation in light of the historical background of the river while improving their self reliance on personal living skills and responsibilities.

Background

Many schools in Ohio conduct resident environmental education programs. Resident programs are those which include an overnight stay. Students participate in a program that is 24 hours or longer in length and includes meals and evening activities.

Resident programs offer unique learning opportunities. Because of their length, there is more time to develop ideas and concepts. Special times of the day, including early morning, night time and meal time provide options not normally available in the classroom setting. Resident programs are held at outdoor learning facilities. These sites offer outdoor settings with varied habitats as well as food and lodging.

There are many aspects of the new Science Model Course of Study that are already being promoted in resident environmental education programs. Because of the setting and length of these programs, there often is learning that is:

- Participatory and hands-on
- Cooperative and team building in nature
- Interdisciplinary
- Knowledge based
- Conducive to inquiry and application

Classroom teachers and staff of resident centers have done an excellent job of being innovative thinkers in putting together resident programs. The new Science Model Course of Study, however, challenges leaders to continue to think creatively about how to best lead learners in these special settings. This is an opportunity for leaders of learners to take what is working and improve it with the goal of strengthening science education.

Procedure

Several different approaches now being stressed are outlined below, along with examples of how they might be addressed through a resident program. Since many resident programs are offered to fourth through eighth graders, sixth grade is used as an example.

- Consider using a *theme based* approach. To help enhance inquiry and application, select a theme that is relevant to the learners. For example, choose a river or body of water that is close to their home environment. Or select a local, national or international concern such as preserving habitats or biodiversity. Build learning opportunities across disciplines that enhance learners' understanding of the theme.

- Use an *action* orientation. In each area of learning in the program, provide learners with activities and ideas that will empower the learner to have continuing involvement with related issues. As learners explore organisms in ponds, for example, involve them in discovering the value of ponds and wetlands. Find ways to encourage learners to be involved with preserving wetlands.

- Think creatively about using a broad *interdisciplinary* approach. Are there songs or music that can enhance a learner's understanding of the natural environment? (Smetana's *Moldau*, a symphonic piece that expresses his interpretation of a river, is an example). Use chemistry to study water quality; history to see how patterns of development have effected water. In the language arts, explore how various cultures have related to wildlife in folk tales.

- Use *scientific skills* to enhance learner's understanding of the natural environment. In small groups, learners can formulate questions and hypotheses about aspects of the environment. They can examine and propose solutions for problems. Fundamental principles can be explored among organisms, observing patterns in nature and seeing the role of energy.

- Relate scientific study to *issues* that are of interest to learners and are important to society. What scientific studies are useful for managing parks and other environmental learning sites? What do we need to know about water quality to determine if fishing is a good recreational use of a river? What kinds of habitats are needed if we want to continue to observe wildlife? When housing or shopping areas are developed, what impact does that have on soil?

- Facilitate *learner directed* education. Provide opportunities for learners to choose issues and areas they would like to study. Learners can help design experiments, ways of recording observations, and projects in which they would like to participate. Learners can be given choices and they can be involved in using equipment, engaging in discussions, conducting experiments and making inferences and evaluations.

- Promote *global* understanding of the environment. We know that polluting a body of water ultimately affects other water resources. Young people today are very interested in the rain forest as well as local habitats. Learning about the environment can provide wonderful opportunities for understanding diverse cultures and our interdependence with people and resources in various parts of the world.

Resident centers or camps can also look at these approaches and think through how they best take advantage of the site and facilities. What kinds of equipment are available for learners? What do displays or exhibits look like? How does food service enhance the program? What artwork hangs on the walls? How are key staff prepared for their role? Are they facilitators and leaders of learners? Does the center in its administrative and educational philosophy and policies reflect these approaches?

The following description of a resident environmental education experience shows how these different approaches might be incorporated.

The early morning sun is shining into the dorm rooms. As some learners are getting dressed, others are out at the weather station collecting data and making observations. They will share their findings with other students later in the day.

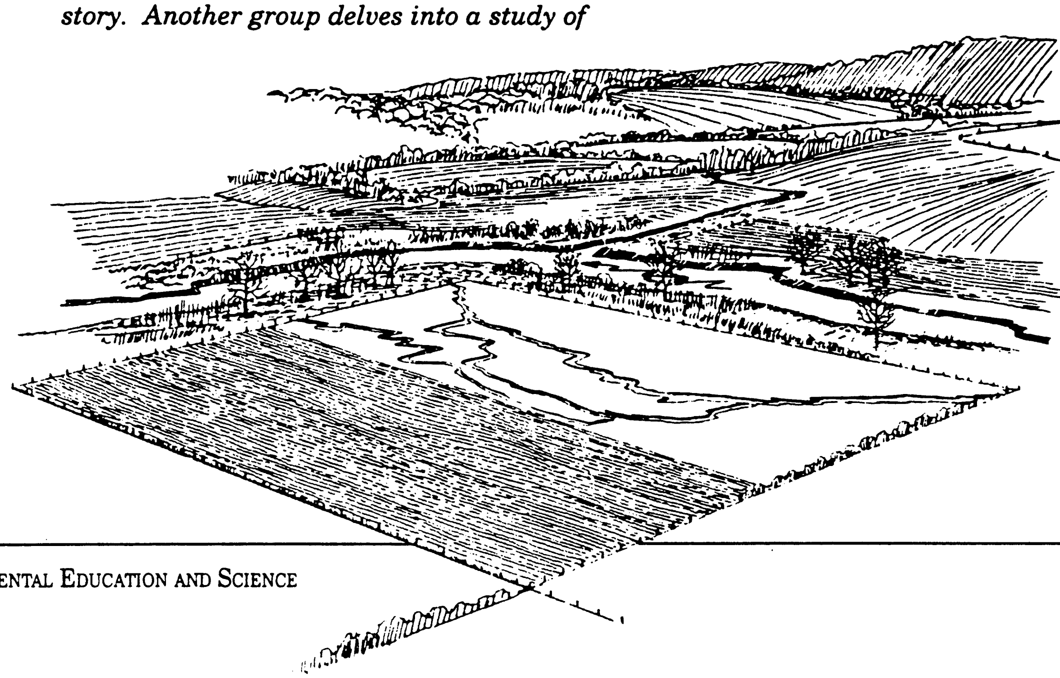
After breakfast the learners prepare for their morning activities. The learners work in groups of approximately 10 young people and two leaders. One small group begins a unit on stories by creating a group story. Another group delves into a study of communities by looking at roles in their communities. They will then travel to pond, forest and meadow communities.

Several groups board a bus to head to the river. They will explore the river using scientific tests, the arts and history. They will spend several hours having first hand experiences around the river.

All of the groups will spend about three hours in their units. Each unit is interdisciplinary and multi-faceted in terms of approach. The groups meet together for lunch and share their morning experiences with each other.

In the afternoon the groups participate in another three hour unit that builds upon their experiences from the morning. The learners who visited the river will participate in artistic interpretations of the river, will analyze their test results and use computers to communicate with other learners in other areas who are participating in water quality experiences.

After a busy day, learners have the opportunity to choose recreational activities or rest before dinner. After dinner the learners participate in a variety of experiences that extend their learning and take advantage of the unique learning setting. One evening they learn about the world at night, including taking a night hike. During a closing campfire they hear stories and sing songs about the importance of night from a cultural and historical perspective.



Another evening they learn about rivers in other parts of the world. As they learn about rivers, they participate as leaders in sharing with other learners about diverse cultures. They may share a story, teach a song in another language, teach a dance or demonstrate a craft activity.

The final evening is a time for learners to synthesize their week and celebrate what they have learned. Through music, drama, movement and art they express their feeling and share their knowledge about the local environment.

At the end of the resident experience learners work with their classroom teachers and the center staff to explore ways they can be involved in taking action in their home communities. They make the bridge to home—their school, community and family.

Amidst all of these activities learners have the opportunity to hike, use their senses to explore and take advantage of teachable moments like a hawk soaring overhead or an owl calling in the night. A resident experience provides an opportunity for learners to live, eat, work and play together. It is a chance for discovery, building friendships and having fun!

Meeting the Objectives

Using sample sixth grade objectives as an example, there are some objectives that fit naturally into a resident program.

Performance Objective:

Provided with examples of patterns in natural phenomena, the learner will design and perform an investigation to document the constancy of the pattern.

Some of the ways this objective might be met in a resident setting are to provide opportunities for the learner to:

- Look for weather patterns and apply them to weather analysis and prediction.
- Observe seasonal changes and investigate ways to record patterns and variations between seasons and from year to year.
- Study daily and seasonal patterns of animal behavior.

Sample Instructional Objective Components:

Share findings and offer explanations for inconsistencies, limitations, and variability in recorded observations from similar investigations carried out at different times in different places, and using different techniques. Use different techniques for observations, perhaps of signs of wildlife or of weather patterns throughout the resident experience. Compare them at the end of the resident program.

Make, interpret and use scale drawings, maps and models. Create maps that show the relationship between the school and the resident center. Interpret topographical maps by using them along a trail. Use models to explain concepts such as watershed and the water cycle.

Investigate various impacts of biological and geological activity on earth. Explore the geologic history of an area. How has that impacted land use? What kinds of trees, plants and wildlife live there?

Maintain a journal over an extended period of time in which observations are recorded and inferences are noted. Keep a journal throughout the resident experience. Provide opportunities for regular recording and interpreting of observations.

Monitoring and proposing improvements appropriate to the disposition of a various types of wastes in the home, school, community, and the environment. The resident center can model disposition of wastes in their food service and through a recycling program. Students can participate in it through meal time and waste collection. They can assess changes they might make at home and at school.

The Big Picture

The resident program does not stand alone as an educational experience. It begins in the classroom and ends in the classroom and at home. In looking at the big picture of a resident program, the curriculum will be most effective if it includes components to do in the classroom before the resident experience and after the resident experience, as well as suggested ways to involve parents and the community in themes that will be explored.

A resident environmental education experience can be very powerful in a young person's life. The opportunity to be away from home, to live and work in small groups, to explore the natural environment in a hands-on way, can have great impact.

The resident program can assist learners and leaders in valuing the natural environment and one another. Those who have participated in resident programming are eager to tell others that it is excellent opportunity for people to develop their sense of wonder and appreciation for the environment. This appreciation can be a foundation to helping learners develop competency in understanding and protecting the natural environment.

SHOPPING AROUND A MALL FOR ENVIRONMENTAL ACTIVITIES

Overview

A group investigation strategy is used to guide learner exploration of various aspects of a familiar setting—a local shopping mall. Groups may focus on a wide range of environmental topics from botany to waste management. Information gathered through research and field study at the mall is shared with other learners to create a rich understanding of the social, environmental and economic impacts of the mall.

Grade Level Range

Intermediate, Middle School, High School

Illustrative Instructional Objective

Learners will sharpen their interpersonal relations skills, gain confidence in activity planning, learn about the complexities of mall operations, and practice taking action on relevant problems.

Background

Learners must experience and explore environmental issues within the context of genuine, familiar, and pertinent real-life situations. With these types of opportunities, students are better able to apply their understanding and knowledge to the task of making responsible and educated decisions about their interactions with the environment.

One of the institutions most visited by learners but least used as an educational resource is the shopping mall, certainly a monumental fixture in today's society for both consumer needs and basic entertainment. The size and diversity of malls make them a microcosm of our towns and cities, having the same environmental and social needs and problems that are associated with all urban communities: transportation, safety, solid waste disposal, sanitation, energy consumption, land use, wise use of natural resources...the list goes on and on.

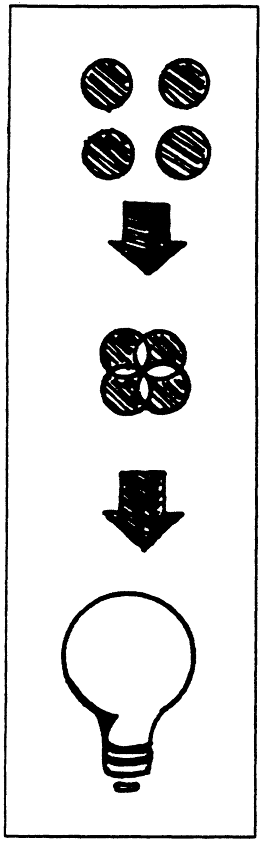
It is this complexity within a well defined area that makes the shopping mall an excellent location for environmental learning opportunities. Malls offer learners the opportunity to observe, collect data, and evaluate many of the issues regarding the connections between environmental quality, economic quality, and the quality of one's own life. These are all concerns that they will need to deal with on a larger scale within their own communities and society as a whole.

Procedure

The cooperative learning strategy "group investigation" can be used to organize this learning episode. This method emphasizes more choice and control by learners than dc other cooperative learning methods. They are involved in planning what to study and how to investigate. Using group investigation, the learning episode has six stages.

Planning and Conducting the Investigations

In the first stage, the leader identi-



fies the broad topic—in this case, a shopping mall—and initiates a discussion by learners to identify subtopics. The leader may begin this stage by asking the class "What would you like to know about. . . " A short lecture might be used to stimulate interest. In groups of two to six, learners identify important points to investigate and decide how to organize for group study. They also decide how members are going to exchange information. A variety of relevant materials should be available for the groups to use. Questions can then be raised by groups and listed on the chalkboard, or learners can meet in buzz groups to generate questions prior to this listing.

In the second stage, learners work together to plan how they will carry out the investigation of their subtopic(s) or set of questions. In addition to generating a listing of who will investigate what and deciding how to proceed, the groups may identify the sources they will need.

The third stage is probably the longest in this group investigation method. During this time, groups work on their investigation. The leader, in addition to helping locate resources, needs to periodically review progress with each group.

NOTE: If individuals or groups plan a visit to the mall to conduct portions of their investigation, careful advance preparation is essential. It is important to make contact with the management office of the mall as well as store owners to let them know about the group investigations and to secure any necessary permissions. Past experience has found the mall and store managers to be most cooperative and willing to help.

In the fourth stage, groups analyze and evaluate the information they have obtained. They need to decide what are the essential parts of their investigation and plan how to share this information with the rest of the class. In addition to integrating the information, they have to decide how best to communicate it. To facilitate the sharing sessions which take place in a later stage, the leader forms a steering committee made up of a representative from each group. This steering committee then coordinates the sharing and use of materials and provides recommendations to make certain the content of each presentation is meaningful and interesting.

In the fifth stage, each group provides a summary of the results of its investigation so that all gain a broad perspective of the general topic. This will involve several class periods.

The sixth stage involves the evaluation of reports and presentations shared by groups as well as individual learning. Peers provide feedback to groups. In addition, each group submits a number of questions and topics to be included in the assessment. The leader solicits feedback from the learners about the topic, the process, and suggestions for increasing students effectiveness as investigators (Sharan and Sharan, 1990: 17-20; Knight & Bohlmeyer in Sharan, ed., 1990:6-7).*

The following areas for investigation might be among those generated by the groups:

LIFE BEFORE THE MALL

In most cases, students will be too young to remember what occupied the mall site prior to construction. Was it farm land, mature forest, a landfill, etc.? Student research through the local government offices of deeds, property transfers, and real estate can turn up some clues. Older topographic maps, aerial photographs, and articles from old newspapers may also provide information. Perhaps the original owner of some of the land or a relative is still living in the area. Personal interviews with these people and other senior members of the community will provide history and insight into past use. Interviews might also delve into how these individuals feel about the resulting use of this land.

THE ECONOMICS OF MALL DEVELOPMENT

The mall has had a significant economic impact on the surrounding area. Identify area businesses that have been developed as a direct result of the mall. What are the resulting positive and negative economic impacts? Have adjacent residential neighborhoods been economically affected (more traffic, different housing patterns, higher or lower property value)? How do nearby residents feel about the economic trade-off associated with the mall?

MALL BOTANY

Why do malls have plants growing in them? Is it an attempt to re-create the outdoors? An effort to offer an aesthetic experience? Learners can brainstorm among themselves and then interview shoppers to get a better understanding of people/plant relationships. Plants offer a great diversity of learning opportunities that will allow students to investigate growing conditions, plant requirements and adaptability. How do plants in the mall stay so lush and green? What are their habitat requirements and how does the mall environment meet them? How about the plants growing outside the mall—both plantings and invaders? The products made from plants which are sold at the mall can be investigated. Be sure to discover the country in which they are produced. Groups may wish to design data and observation sheets which will standardize the investigations.

MALL GEOLOGY

Between the various materials used in the construction of the mall and the products sold in jewelry stores, a tremendous number of rocks and minerals are accessible. Where did they come from? How much do they cost? Why are certain kinds chosen for construction? Are there alternative materials that would have less of an impact on the environment? These are just a few of the areas of investigation that can begin to look at the wise and economic uses of natural resources.

ENVIRONMENTAL QUALITY OF A PARKING LOT

Using some investigative tools and scientific instruments, groups can begin to evaluate the environmental impact of large areas of blacktop and its use by thousands of automobiles. Temperatures in the open parking lots can be compared with those in an open field or forest. Measurements of noise levels, auto emissions, and nonpoint pollution in stormwater runoff can be taken. Issues such as mass transportation can be investigated by studying ways people come to the mall. How big is the parking lot and how many cars does it accommodate? What is the average number of people per car? Analyzing data such as this will help begin to determine the efficiency and environmental impact of this land that has been set aside for parking.

WILDLIFE IN AND AROUND THE MALL

Animals, both native and non-native, can be found in abundance within and around the mall. The various indoor and outdoor plantings offer habitat for a variety of insects and small mammals which can be inventoried and observed. Are these the same organisms that would be found if this site were in its natural state? If not, what has been displaced? Can any wildlife be found in the pet store? If so, what regions or countries do they come from? How and why are wildlife images used in advertising and product names? As with the plants, groups can begin to discuss the need for us as a society to maintain contact, even if artificial, with our natural surrounding.

WASTE MANAGEMENT STUDY

Solid and sanitary waste issues are dealt with in all communities and the mall community is no exception. Groups can research and develop a flow chart which traces the production and disposal of these wastes by investigating the following kinds of questions. How much solid waste is produced at the mall and what is the disposal procedure? Which stores generate the most waste? Is there a recycling system in place? Does the mall have its own package plant to deal with sewage treatment or does it depend on the municipal system? How many people does it serve in a designated period of time? Who pays for the waste treatment or removal and how much does it cost?

ADDITIONAL IDEAS

Helpful information could be obtained by investigating energy flow, architectural design, food varieties and origins, parking lot drainage patterns and the environmental impact of the mall on the community. These investigations could include interviews with employees and shoppers concerning career opportunities, population distribution, comparison shopping, and the efficiency of malls versus "main street shopping."

Synthesizing and Sharing Information

Processing the information and data collected during a group investigation is a critical element for successful and meaningful learning. This involves both a period of analyzing and an effort to share this information with others in a constructive way. Groups may choose to use the following or other methods to process the experience and knowledge gained.

- *Journaling*—Journaling provides learners with an opportunity to reflect on a past experience and an outlet to express understandings or misconceptions. The journal entries might be very open-ended or might react to a question such as, "Have malls become a substitute habitat for humans, complete with food, shelter, social contact, and interaction with elements of our natural environment?"

- *Community Action*—The "action" component of learning can very often have the most lasting impact. Depending on the information gathered, groups might share their data regarding transportation to initiate an effort to encourage use of car pools or mass transit. Or, they may lobby the city government to curtail continued retail development in their community. These actions must result from the group's recognition of a need and the desire to take action for the betterment of their community.

- *Town Meeting Simulation*—A town meeting can be used as a means to present information and a method to decide an issue that impacts the entire community. For example, as their presentation, learners could assume (or have other learners assume) the roles of the various constituents that might be involved in the decision-making process that would determine if a mall is to be built. An actual location in the town can provide a real reference point to consider as they think through roles such as the potentially displaced homeowner, community member, the economic development agent for the town, the head of the large retail establishment that will anchor the mall, the representative from the local historical society, the scientist who has completed an environmental impact statement, etc. Statements and evidence which will clearly articulate positions on the issue might supplement the actual town meeting. After all information has been presented, the question of development could be voted on by the entire group.

Assessment

The diversity of activities presented in this episode are particularly appropriate for ongoing assessment. Investigations conducted by learners and the subsequent sharing of the information gained could provide the opportunity for both peer and self assessment.

Materials

Will vary according to activities chosen.

References

*Sharen, S. (Ed.). (1990). Cooperative learning: Theory and research. New York: Praeger Publishers.

TAKING ACTION THROUGH RECYCLING

Overview

A "hands-on, minds-on" environmental project initiated by a group of learners and educators from the middle and freshman schools in one district evolved into an ongoing cooperative partnership among district schools, area businesses, local government and community members. Operating under the premise of the community as a classroom, the students worked to convert an abandoned bus garage into a drop-off recycling center for area residents and schools. But more importantly, the students and teachers participating in the project sought to heighten their awareness, sensitivity and knowledge about the environment and to identify, investigate and solve problems locally.

Grade Level Range

Middle School, High School

Illustrative Instructional Objective

Learners will use mathematics and community resources to gather information on consumer product usage, through the use of estimates and measurements. They will then make recommendations for disposing of consumer products properly, thereby gaining confidence that they can make a positive difference in their community.

Background

The project called LINK, was designed and implemented by a group of 9th grade students, educators, and local leaders to promote community spirit and improvement. LINK acts on the belief that young people are valued resources in their communities and capable of giving leadership and direction through ongoing service. Service learning provides teachers the opportunity to incorporate an experiential learning methodology which has proven effective with all learners, especially the "hands-on" learner.

Student and teacher volunteers from the middle and freshman schools along with local residents had assisted with a voluntary community recycling project for several years. When an old bus garage behind the freshman school was scheduled for demolition the students suggested that the garage be renovated and converted into a combination drop-off recycling station and solid waste reduction education center.

Working with a local architect, LINK members investigated the feasibility of salvaging the garage and structurally converting it into a recycling service learning center. The only roadblock seemed to be money. Students determined that they would need about $40,000 to renovate the garage and buy a vehicle to use in the project.

Students and educators approached the village council and said, "We need to do this, and how can we get the money to do it?" Working cooperatively, the school district and village applied for and received a grant from the Ohio Department of Natural Resources, Division of Litter Prevention and Recycling.

The Recycling Service Learning Center began operation. Residents and area businesses could drop off white paper, beverage cans, milk cartons, drink boxes and telephone books. There was also a pick-up program at the village office and at all the district schools. Students, educators, and community volunteers staffed the center which would be open to the public one day a month.

In order for the recycling program to be effective, the students and teachers realized that they must educate all students and residents about solid waste management and pollution prevention strategies.

Procedure

A multi-faceted approach to education and awareness was used. Students at the middle, freshman and high schools formed Green Teams. Team members conducted waste audits of school and government buildings and publicized this information. They analyzed each building to determine the best place to put recycling containers.

Green Team members designed displays, wrote fact sheets and developed newsletters that were distributed to students and local residents. Newsletters focused on the success of the program and offered information on creative ways to reduce and reuse products.

At the elementary, middle and high school levels, recycling and waste minimization were integrated throughout the courses of study. As a result, learners interacted with representatives from local environmental agencies and developed science projects that focused on the 3Rs (reduce, reuse, recycle). They also participated in hands-on activities such as making recycled paper using the process of blending it into pulp, pressing the pulp against screening to form it and then going through several drying steps.

Learners at all grade levels participated in field trips to the local landfill, compost facility and waste-to-energy facility (a trash burning power plant). They organized Adopt-A-Stream and Adopt-A-Street programs. Students conducted litter pickups and studied its impact on the environment.

Green Team members at the high school investigated products made from recyclable materials. They examined the cost performance of such materials and provided their findings to area businesses and government agencies.

Assessment

Students kept journals about their experiences. Learners and educators collected data on the quantity of recyclables collected and submitted these in reports to the Department of Natural Resources.

Materials

Will vary depending on activities chosen.

References

Project LINK, Groveport Madison Schools, Groveport, OH.

UPS AND DOWNS OF EARTH CHANGES

Overview

This episode is designed to encourage learners to look at how natural and human-caused changes in earth systems impact a range of factors in the environment and in society. The technique described in the episode can be applied to a variety of issues and can be used at various points in the instructional/assessment process.

Grade Level Range

Intermediate, Middle School, High School

Illustrative Instructional Objective

Learners will describe earth changes through a cause and effect approach, formulate a concept map model, improve divergent thinking skills, ask for evidence which supports or refutes explanations, and predict various scenarios for human society when earth changes occur.

Background

This episode is designed to help learners develop divergent thinking skills and identify both positive and negative effects of natural and human-caused change while focusing on changes in the earth as a system.

Some learner outcomes might include:

- developing confidence in divergent thinking
- identifying multiple interrelationships in all aspects of the changing earth system
- relating natural earth processes and human-caused changes to human society
- distinguishing total cause-effect relationships from simpler correlations

Procedure

An earth change that learners have probably experienced, observed, or studied should be chosen by the group. The change can be a natural one (flood, volcano, etc.) or one which humans have caused (human population growth, global climate change, etc.). The following process to develop a concept map model can be conducted by the leader, or to make the episode more learner centered, individuals or pairs of learners could take the lead, with coaching by the leader and feedback from the group.

1. Conduct a brief brainstorming session to help the group envision what things in the earth system would be affected by the change. The effects might be positive or negative ones. Do not strive for an exhaustive list, just enough to stimulate a divergent way of thinking. (Example: Mississippi floods -> fewer crops, less shipping, spread of zebra mussel, loss of homes, schools closed, water-borne disease threat, more boat sales, and the like.)

2. In groups of 4-5, learners then develop impact scenarios on some of the brainstormed effects. Scenarios should not be limited to the suggested

impact but include further divergent thinking. An impact scenario is a chain of events leading from the earth change to a final impact (example: Miss. flood -> high water -> levees fail -> croplands drowned -> fewer crops -> higher food costs to consumers -> less food for poor people...). Younger learners may want to use "+" or "-" to indicate changes in things along the web, or up/down arrows to show increase or decrease.

3. Groups add their scenarios to the board one at a time, starting from an existing link or the central change and drawing arrows to link with other scenario parts as they can. The chains grow into a web of change. They should note how many factors in the earth system are interrelated, so that a change in one causes changes in others. They may also note that some changes are delayed ones and others are immediate. (An example of a concept map is on the next page.)

4. More advanced learners can examine each link in the web to determine if it is truly a cause-and-effect relationship or if the factors are related but not necessarily causal.

This episode can be used in a number of ways:

- As a needs assessment for an interdisciplinary unit, to guide construction of learning experiences that build on the groups' current level of understanding.
- As a pre-test/post-test to evaluate new interdisciplinary thinking or knowledge change.
- As a self-reflection by students concerning how they value different parts of their environment and how they view its interactions.

Assessment

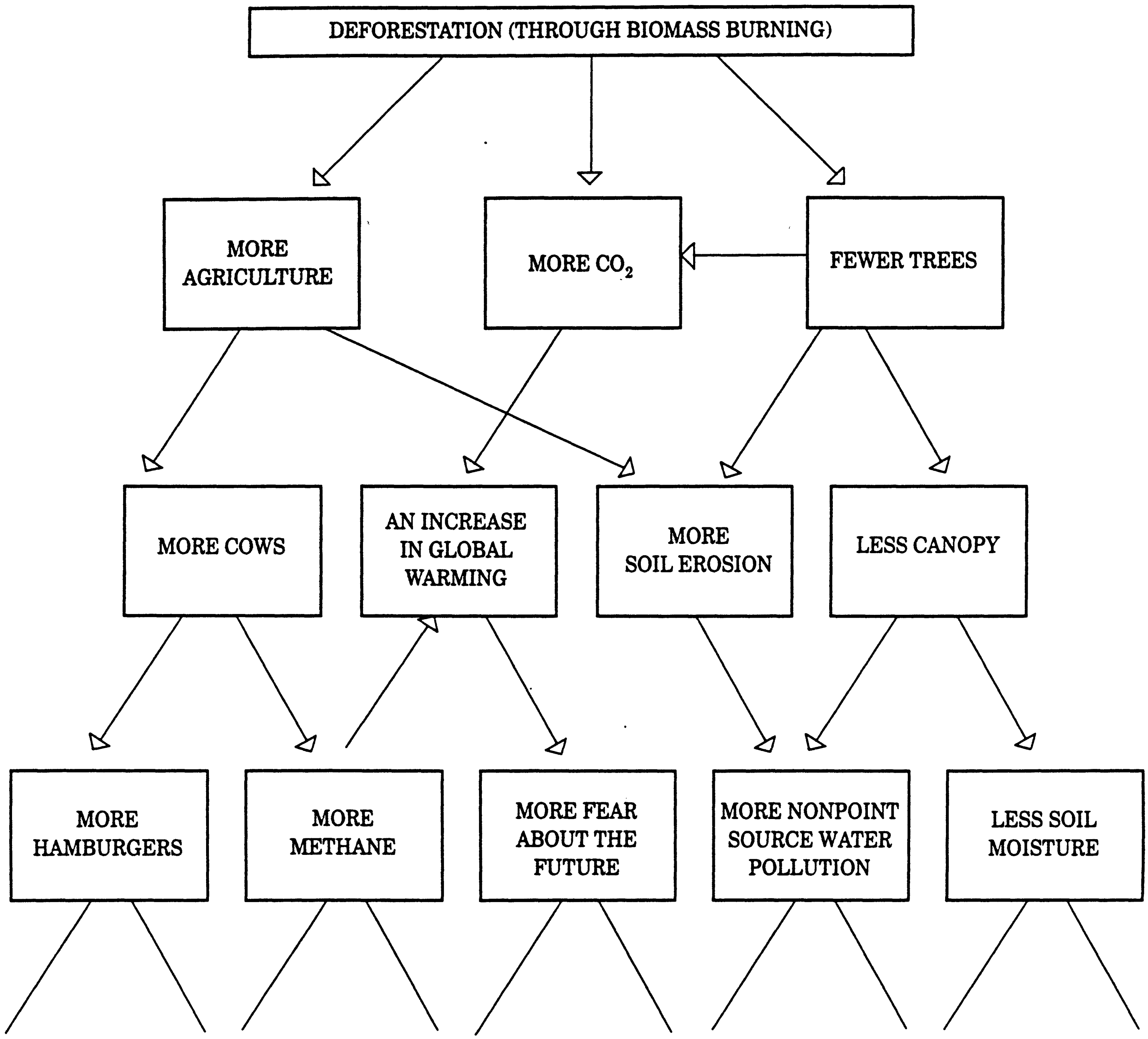
- ❑ For quantitative measure, count the number of correct (defensible) linkages on pre/post webs.
- ❑ Use concept maps as an assessment of class progress on a topic and development of divergent thinking.
- ❑ To assess group or individual growth in knowledge of linkages, concept maps can be done by small groups on butcher paper at their tables, or on a single page by individuals.

References

Fortner, R.W., V.J. Mayer and T.P. Murphy, eds. Activities for the Changing Earth System. Columbus: Ohio State University Research Foundation; Earth System Education Program. pp. 185-7.

Adapted from:

"More or Less" an activity developed by Zero Population Growth, Washington, DC.


DEFORESTATION (THROUGH BIOMASS BURNING)
MORE AGRICULTURE
MORE CO_2
FEWER TREES
MORE COWS
AN INCREASE IN GLOBAL WARMING
MORE SOIL EROSION
LESS CANOPY
MORE HAMBURGERS
MORE METHANE
MORE FEAR ABOUT THE FUTURE
MORE NONPOINT SOURCE WATER POLLUTION
LESS SOIL MOISTURE

URBAN PLAYGROUND INVESTIGATION

Overview

In this episode, students will observe plant and animal life in an urbanized area. The investigations could take place on a school lawn, playground or neighborhood park.

Grade Level Range

Intermediate

Illustrative Instructional Objective

Learners will extend their understanding of how a scientist investigates an unknown using observational skills, measurement skills, and data recording skills; appreciate the difficulty in accurately naming species of plants and animals when there are millions of species; increasingly notice change over time as a concept; and improve their ability to evaluate the quality of their own (or group) work.

Background

For many schools, taking off-site field trips is difficult because of financial or logistic considerations. Any school site, whether in an urban, suburban, or rural area, can be a rich resource for both short and long-term activities. Changes that occur over time in the environment are much easier to observe and track when the school site is used. In many cases, investigations can be done without any modifications or "naturalizing" of the site.

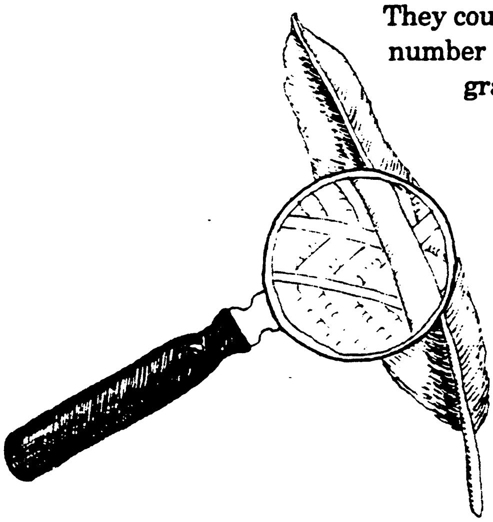
This episode uses a simple lawn area adjacent to the school. The following learner outcomes could result from the episode.

- Recognizes the importance of working like a scientist (guess, test, tell).
- Appreciates that scientists can be male or female of any race or culture.
- Uses hand lens or hand held microscope properly.
- Uses information from the five senses to classify and compare parts of his or her environment and to collect data.
- Uses various ways to record the results of an investigation.
- Recognizes the basic steps of an investigation.
- Recognizes that scientists often need to work together.
- Identifies the basic parts of a plant: stems, leaves, flowers, seeds.
- Collects and organizes simple scientific data into logical format.
- Recognizes that the metric system is used by scientists world-wide.
- Develops the skills of questioning, measuring and drawing conclusions.
- Observes and examines the behavior of objects and changes in the biological world.

Procedure

Learners will conduct a detailed observation of an area they see daily. The observations will include both living and non-living things and will take place over time to allow students to compare changes throughout the year. Begin the investigation by having learners make predictions about the various living and non-living things they will find. Then, working in pairs, learners will measure a piece of yarn or string 100 centimeters long. To determine their observation area, they should start from an asphalt area and, using the string, measure 100 centimeters into a grassy area of the school yard. At that location, the learners will then designate their study site by placing a hula hoop, (or circle of rope) on the grassy area.

Learners should then use their senses to fully investigate their area. Initially, they should disturb it as little as possible. Using the hand lens, hand held microscopes, or any magnifying lens, the learners should observe plant and animal life in that area.



They could count the variety and number of different plants and grasses and record pictures of them in their journals. They can look for patterns in their area, including specified shapes like parallel lines, spirals, circles, etc. Students can gather one of each type of grass or plant life, gently pulling to preserve the root system, then examine each with a hand lens and record their findings through written descriptions or drawings. Living things could be examined in a similar way. What insects or evidence of other animals do they find? Learners may dig a small area of the earth, place it on white paper and examine it for signs of life. All plant and animal life should be documented in their journals for comparison at later times during the year.

Students can also observe and record litter that is found in that area. They can ask questions related to the effect such litter can have on animal life. Is it biodegradable? Is it student generated? Is it adult generated? What recycling efforts could be initiated by the students, staff, or community to solve the problem?

Before concluding their observation, learners should devise a plan to record and remember exactly where their observation area is so they can return to the same place again. They should predict what that area will look like at other times of year and record their predictions. Later they should return to the same area and repeat their observations. What does the plant life look like now? Which plants are not there? What different types of litter are there? Are there differences in the insects or animal evidences in different seasons of the year?

If a grassy area is not available, a blacktop area can also be used. Learners can observe plant life that is growing through the asphalt, litter, animal life, etc. Learners should try to explain why some plants, animals and insects may not be present around their school yard. They may wish to initiate a "diversification/beautification" planting program that would introduce butterflies, birds, and other animals that may otherwise be absent from their school and neighborhood environment.

Assessment

A "check-list" could be used to record and evaluate learner participation, collaborative interactions, skills demonstrated (such as observation, prediction, classification, comparison, measuring, data collection, organization, etc.). Assessment could also be based on the quality and completeness of the journals that are kept throughout the year. Additional evaluation activities could include:

- ❑ Graphs showing the variety and number of living organisms found in their area.

- ❑ "Inventory" records kept on plants, animals, litter, and soil types found.
- ❑ Tour guidebooks produced to introduce visitors to the learner's designated area.

Materials

- meter sticks
- yarn or string
- hand lens
- hand held microscope
- a hula-hoop
- science journals
- cameras
- spade (or any digging tool)
- colored pencils, crayons, or markers
- insect and plant identification books
- white paper

References

"100 Inch Hike" from Acclimatization, Steve Van Matre, (1972), The American Camping Association.

WATER, WATER EVERYWHERE

BRAINSTORMING

Overview

This learning episode captures a very open-ended method for exploring the topic of water in a potentially transdisciplinary way. The episode also exemplifies one effective strategy for using brainstorming to encourage student-centered learning.

Grade Level Range

Intermediate, Middle School, High School

Illustrative Instructional Objective

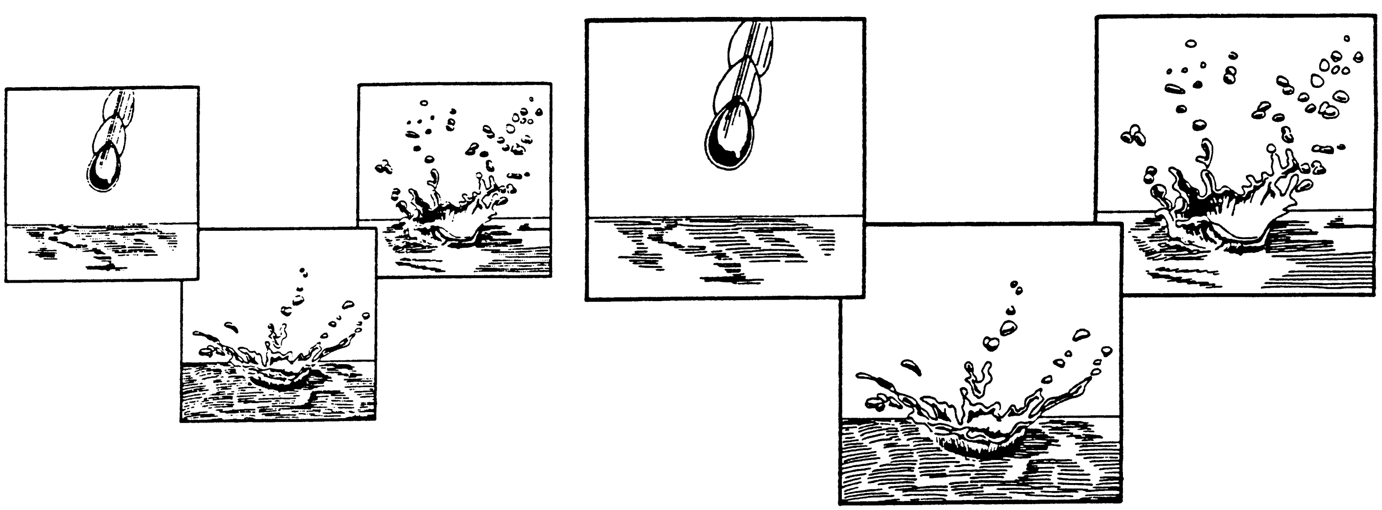
Learners will actively participate in the processes involved in listing, choosing, planning, conducting, and evaluating relevant water activities which lead to increased knowledge, sharpened skills, and positive actions.

Background

In this episode, the left hand column contains words, phrases, or instructional objectives that suggest the basis for the actions that are described in the right hand column. The columns parallel each other but do not have a one-to-one correlation.

To make this learning episode of manageable length, different activities can be selected depending on the learners' developmental levels, interests, and abilities. To assist in this process, the episode focuses on the use of brainstorming to engage learners and help them set directions for their learning.

The episode may be used as an interdisciplinary science unit which includes life, earth, space, and physical science concepts. Additionally, with the diverse activities suggested it can easily be used as a theme-based unit (transdisciplinary) that includes the exploration of concepts from disciplines outside of science. More importantly, the episode makes it possible to work both on the general goals of elementary and secondary education and the five general science education goals. As more is known about how learning occurs, the use of the holistic, multi-dimensional approach demonstrated in this episode becomes even more important.



Procedure

The left column shows objectives and gives rationale for the right column.

The Purposes for Action	Description of Leader-Learner Activity
Planning the episode • learner involvement • developing confidence • cooperative goal setting • risk taking • creativity	• Conduct a preliminary meeting with the planning team (teacher, teacher team, teacher-learner team). • Think about hyping the episode, processes to be used, goals to be pursued, length of time, and diversity of people to be involved. • Emphasize the fluidity (openness) of the episode (adjustments and new conditions will emerge as the process unfolds).
Initial session with all learners • maximum participation • non-threatening environment • all contributions genuinely accepted by leaders and learners • skills: divergent thinking; classification	• Conduct a brainstorming session with the whole class so that the "technique" can be demonstrated and refined. • Have one, two, or three learners at the blackboard or a 20 foot long "wrapping paper" writing place to record the brainstorm ideas. Note: The natural tendency is for the teacher to be the leader, often resulting in a teacher-dominated direction. Care should be taken to let learners control the direction. • As topics and activities for the water episode are contributed by the learners (the teacher(s) should judiciously suggest items too), each learner should be asked in which position it should be added. In other words, as items are added, the contributor should make a judgment as to the similarity or difference of his/her item to those already suggested, creating cluster categories. This allows the learners to begin to think of new items that are consistent with their experience and ability in brainstorming and categorization. More creative or higher ability students can derive satisfaction from suggesting more divergent items, whereas less experienced or lower ability learners will derive satisfaction from suggesting items that are very similar to ones already on the board. • After one or two sessions, there should be a wide variety of ideas in the form of questions or statements of fact or just phrases suggesting opportunities for investigation. Note: The length and number of the sessions depend on such factors as learner age, previous brainstorming skill development, and ability.

The Purposes for Action	Description of Leader-Learner Activity
Small group refinement • small group discussion skill development • refinement of categorization skills • tolerance of personality diversity • every learner a contributor	• Form groups of four or five to further refine the master list. • Encourage clarification of the items. • Move items to other categories depending on discussion. • Expand or reword items. • Determine new categories or titles for them. • Complete a revised list. • Have each small group share with the other groups their revised list in written form.
Individual or small group interest selection • learner goal setting (realistic yet challenging) • participation in the choice of learning activities	Note: If learners have not had opportunities to learn how to set their own goals and choose activities, some judicious guidance will be needed. • Allow both individual and small group interest selection. This could be done informally over a few days to allow learners to begin to find others with similar interests or discover that one of their interests is unique.
Individual and small group planning • plan & sequence learning activity • decide on responsibilities • set tentative timelines	• Allow time to develop a plan of action: refining activities, problems, or investigations. • Be aware of group decision making. • Allow for individual interests. • Write final plan.

The Purposes for Action	Description of Leader-Learner Activity

Individual and small group activity
• seek information in several different places
• invent, describe and carry out simple cause-and-effect investigations
• speculate on commonly held assumptions about phenomena in their world
• choose appropriately accurate measuring devices
• take time to coherently discuss or explain outcomes of observations and investigations in terms of how they conflict, support or extend their previous understandings
• explore the impact of light and heat on water
• explore different ways of stating who, what, where, why, when questions
• discover patterns
• explore the relative contributions of the components in a system
• explore the significance of historical events related to their activity
• investigate the chemical and physical properties of water
• manipulate various containers to discover and compare capacities
• identify all sides of community issues, the reasons for each side (e.g., lack of information, supporting information, media, emotion) and generate courses of action
• play a variety of roles in group work
• record observations using a variety of technologies
• take time to redesign and repeat investigations
	• Over a period of time, encourage small groups or sometimes individuals to engage in: (1) informational searches; (2) designing and carrying out appropriately complex investigations; (3) designing unique ways to communicate ideas and concepts to others; (4) making connections between or among seemingly disparate concepts; and other learning pursuits.
	• Gently but firmly convey to the learners that they are responsible for their learning, for obtaining information, for assembling needed materials, for working out glitches in the process or plan, and for evaluating their own or their group's work.
	• The brainstorming session should have produced enough activities to last the whole year so the learners (with gentle advice from the leader) should choose one or more activities they would like to pursue in the time available. Often the pursuit of one activity will cause a spinoff activity that will be pursued with great enthusiasm. The learning should be as open-ended as possible with flexibility as great as is comfortable for learners and leader.
	• The following list of learning activities are a sample of those that might have been generated by the learners with minimal input from the teacher. It is important to use the learner-generated list and not just give them this one. The following list is not grade level specific, but suggests a wide range of activity for multi-aged groups, high ability learners, or mixed ability learners:
	  • determining the factors that control the rate ice melts
	  • determining and evaluating the taste of different waters
	  • measuring water volume, flow, temperature
	  • discovering the many different sources of water
	  • finding out why water is called the universal solvent
	  • learning about the three states of water and the processes and conditions of the transformations
	  • investigating nonpoint sources of water pollution and strategies for pollution prevention

The Purposes for Action	Description of Leader-Learner Activity
• discuss, research, and write about current water events • listen to, reflect upon, and interact with ideas and expressions of others • maintain journals of observations and inferences	• water as a beneficial and destructive force • supply, demand, use, and conservation of water • the physical properties of water • scientific discoveries about water • role of water in the various cultures of the world • role of water in biological systems • sports and water • uses of water in production art • meditative, spiritual, aesthetic, and recreational uses of water • the cost of water in selected places or as an ingredient in products • the poetry, prose, and art of water • water as a habitat Note: As you can see, a brainstorming session may result in a very long list of possible investigations or activities.
Assessment ***Conclusion, communication and evaluation*** • analyze and resolve conflicts and debates that occur during learning activities • use appropriate terminology to report investigations of science concepts • use a variety of modes of expression to communicate ideas • maintain group records	• Summarize, analyze, organize and otherwise bring activity to closure. • Evaluate the processes involved in the activity individually and collectively. • Evaluate the activity according to the initial or revised goals. • Determine the format students could/should use for communicating the concluded activity to a leader, parent, peers, community group, or others. • List the content and process learning that accrued. • Reflect on such ideas as confidence, self-esteem, risk-taking, tenacity, patience, assertiveness and others.

Materials

Will vary depending on directions chosen by learners.

WETLANDS AND WASTEWATER

Overview

In this episode, learners gather information and data on wetlands in order to understand their value. In particular, they discover ways in which wetlands can serve as natural sewage treatment systems and then can compare their findings with processes used in treating sewage in their community. To apply their knowledge, learners can then make connections and take actions related to water quality issues in their own community.

Grade Level Range

Intermediate, Middle School, High School

Illustrative Instructional Objective

Learners will share and compare investigative results with other groups, learn about wetland habitat systems and human-designed wastewater systems, identify and address scientific issues of local importance, and then promote and carry out practices that contribute to sustainable wetlands.

Background

The topic of wetlands, including both their ecology and preservation, has become prominent in recent years. A new aspect that is currently emerging is the use of constructed wetlands to treat wastewater.

These constructed wetlands are a new alternative to conventional wastewater treatment. They mimic natural systems in the way they are operated. The designs are still evolving, although it is estimated that there are over 500 systems in operation today.

The most common design is a wetland that is one to three feet deep and built with an impervious bottom and sides. Effluent from a septic tank enters on one side of the wetland and the liquid flows through washed gravel in which emergent wetland plants are growing. These plants then serve to break down pollutants and organic matter.

Because wetland plants are adapted to growing in stagnant water, they have mechanisms to deliver oxygen to their roots. Bacteria living in association with plant roots do most of the work in breaking down the pollutants. Treated water then goes to a drainfield.

Learner outcomes might include:

1. Investigating biological activity in wetlands.
2. Identifying issues related to conserving wetlands, including activities about existing wetlands and constructing new and replacement wetlands.
3. Working with people involved in their community's wastewater treatment.
4. Collecting and using data and information to understand issues related to water quality in their community.
5. Working with other learners to compare and contrast biological activity in wetlands with wastewater treatment systems.

6. Exploring ways that wetlands help filter out nonpoint source pollutants such as stormwater runoff from streets and parking lots or acid mine drainage.

Procedure

Learners can begin this episode by using their skills in gathering information. This episode may be most effective if learners work cooperatively to gather and synthesize information. The synthesis and expression of their findings will provide an opportunity for making connections between natural biological activity and human activity.

1. Students may work in pairs or small groups to select a topic related to wetlands on which they would like to do research. Some of the topics they may choose are: wetland vegetation, birds that breed and stop over in wetlands, wetlands wildlife, how wetlands control flooding, regulations simultaneously allowing the development and protection of wetlands, current issues and legislation related to preserving wetlands, ways that wetland vegetation filters nonpoint source pollutants, recreation and wetlands, and wetlands management. Students can use their school and/or community library, talk with local resource people from government agencies, nature centers or environmental organizations, and/or industrial and commercial developers, and look for current events related to wetlands in newspapers and magazines. They are to learn about their topic in order to share with others so that all learners will have a broad understanding of wetlands.

2. Learners may choose a way to interpret what they have learned to other learners. Creativity should be encouraged. Learners may make visuals, including charts, graphs and pictures; they may write creative stories, songs, poems or drama; they may involve other learners in role plays, discussions, or experiments. Leaders of learners may guide each small group by suggesting methods they may use to share their information with others. After all of the learners have shared, focus the attention of the group on the potential of wetlands in filtering waste. Groups can discuss what they have learned related to their specific topic that can contribute to the whole groups knowledge.

3. New small groups can be formed to learn about human-made wastewater treatment facilities. These new small groups will include learners who have looked at different aspects of wetlands. The learners might tour their local facility or hear from one or more resource people involved with wastewater treatment. Some groups might choose to explore different ways that communities, businesses, and industries treat wastewater. Others might research examples from other communities, especially those that have created wetlands for sewage or mine drainage treatment.

4. The gathered information can then be synthesized by learners. In small groups, they can compare and contrast

what they discovered about wetlands with what they learned about sewage treatment. Emphasize that constructed wetlands are a new technology and that they will not work in every situation. There are still concerns to be worked out related to the design, freezing potential and reduced performance in cold weather, maintenance and operation.

What will be interesting to learners is the way wetlands serve as a natural means of cleansing natural water. This is one of the major values of wetlands. How does our understanding of wetlands influence our perspectives on wastewater treatment? Why is it important to understand biological processes in wetlands when considering wastewater treatment? As a result of what learners have discovered, what further action would they like to take?

Enriching and Expanding This Episode: This episode lends itself very well to active learning. A local environmental organization, state, county or city resource person can help identify a wetland in your area that learners might explore. Many companies have wetlands on their properties that they are conserving and managing. Many wastewater treatment plants offer tours to school groups, and often personnel are available for presentations or consultation by phone. They can also suggest additional resources.

A variety of resource books are available with additional activities to explore wetlands, especially environmental education curriculum guides which contain related activities.

Assessment

Learners may develop a creative way to present their learning to another class or grade level. Invite learners to write letters to community leaders, newspapers or resource people that reflect their interest in wetlands and wetland preservation.

Ask the learners to assess what they have learned. Ask them to write or share with one another at least three new discoveries they made, how their attitudes toward wetlands and wastewater treatment have changed (if they did) and what additional questions they have about wetlands and wastewater treatment. Learners may work individually or in small groups to list as many ways as they can that natural wetlands and sewage treatment are the same and ways in which they differ.

Materials

Will vary depending on investigations chosen.

References

Environmental Building News, Vol. 3, No. 2, March/April 1994.

WHAT CAN YOU LEARN ABOUT A LEAF?

Overview

This learning episode focuses on the processes of observing and classifying through an investigation of various characteristics of leaves and the patterns that can be found in those characteristics. The episode presents one method for approaching the classification of leaves in an inquiry-centered way.

Grade Level Range

Primary

Illustrative Instructional Objective

Learners will select tools, materials, and procedures to explore similarities and differences in leaves by designing, conducting, and repeating investigations individually and collaboratively and then participating in evaluative procedures with other learners and the leader.

Background

The outdoors provides excellent opportunities for learners to expand and enrich their learning skills and become more proficient in their use of the scientific processes. In this activity, the learners collect and observe leaves to determine their characteristics. Various sites are suitable for collecting a variety of leaves necessary for this activity. School grounds, neighboring residential areas (with the owner's permission), or nearby natural areas are suggested.

Although many choices are available, this activity is especially suited to:

- sharpening the learner's attention to detail in observing an object (leaf);
- increasing the learner's ability to notice similarities and differences (among leaves); and
- gaining confidence in planning and carrying out a simple small group activity without constant direction from the leader.

Although learners may discover the names of some of the more common and distinctive tree leaves, this is not the major purpose of the activity. This activity may well be the forerunner to the learner's eventual ability (at a later time) to use their observation skills along with a leaf key to identify leaves on their own.

Procedure

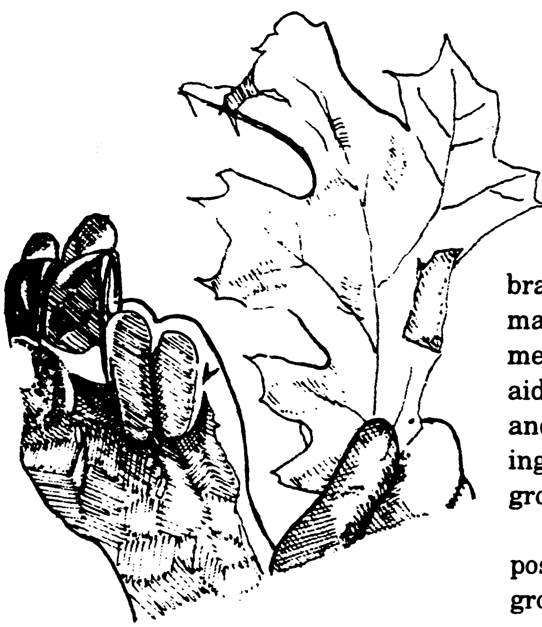
Setting the Stage

- Read a poem or story about trees
- Web what "observation" means
- Introduce the basic purposes of the activity
- Clearly list the responsibilities of the small groups:
  - planning
  - collecting needed materials and equipment
  - doing and recording observations

- Review small group activity behavior if needed

Planning And Preparation

The leaders and learners need to jointly plan how they will collect the leaves for this activity. The learners should be aware of the purposes of the activity and feel confident they can work toward their accomplishment. Small groups need to brainstorm the list of materials and equipment that they need to aid in their collection and observation. Sharing the lists among groups may be useful.



To the extent possible, the small groups should be responsible for gathering the materials and equipment needed for the activity. This relieves the teacher of part of the time commitment usually required and helps the learners increasingly take responsibility for part of a learning activity.

The Observation Activity

- Review the purposes of the activity
- Begin the exploration with a challenge such as "See what you can find out about the leaves."
- Reconvene groups as a whole class for mid-activity sharing using key questions such as:

What interesting observations did you make?

What similarities and differences did you see?

What details did you discover that were entirely new to you?

Are there more things you would like to learn about leaves?

- Groups go back to re-examine leaves using new ideas.
- Close activity by reconvening as a whole group. Re-emphasize the original purposes.
- Make a large chart listing observations made by the learners.

Extensions

- Use leaves to enhance sorting skills. Learners can divide leaves into two categories based on attributes.
- Depending on the sophistication of the learners and the time available, this activity could be broadened to include all green (live) or brown (dead) leaves.
- Groups may pursue the purpose of plant leaves (food factory) or explore the progression from green leaf, to dead leaf, to decomposition of leaves.
- Learners should be encouraged to use their current knowledge and skills as a launching point into new and exciting areas of inquiry.

Assessment

- ❑ During the activity, the leader assesses group work using "Clipboard Cruising Chart." (see sample)

- ❑ Each small group should discuss the question, "How did we do?"

Did we meet our objectives?

Did we get finished?

Did we get better at working with others?

Are we better observers than we were before?

What changes would make our next learning episode better?

Did we enjoy the activity?

What might we like to learn about leaves on our own?

Were we able to accomplish the activity mostly on our own?

- ❑ A similar activity using another group of objects could also be used as an assessment. For example, groups of seeds, feathers, rocks, model cars, marbles or sticks could be observed and compared.

Materials

- an appropriate collection of leaves (3 - 5 varieties with suitable storage containers–Ziplock bags work well)
- magnifying glass or low power microscope (preferably binocular)
- newsprint, crayons, pencils, graph paper, scissors, string, unifix cubes and metric rulers for measuring
- print materials about leaves

Clipboard Cruising Chart

Cooperative Learning Skills

Student Name	Using materials in an appropriate way	Working effectively with others	Verbalizing with the group	Following directions	Making careful observations/ predictions	Willing to try different approaches	Willing to take risks	Recording data accurately	Following through project to completion		

WHAT TO DO WITH MILLIONS OF GALLONS OF WATER IN A COAL MINE

Overview

This learning episode was developed as a result of an actual occurrence in a midwestern state in 1993. The core of this episode is a simulated watershed meeting at which the mine dilemma will be addressed. In preparation for and as an extension of the meeting, learners will explore many of the scientific, economic and social aspects of an environmental dilemma.

Grade Level Range

Middle School, High School

Illustrative Instructional Objective

Learners will seek elaboration and justification of data and ideas, investigate models and theories that help explain the mine and watershed system, participate actively in dialogue about and resolution of this environmental issue, and study and propose improvements in public decision-making activities of the stakeholders.

Background

Water held in an abandoned portion of an active underground coal mine worked its way under an engineered barrier and flowed into much of the remainder of the mine. The company which owned the mine was faced with a difficult situation. Unless this water was quickly pumped from the mine, the rock strata in the mine roof, floor, and walls, as well as the mining equipment, would be permanently damaged. The damage would force the mine to close, and the workers would be unemployed. In addition, economic effects from the mine closing could force the closing of a sister mine. The mine is in an economically depressed area of the state where there are few good paying jobs. The coal from these mines, which was used to produce electricity at a nearby power plant, would have to be replaced with coal from other sources, the cost and reliability of which were uncertain.

The streams into which the mine water would be pumped (released) did not provide public drinking water supplies and were already affected by existing drainage from old abandoned surface mines in the area. Scientific surveys showed ninety percent of the fish in the streams were minnow species.

Unfortunately, the mine water had a high iron content and acidity level. Under normal operating conditions, water from the mine passes through a water treatment facility, where chemicals are added

to raise its pH (lower its acidity). The process of raising the pH of the water causes the formation of a brown iron hydroxide precipitate. This precipitate is allowed to settle out in specially constructed settling ponds. The treated water, which meets all environmental standards, is then released from the pond into receiving streams. The water treatment process protects aquatic life in the receiving streams and also ensures that the streams can be used for other purposes, such as livestock watering and fishing.

The dilemma was posed because the settling ponds at the existing mine water treatment facility did not have the capacity to fully treat the quantities of water which would have to be pumped in order to de-water the mine before serious damage to the roof, floor, and equipment had occurred.

If the water were pumped into the stream totally untreated, most aquatic life in the stream would be killed. On the other hand, treating the water for acidity but not allowing the iron hydroxide to settle out would result in the brown precipitate covering the bottom of the stream. This would affect fewer fish immediately, but would ruin the habitat of bottom-dwelling organisms, including insects and fresh-water mussels, and would thus slow the eventual recovery of all aquatic life in the food web. It was agreed by all concerned that treatment of the water in place, i.e., in the mine, was not feasible.

The company hired ecological experts to work with its own environmental and engineering specialists to come up with a plan to remove the water quickly with the least environmental effect. Discussions between these company representatives and state environmental agencies resulted in a plan to pump the water from the mine, raise its pH slightly (but not enough to create a significant accumulation of precipitate on the creek bottom), and release it into the creek. Several small ponds were quickly constructed to give the chemical used to raise the pH sufficient time to thoroughly mix with the mine water.

This plan was based on a combination of field observations and studies of scientific literature, all of which were undertaken before pumping began. In the field, scientific assessments were made of the types of aquatic life living in the main stream and nearby unaffected streams, of the habitat afforded by the streams, and of the availability of nearby sources of aquatic life to recolonize the stream to be affected. Specialists reviewed the scientific data available on the effects of lower pH, high-iron water on aquatic life, and on the nature and time scale of stream recovery from an environmental disturbance of this type. The state environmental agency also reviewed its own data on the recovery of another stream which it had studied extensively. The prediction of both company and agency scientists was that although immediate damage to the stream would be severe, there would be no permanent effects on the stream or aquatic habitat. Natural recovery of the aquatic life was expected to occur within two years.

The results of the pumping were as expected. Most of the aquatic life which remained in the primary receiving stream did not survive the mine water release. However, the habitat for aquatic life was not significantly altered, which allowed for natural repopulation of stream. Water quality returned to normal shortly after pumping ceased. Natural stream recovery was permitted to take place, with the company taking some steps as advised by natural resource experts to accelerate the natural process.

Although the environment was temporarily degraded, it was restored and no jobs were permanently lost. The mine reopened after seven months of work to rehabilitate the mine's structure and underground equipment. All employees idled by the water problem returned to their jobs.

Procedure

1. Distribute learner information sheets (attachment) and brainstorm scientific, economic and social issues involved in this case study. List the different interests involved.
2. Leaders and learners together should devise a plan for gathering information, presenting the different sides of the issue, and evaluating the project. Differing perspectives representing scientific, economic and social interests should be addressed. Related activities might include:

- Investigating the life cycle of common organisms found in nearby streams.
- Describing the food web associated with aquatic life in a freshwater creek.
- Monitoring the water quality of a nearby creek by observing aquatic macro-invertebrates.
- Watching and discussing videos of fish sampling and laboratory testing.
- Exploring the long- and short-term impact on the aquatic ecosystem of the stream.
- Analyzing the potential economic issues related to the flooding of the coal mine and the subsequent release of the mine water into a creek.
- Investigating the role the mine played in the local community.
- Exploring the local support for the mine, i.e., interviewing people involved in mining both on the management and the labor sides or conducting a community survey.
- Investigating the properties of acids and bases.
- Studying pH levels and how they change.
- Researching how aquatic organisms react differently to water containing iron, depending upon the metal's form and concentration.
- Investigating the chemical reactions that would occur as various chemicals were added to water and improve the pH level (see the sample activity below).
- Noting similarities and differences between experiments they might conduct and actual treatment of water from the coal mine.
- Exploring the long- and short-term aesthetic impact on the area.
- Researching the origins, mining and uses of coal.
- Improving communication and cooperation skills as the pros and cons of possible solutions to this environmental problem are debated.
- Researching the correct procedures for conducting a town (watershed) meeting and setting the rules for the simulation.
- Conducting the following demonstration to simulate one way to treat mine water.

Measure one teaspoon of ferrous sulphate powder into a paper cup. Add a tablespoon of white vinegar. Observe this solution, which represents the acidic mine water with iron in a non-precipitate form. (The solution should be clear). Test with litmus paper (which should show a low pH). Add one to two tablespoons of baking soda to the solution which now represents mine water to which a base has been added. Very gently blow bubbles into the solution or stir to aerate the solution and mix the baking soda thoroughly. Observe the solution again. (A dark brown stain and a coating of precipitate should be visible). This simulates the normal treatment mine water would receive, with the precipitate then settling out in specially constructed ponds. In the environmental dilemma, time did not permit this full treatment of the mine water.

3. Conduct the watershed meeting with learners taking the roles of the following:

   - an officer to preside over the meeting
   - mine representatives including owner, manager, environmental and engineering experts, workers
   - watershed landowners including farmers
   - personnel from government agencies responsible for environmental regulation, wildlife, mining
   - representatives from environmental groups
   - media representatives
   - scientist(s) from local college
   - governor's office
   - state legislators

   Learners not assigned to specific roles would still participate in the discussion and decision making part of the meeting as general watershed residents.

4. The meeting should result in a formal list of recommendations on how to best resolve this dilemma. Share the actual strategies that were used in the "real life" mine flood occurrence as well as the results, and compare with the student recommendations. Allow learners to discuss the differences and similarities, and the pros and cons of each.

Assessment

Learners should take an active role in defining and choosing assessment strategies. Assessment tools could include one or more of the following:

- ❑ Preparing an audio-visual program which illustrates and explains one of our serious environmental problems and technologies and practices which can be applied to solve it.
- ❑ Distinguishing between facts, opinions, and opinions stated as facts by reviewing newspaper articles on environmental issues—can you tell which side of an issue was supported by the magazine or newspaper that reported it?
- ❑ Developing an attitude survey which solicits responses from students and parents about an environmental issue—then compiling the results and preparing a chart or exhibit comparing the results.
- ❑ Researching local laws, ordinances, and information related to a particular environmental issue including the environmental safeguards and costs of compliance.
- ❑ Attending a community meeting and reporting on it to the class.
- ❑ Designing a display showing the differing viewpoints on a specific environmental issue.
- ❑ Compiling a class scrapbook or notebook of environmental articles found in current news magazines—articles could be organized into major environmental categories and ranked in order of the frequency of their mention in the media.

Materials

Will vary according to activities chosen.

LEARNER INFORMATION SHEET

What To Do With Millions of Gallons of Water In a Coal Mine

Problem

Water stored in an abandoned portion of an active underground coal mine has broken through an engineered barrier and flowed into the remainder of the mine. If left in the mine, this water will quickly damage the rock strata in the mine roof, floor and walls, as well as the mining equipment. The damage will force the mine to permanently close. The coal miners will be unemployed, and the coal used to produce electricity at a nearby power plant will have to be obtained from other sources.

Unfortunately, the mine water has a high iron content and is very acidic. Under normal operating conditions, water from the mine passes through a water treatment facility, where chemicals are added to raise its pH (lower the acidity). The process of raising the pH of the water causes the formation of a brown iron hydroxide precipitate. This precipitate is allowed to settle out in specifically constructed settling ponds. The treated water, which meets all environmental standards, is then released from the ponds into receiving streams. The water treatment process protects aquatic life in the receiving streams and also ensures that they can be used for other purposes, such as livestock watering and fishing.

This is a dilemma because the settling ponds at the existing mine water treatment facility do not have the capacity to fully treat the quantities of water which have to be pumped in order to de-water the mine before serious damage to the roof, floor and equipment had occurred. If the water is released totally untreated, most aquatic life in the stream will not survive. On the other hand, treating the water for acidity but not allowing the iron hydroxide to settle out will result in the brown precipitate covering the bottom of the stream. This will affect fewer fish immediately, but will ruin the habitat of bottom-dwelling organisms, including insects and fresh-water mussels, and will thus slow the eventual recovery of all aquatic life in the food web. Treatment of the water in the mine is not feasible.

Possible Solutions *(there may be others—be creative!)*

1. Leave the water in the mine. This would necessitate closing the mine and the permanent loss of the mining jobs and equipment.

2. Pump the water from the mine and release it, untreated, into the stream.

3. Pump the water from the mine, raise its pH slightly (but not enough to create a significant accumulation of precipitate on the creek bottom), and release it to the creek. Several small ponds could be quickly constructed to give the chemical used to raise the pH sufficient time to thoroughly mix with the mine water. This would most likely cause immediate loss of aquatic life in the stream. Natural recovery from this temporary impact would be accelerated by company activities and would be expected to occur within two years.

4. Pump the water from the mine and fully treat it to prevent any effects to the receiving stream. As mentioned above, this could not be completed in time to prevent serious damage to the roof, floor and equipment in the mine.

WHAT'S GOING ON WITH THE WEATHER? GLOBAL CLIMATE CHANGE

Overview

This episode is intended to illustrate the complexity of an environmental issue and the interrelationships among the environment, energy use and economics. It starts with the development of basic scientific knowledge of the climate system and factors that can affect weather and expands to the interactions of environmental concerns over climate change with other societal needs such as energy supply and economic development.

Grade Level Range

Intermediate, Middle School, High School

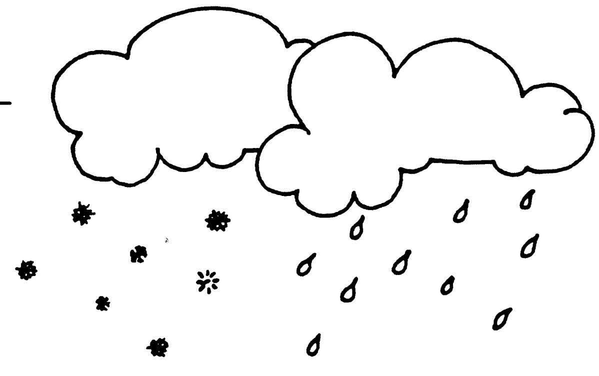
Illustrative Instructional Objective

Learners will work as contributing members of a collaborative group to formulate hypotheses about global climate change, participate in a debate, develop environmental impact statements for the next century, and realize that scientific investigation is always tentative and that newer or more insightful investigations may alter previous understandings.

Background

Item: Six of the warmest years in the past 100 years occurred during the 1980s, making the 1980s the warmest decade on record.

Item: Severe winter weather in 1994 forces extension of school year to make up for extra snow days used.



Based on temperature data that extends back roughly 100 years, the decade of the 1980s appears to include an unusual number of years with average global temperatures higher than normal. This, coupled with an apparent overall small warming trend in the 100-year record, has resulted in speculation that human activity may be altering the global climate. Complex computer models that attempt to predict such alterations suggest that the next century will see even greater warming as well as other consequences of a changed climate.

One of the notable features of the milder weather during the 1980s was a general lack of extended periods of severe winter weather. The winter of 1993-94 broke this pattern with a vengeance, with record low temperatures recorded throughout the Eastern U.S. during January and a series of severe winter storms that brought snow levels unseen since the mid-1970s. This extended period of severe winter weather followed a late winter East Coast storm in March, 1993 referred to as The Storm of the Century.

What is the significance of the 100-year temperature record for predicting future climate patterns? Does the unusually severe winter of 1993-94 suggest that the warming trend of the 1980s is over?

What is the distinction between long-term climate patterns and short-term weather anomalies? What is the possibility for such a climate change? What human activity is occurring that has the potential to impact the climate? What is the significance for changing or halting such activity? These questions and many more relate to the issue of global climate change and the ongoing debate over what action if any should be taken to avoid possible climate change.

Procedure

This episode is intended to illustrate the complexity of an environmental issue and the interrelationships among the environment, energy use and economics by starting with the development of basic scientific knowledge of the climate system and factors that can affect weather and expanding to the interactions of environmental concerns over climate change with other societal needs such as energy supply and economic development. The episode focuses on an exploration of the core concepts of climate and weather, but allows for explorations into related areas of earth systems, energy use and alternative sources of energy, and economic development in the industrialized and developing countries of the world. The episode suggests opportunities to explore the following areas:

- Climate and Weather
- Earth Systems
- Energy: Current Uses and Alternative Sources
- Economics/Politics/Government
- Conflicting Results in Scientific Investigations

Activities related to this learning episode should be planned, implemented and evaluated jointly by the leader and learners. For example, learners should be responsible for preparing invitations for any outside speakers and developing questions to use with speakers, writing thank you notes as appropriate, obtaining research materials from library or other sources, summarizing/graphing results of any weather measurements or data obtained from newspapers or other sources, and discussing in groups or with the entire class information developed during the episode and its relevance to the students.

Getting started

Use a brainstorming technique to generate questions and possible corresponding activities for areas such as the following. Sample questions and activities have been included as examples. Activities could be conducted individually or in groups. Different groups could focus on different topical areas.

The leader should serve as a facilitator and assist learners as they determine what areas to focus on and as they develop a list of results to be achieved. Through critical review and questions, the leader should guide the students to a broad evaluation of the topic or sub-topic.

CLIMATE AND WEATHER

Possible Questions:

What is climate?

What is weather?

How are they related? How do they differ?

What is temperature? How is it measured?

What is precipitation? How is it measured?

What things affect the weather and climate?

How does the weather differ around the world?

How has the climate changed in the past 100 years? 10,000 years? 1,000,000 years?

What may have caused theses changes?

How might human activity affect the weather? Climate?

What is a greenhouse?

What are greenhouse gases?

What greenhouse gases occur naturally? How do they affect the climate?

What greenhouse gases result from human activities?

What changes have occurred in greenhouse gas levels in the past?

What changes in greenhouse gas levels are predicted for the future?

How might these changes affect the climate?

Possible Activities:

- Learn to use a thermometer to record temperature.
- Learn how temperature readings are affected by sunlight, shade, type of surface, etc. by taking readings in different locations in the classroom or outside.
- Check the daily newspaper to record changes in weather locally, statewide and nationally. Compare daily readings to normal values, if possible.
- Chart local temperature readings (daily average, high and low temperature).
- Use newspapers and other media sources to review weather conditions in other parts of the world (The Weather Channel, on-line information services, etc.).
- Chart local temperature readings against readings from other parts of the world.
- Obtain information on long-term climate patterns from Ohio, U.S. and world.
- Construct a "greenhouse" (two-liter soda bottle model).
- Contact a local meteorologist for his/her views on climate issues. Invite them to the classroom for a discussion of climate and weather. Prepare questions for the discussion.

EARTH SYSTEMS

Possible Questions:

What are the different systems that make up the Earth?

How might the atmosphere, ocean and land systems interact?

How might these interactions affect climate?

How might the climate affect these systems?

How might a change in the climate affect these systems?

What steps could be taken to protect some systems if the climate changed?

What is the carbon cycle?

What are the natural sources of carbon dioxide?

How does carbon move between different systems?

How might human activities be affecting this cycle? Energy use? Deforestation?

How does Earth differ from other planets in the solar system?

Possible Activities:

- Prepare a poster illustrating the carbon cycle
- Identify activities by learners/ families that might affect the carbon cycle
- Obtain and graph data on atmospheric levels of carbon dioxide for various time periods
- Discuss possible reasons for changes in those levels
- Prepare a poster/paper comparing Earth, Mars and Venus and explaining why life is possible on Earth.

ENERGY USES AND ALTERNATIVE ENERGY SOURCES

Possible Questions:

What energy sources are currently used in the U.S.? In Ohio?

How do the learners use energy? How does the leader use energy?

What energy sources are used in other countries?

What are the benefits of energy?

What are some of the impacts of energy? In U.S.? In other countries?

How does energy use in the U.S. compare to other countries?

What energy sources are used in other countries?

What are the benefits of energy?

What are some of the impacts of energy? In U.S.? In other countries?

How does energy use in the U.S. compare to other countries?

What are the implications of growth in energy use? In U.S.? In other countries?

What energy sources are available for growth?

What alternative energy sources are available? Solar? Wind? Trees?

What are some of the current problems with these energy sources?

What alternative energy sources might be available in the future?

Possible Activities:

- Interview other members of the household on how they use energy and what it costs.
- Evaluate how an increase in energy costs might affect use. Explore ways that the household could use energy more efficiently.
- Prepare a poster illustrating how learners and their families use energy.
- Invite a representative from an energy company (electric utility, natural gas company, oil company, etc.) for a classroom discussion on energy sources. Prepare questions for discussion beforehand.
- Evaluate and debate relative benefits and impacts of various energy sources (break into groups).

ECONOMICS/POLITICS/ GOVERNMENT

Possible Questions:

How much does energy cost?

How might an increase in energy costs affect the use of energy?

What might the government do to affect the cost of energy?

What might the government do to affect the sources of energy?

What might the government do to affect the emissions of greenhouse gases?

What is the government doing now?

How might this affect Ohio?

Possible Activities:

- Obtain information on what the U.S. is doing to limit greenhouse gas emissions.
- Evaluate how these actions might affect the state of Ohio and people living in Ohio.
- Obtain information on what other countries are doing to limit greenhouse gas emissions.
- Use on-line services to obtain views of other groups on climate change issue.
- Use on-line services to express views of the learners to others.

ACCURACY AND CONFLICTING RESULTS IN SCIENTIFIC INVESTIGATION

Possible Questions:

How do scientists minimize bias, errors, and uncertainty?

Do scientist always report their findings accurately?

How do consumers of scientific investigations know that a study is reliable?

Can scientists sometimes miss important information that might change their results and conclusions?

How do scientists deal with results and conclusions from similar investigations which contradict each other?

How do scientists balance the need to build upon well established and accepted principles and the need to be open to ideas which are new, different or contradictory?

Possible Activities:

- Evaluate investigations by scientists and/or learners for bias and accuracy.
- Find and discuss an article which reports on an investigator who in some way misrepresented results or conclusions from a study.
- Evaluate the reporting of scientific investigations in the media.
- Find examples of new information that calls into question long accepted explanations.

Culminating activity

Use a fishbowl technique to discuss and try to reach consensus on an overarching question such as "Is climate change occurring?" or "What changes should be made in human actions?" If different groups have focused on different areas, have one person from each group sit in a circle (the fishbowl) and discuss the question. The rest of the group observes the fishbowl discussion and are rotated into the fishbowl periodically.

Assessment

A variety of ongoing assessment strategies should be used for learners and leaders to track progress. For example:

- ❑ Keep a journal detailing their activities, investigations and results.
- ❑ Teams of learners design "reports" that present their findings in multiple formats, for example, in pictorial, written and chart form.

- ☐ Fishbowl discussion with the leader and possibly peer reviewers using a checklist to record participation and the quality of contributions.

Materials

Will vary according to activities chosen.

References

Greenhouse Effect and Global Warming, The. Enterprise for Education, Inc. Santa Monica: 1991.

Trends '91: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center. Oak Ridge National Laboratory, December, 1991.

Heated Debate, The. Balling, Robert C. Pacific Research Institute, 1992.

YOUR CITY IS FULL OF ROCKS

Overview

This episode encourages the exploration of the many aspects of geology in an urban area. The springboard ideas presented can be adapted to many grade levels and combined into various configurations of whole class or individual activities.

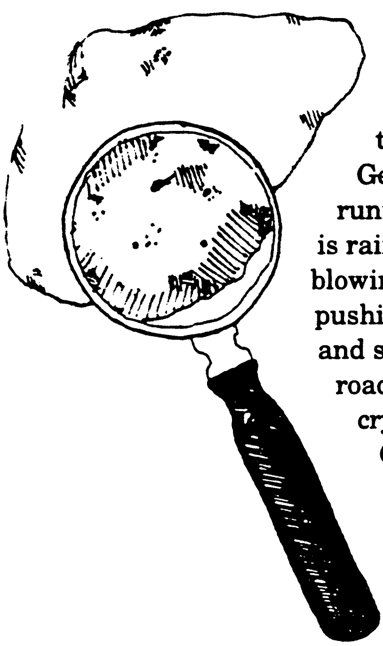
Grade Level Range

Primary to High School

Illustrative Instructional Objective

Learners will take responsibility for equipment, dress appropriately, follow all safety guidelines, and record qualitative and quantitative information about 10 rocks seen on an outdoor scavenger hunt.

Background



Geology is about people, plants, and animals living together on a piece of earth. Geology is tall buildings and rain running down a city street. Geology is rain, snow, sleet, wind, and dust blowing across the city. Geology is the pushing up and breaking of sidewalks and streets. Geology is salt eroding roads and bridges. Geology is finding crystals in the walls of a building. Geology is the rocks and fossils found all around us in the city. This episode demonstrates that each and every city is the perfect learning environment for the study of geology. The learner's concept of geology will definitely be broadened. Furthermore, the learner's attitude and appreciation of city geology will increase significantly as each learner becomes a geologist.

Leaders and learners should review the many springboard ideas presented and select those that apply to their location, interests, and amount of time that can be devoted to this topic. For maximum results in learning and attitudes, activities from this episode need to be ongoing or conducted for an extended time period.

Procedure

The general approach of this ongoing episode is for the learners and leaders to design and perform scientific investigations on his/her immediate environment. As a result of the gained insights, each learner could propose some geology-related improvements for the city. The following are ideas for investigations and activities.

1. Become a detective and find as many different rocks as you can in your city.

2. Compare and contrast rocks found at various locations in the city.

3. Do a "rock hunt" around your school site. See how many different types of "rock" you can find. Which are manufactured and which are natural? Don't forget your school building!

4. Determine that all rocks have minerals, color, texture, hardness, size, shape, mass and dimensions.

5. Design experiments to test each of these properties of rocks.

6. Discover the patterns in rocks and crystals.

7. Learn to use a hand held microscope correctly.

8. Examine all rocks and classify according to Moh's Hardness Scale.

9. Take a field trip to identify and record igneous rocks in your city including granite buildings, curbstones, cobblestones, paving blocks, monuments, statues, etc. Speculate why igneous rocks would be used for this purpose.

10. Identify and record all sedimentary rocks utilized in your city - brownstone and sandstone houses, limestone gravestones and shale.

11. Explore and record imprints found at muddy playgrounds, or in soft asphalt, puddles, and wet pavement or concrete which could become fossils of our current time period if geologic conditions were right.

12. Analyze what object or organism made these imprints—footprints, leaves, seeds, nuts, sticks, shells, etc.

13. Identify and record metamorphic rocks in your city—brick buildings, marble statues, marble steps, marble inside or outside walls of buildings, marble gravestones, brick walls, building stones, crushed gneiss to cover parking lots and shoulders of highways.

14. Compare and contrast igneous, sedimentary and metamorphic properties and uses.

15. Identify manufactured rocks—cement, bricks, concrete blocks.

16. Design a field trip beginning with the oldest rock formations in your city and concluding with the youngest rock formations.

17. Speculate and then design experiments to demonstrate how acid rain affects buildings, monuments and gravestones.

18. Investigate the impact of weathering and weather changes on buildings, monuments, roads and gravestones.

19. Compare and contrast how buildings, sidewalks, monuments, and gravestones change a walk on a sunny day and on a walk on a rainy day (or just afterwards).

20. Create a scavenger hunt of rocks and/or rock uses in your city.

21. Create a city map depicting where different kinds of rocks can be found.

22. Maintain a journal of rock shapes, sizes, colors, patterns, textures, and uses.

23. Create rock sculptures and jewelry.

24. Invite different geology experts in your city to become speakers—building inspectors, building contractors, etc.

25. Learn how to use a rock tumbler.

26. Become rock pen pals with relatives or students from another state and exchange indigenous rocks.

27. Compare and contrast rocks from different states.

28. Seek information on geology-related field trips—cemeteries, banks, government offices, rock hound store, etc.

29. Gain an appreciation of rocks and geology that could become a lifelong hobby.

Assessment

1. Learners report to class information gleaned from experiments.

2. Learners display all their scientific data so comparisons and contrasts can be made.

3. Individual groups can design service projects related to urban geology.

4. Learners communicate to their parents or other classmates the skills, knowledge, processes, and attitudes gained from this episode by means of a play, TV program, debate, assembly, creative writing, etc.

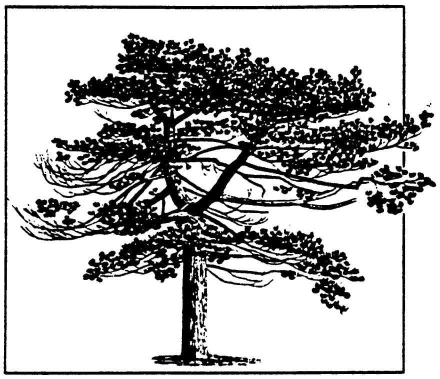
Materials

Will vary according to activities chosen.

Branching Out: Developing Your Own Learning Episodes

Branching Out: Developing Your Own Learning Episodes

One of the major purposes of this document is to stimulate educators to reflect about and design/redesign their curriculum. Hopefully the models and sample learning episodes have stimulated ideas and provided some motivation to try out some new and different learning experiences.



This section outlines four approaches which can be used to branch out from this publication. We encourage you to start today to develop your own ideas, perhaps by doing one of the following.

Modify a Learning Episode From This Publication

One approach is to select a sample learning episode from the "Getting Started" section which closely meets your instructional needs. Try it out, adapt it, and then write up your modifications.

Modify an Existing Learning Activity

Based upon your curricular needs, select an activity which you have written and used before or choose one from a published activity guide (see Appendix D). Evaluate its strengths and weaknesses based upon the components of curriculum and instructional considerations discussed in "The Big Picture: Building Blocks and Models" section. For example, you might ask yourself the following:

- How well do the instructional objectives reflect the four strands—inquiry, knowledge, conditions for learning and applications?
- Is there an emphasis on inquiry learning? Do learners explore and investigate using process skills and thinking skills? Do learners have the opportunity to develop positive attitudes toward environmental investigations?
- Does the activity use an integrated approach? Is it theme-based?
- Is the activity learner-centered? Do learners help plan the episode? make decisions during the episode? do self-assessment?
- What opportunities are there for active hands-on, minds-on learning? Do learners interact with real objects in real environments? Do they interact in a constructivist way with ideas, concepts or questions?
- How many different teaching strategies are used? Do they range from exposition to inquiry? Does learning occur in a different learning environment?
- Do the assessment strategies appropriately match the teaching and learning strategies? Do they represent a diversity of strategies?
- Do learners have the opportunity to work in small groups? cooperatively? collaboratively?

Based upon your answers to these questions, revise the existing learning activity into a "new" learning episode. Your objectives and the learning environment created should also reflect the key

Table 1

Overview of Animal Tracking Unit

Original Approach	*Revised Approach*
Students will write the definitions of the following terms as they apply to animal tracks: print, track, straddle, stride, and leap.	Unobserved by others, students take turns making patterns of tracks by walking, running, hopping, jumping, etc., in the snow. In groups, students then examine each other's tracks and try to guess and/or duplicate how the tracks were made.
Students will name the characteristics of the following kinds of prints: hoofed and padded.	Students observe movements of various animals (either actual or on videotape) and, working in groups, draw and describe the patterns of tracks these animals might make.
Students will list the characteristics of the following gaits: walking, trotting, loping, and galloping.	Groups of students try to match patterns of tracks (actual or in drawings) with the types of movements made by the animals observed.
Students will name the characteristics of the tracks made by perfect and imperfect walkers.	Students classify the animals they observed into groups according to their movement patterns.
Given examples of different types of gaits, students will classify these as walkers, hoppers, bounders, etc.	Working in pairs or small groups, students select or design an investigation to complete on a track topic of interest to them.
Using a key, students will use the above characteristics to identify drawings of animal tracks or real animal tracks.	Students use an animal track key to match animals to the drawings of their tracks.
Given sets of identified and unidentified animal tracks, students will match them.	Students study "track stories" (either real ones they found or drawings) and try to recreate the story (e.g., a set of hopping tracks leads from tree to tree) and then create their own "track stories" in groups and try to retell or act out each other's stories.

Analysis of Approach	*Analysis of Approach*
Emphasis on knowledge strand	Emphasis on inquiry, knowledge, conditions for learning and applications
Emphasis on memorization	Emphasis on development of process skills and investigation
Focus on science	Integrates several disciplines; focuses on "patterns"
Mostly teacher-directed	Mostly learner-centered
Little active, hands-on learning evident	Mostly active, hands-on learning
Little diversity in teaching strategies evident	Incorporates a variety of teaching strategies
Individual learning implied	Emphasis on cooperative learning

components and instructional considerations discussed in the first section. Table 1 provides an overview and analysis of an animal tracking unit, contrasting a teacher's previous approach (traditional lesson) with the revised approach (learning episode).

Develop Your Own Learning Episode

In essence, start with a blank sheet of paper or computer screen. While some people like to work alone, we encourage you to involve a colleague(s) and/or learners in the process. Not only are two or more heads usually better than one, but it is often more fun and exciting.

Based upon your course of study, instructional objectives, and the interests and natural curiosity of learners, begin to develop and write a learning episode.

- Determine the focus (e.g., theme, issue, topic, skill).
- Consider instructional objectives which reflect the four strands.
- Brainstorm ideas.
- Begin to flesh out the "best" ideas.
- Develop your learning episode using your own format or the one from this publication.
- Evaluate the episode based upon the questions listed above.
- Revise.
- Try out the learning episode with learners.
- Revise.

Web a Learning Episode Based Upon a Curriculum Model

Some learning episodes are short-term with a specific focus while others are long-term with a very broad focus. When developing the latter, it is particularly helpful to use a holistic planning strategy. For example, the curriculum models presented in the first section, "The Big Picture," are based upon a process known as webbing. When webbing, you use brainstorming to generate a schematic representation of an idea. This product is known as a web.

A web is an excellent planning tool. While it can be used to map out the ideas and skills within a single learning episode, it is also very effective for showing the relationship among a number of episodes which represent a larger piece of the curriculum (i.e., one of the models). Webs are particularly helpful when using an integrated approach.

As with the previous approach, the web should be based upon your course of study, instructional objectives, and the interests and natural curiosity of learners. In addition, it should be broad-based enough to incorporate a rich array of ideas, resources, and learning opportunities but narrow enough for learners to see the interconnections.

No set procedure exists for producing a web. The process, however, lends itself exceptionally well to a learner-centered approach which would involve learners in the entire development process. The following steps are suggested as guidelines for the process:

1. Select a focus based upon a curriculum model—topic, theme, issue, concept, event, person, book, etc.

2. Brainstorm everything that comes to mind in connection with the central focus—i.e., topics, ideas, and questions which explore and extend the focus.

3. Group the ideas into broad categories. Brainstorm and research additional categories or subcategories.

4. Identify interdisciplinary instructional objectives.

5. Identify a rich array of teaching strategies, activities and resources.

6. Develop the "final" web as well as appropriate learning episodes which
   - set the stage and peak interest,
   - introduce the main focus,
   - provide multiple opportunities for learning, and
   - culminate, summarize and extend.

7. Continually revise the web.

On the following pages, an example is provided of a web on winter, "Winter Wonders," which is used here to model the webbing process. The product of each of the steps outlined above are illustrated on pages 130-133.

Once developed, the richness of this type of web allows for multiple ways to implement it depending on purpose, interest, time and other considerations. The leader and/or learners may decide to only implement part of a web or all of it. For example:

- A classroom could complete the "whole" web by having everyone experience all of the learning episodes for each arm (subtopic) or by dividing into small groups and having each group focus on only one arm.
- A classroom could complete part of the web by doing only a few of the learning episodes from each arm or all of the learning episodes from one arm.
- A school could complete the whole web by having each grade level do a different arm or each grade complete several learning episodes from all arms.

Once an approach is selected, a strategy for keeping track of learners' work and progress is important. For example, each learner can maintain a folder which contains a photocopy of the web. Each time a learning episode is completed by a learner individually, in a small group or by the whole class, he/she should color in or cross off the episode on the web. Evidence of the completed work is then placed in the folder (e.g., poem, drawing, notes from investigation, completed assessment form for a project or presentation).

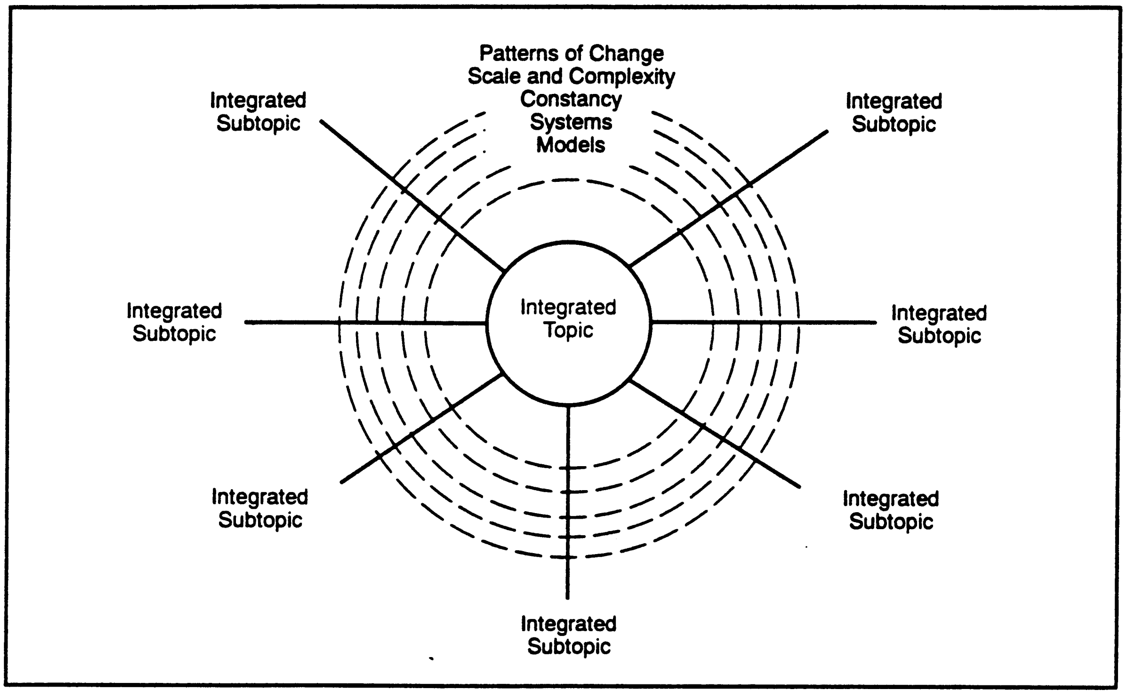
In addition to serving as an organizational tool, the folder can facilitate assessment. Items placed in the folder can be based upon learner contracts where the leader and learners decide which learning episodes will be completed and what criteria will be used to assess them. Some of these, in turn, can be added to the learner's portfolio. In addition, other ideas for assessment can be gleaned from the various learning episodes in the previous section.

Appendix G contains several "blank" models and webs to help you keep branching out. Start now to develop your own ideas into a learning episode using an approach discussed here or one of your own.

STEP 1

Select Focus Based on Curriculum Model

There are many possibilities for curriculum models as indicated by the continuum on page 4. This web, called "Interdisciplinary: Integrated Topic," is based upon a variation of one described in "The Big Picture" and would come between Model 3 and Model 4. This interdisciplinary model focuses on an "integrated topic" with the rays of the web extending to "integrated sub-topics." These sub-topics draw upon different subject areas, blurring the disciplinary boundaries. The emphasis is on the different topics with the five themes interwoven throughout the investigations and explorations of the topics. Based on this model, the focus of this web is on the topic "Winter Wonders."



Steps 2-3

Brainstorm, Categorize, Brainstorm Further

Once the focus is selected, in this case "Winter Wonders," the leader and learners brainstorm ideas. These are then categorized and labeled. Further brainstorming and research can expand the initial web.

WINTER WONDERS

SOCIETY & CULTURE

- Utilities/Energy Conservation
- Services
  - snow removal
  - care for seniors, homeless
  - emergency
- Livable winter cities
- Farm Life
- Food
  - winter fruits/vegetables
  - maple syrup
- Recreation and Games
- Winter Around the World

SHAPERS OF THE EARTH

- Glaciers
- Snow Slides & Avalanches
- Effects of Freezing & Thawing
  - soil formation
  - heave sidewalks
  - crack walls
  - break pipes, gutters

WEATHER & CLIMATE

- Reason for Seasons
- Weather Patterns
- Wind Chill
- Wind Effect
- Temperature
- Snow Distribution
- Winter Storm Safety Rules

SNOW AND ICE

- Snowflakes
- Frost
- Icicles
- Showdrifts
- Sublimation
- Amount of Snow to Water
- Freezing and Melting
- Condensation & Evaporation
- Snow Cover and Temperature
- Signs of Pollution

SURVIVAL, SAFETY & HEALTH

- Winter Storm Safety Rules
- Travel (auto)
- Hypothermia
- Clothing
- Ice & Snow Safety
  - food
  - shelter
  - make snowshoes

AWARENESS & AESTHETICS

- Scavenger Hunt
- Perceptions & Attitudes
- Personal Expression

ANIMALS

- Migration
- Hibernation
- Physical Adaptations
  - color
  - coats
- Food
  - storage
  - feeding
- Shelter
- Tracks and Tracking
- Insects

STREAMS, PONDS & LAKES

- Mapping
  - ice thickness
  - depth of water
  - temperature
- Light Penetration
- Water Currents
- Plankton Collecting
- Bottom Vegetaion
- Water Sampling
- Ice Fishing
- Ice Safety

PLANTS

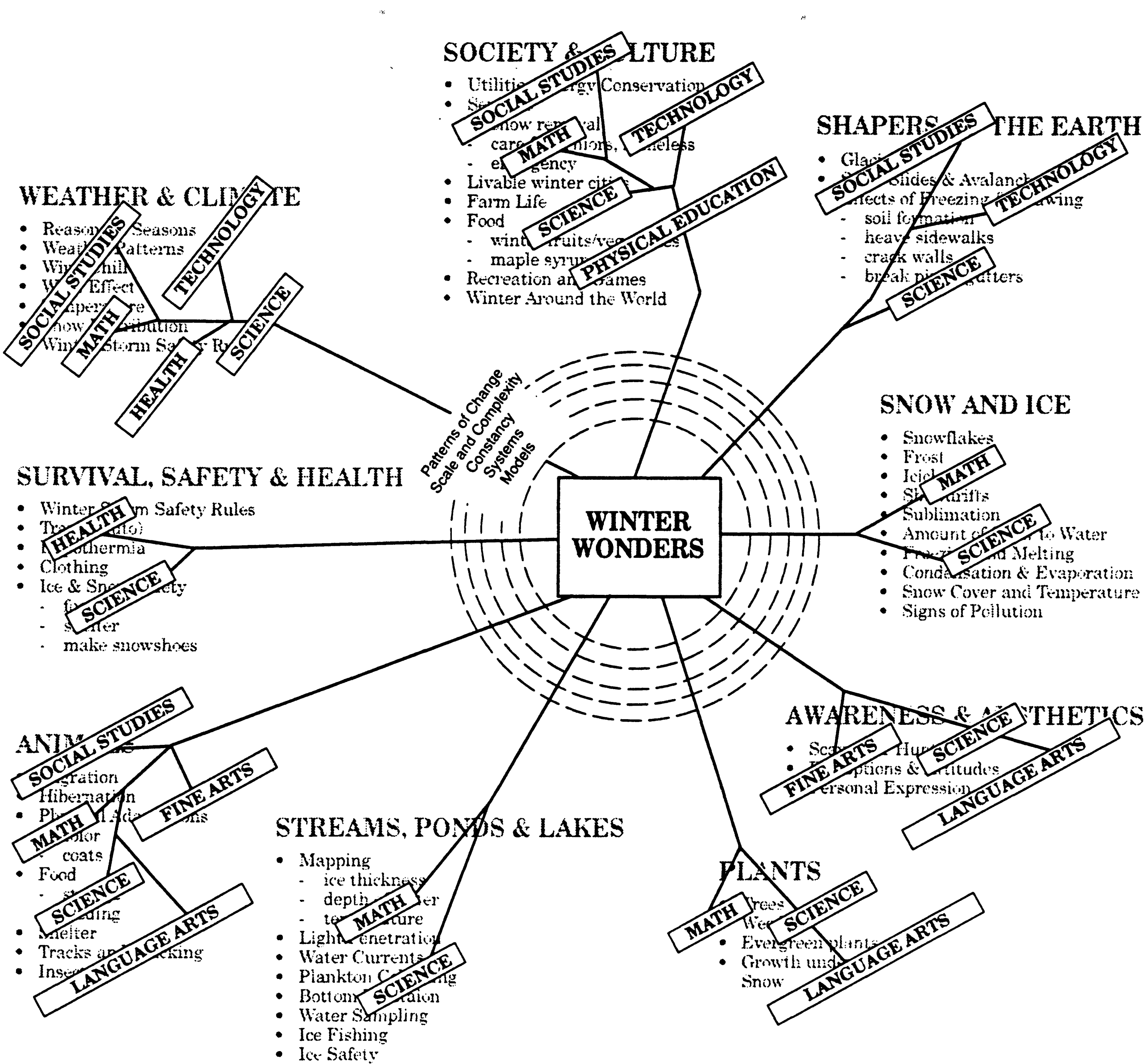
- Trees
- Weeds
- Evergreen plants
- Growth under the Snow

Step 4

Identify Interdisciplinary Instructional Objectives

This figure shows the integrated topic and subtopic with the interdisciplinary connections. Instructional objectives would not only reflect this integration but also incorporate the themes (e.g., patterns of change, constancy). Objectives would only be written for the specific parts of the web which leaders/learners decide to implement.

Example objective: Working in collaborative groups, learners will explore patterns of change in migratory birds in their community over the last twenty years.



Steps 5-6

Identify teaching strategies and develop "final" web

This figure is based upon the subtopic "Animals" from the previous web (Step 4). It illustrates the different learning episodes which could be used to teach this arm of the web. Some of these would be adapted from existing materials, some would be developed by the leader of learners, and some by the learners. Table 2 lists the sources of these learning episodes. If the class is going to do another arm, a similar web would be developed (e.g., weather and climate). The number of subtopics developed and the number of learning episodes identified per subtopic depends upon many factors including time and interest of learners.

WINTER ANIMALS--SUGGESTED ACTIVITIES

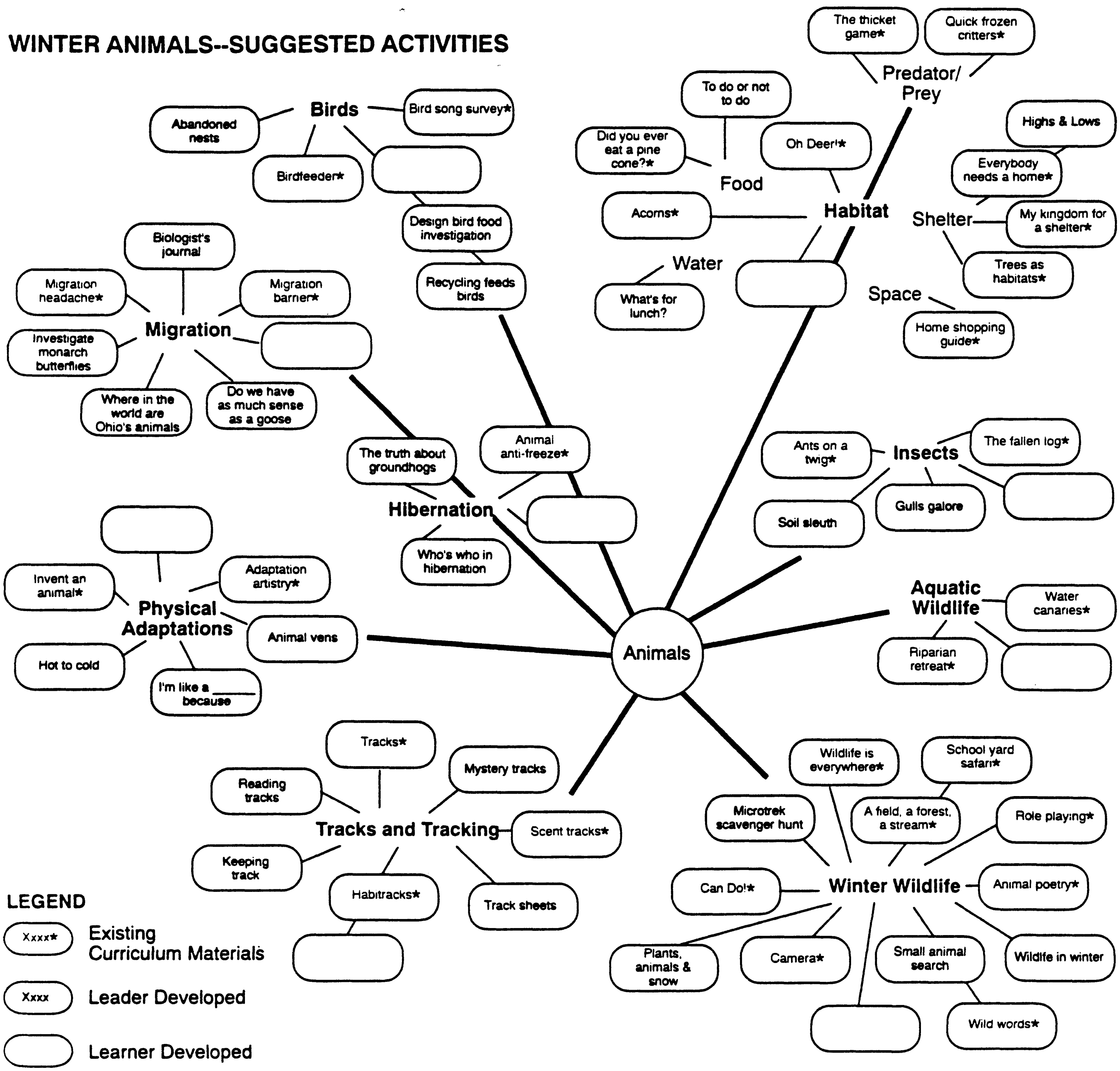


TABLE 2

Winter Animals – Suggested Activities

Migration

Existing: Migration Barriers (Project WILD); Migration Headache (Aquatic Project WILD)
Teacher Developed: Investigate migration of monarch butterflies; Where in the World are Ohio's Animals in Winter (project); read "Do We Have as Much Sense" (extensions); Biologist's Journal (write journal as if following a migrating animal).

Hibernation

Existing: Animal Anti-freeze (OBIS)
Teacher Developed: The Truth About Groundhogs (project); Who's Who in Ohio Hibernation (project)

Physical Adaptations

Existing: Invent an Animal (OBIS); Adaptation Artistry (Project WILD)
Teacher Developed: Hot to Cold (propose adaptations for desert animal evolving to cold climate); I'm like a _____ because...(choose an animal and explain in writing how your winter adaptations are the same and different); Animal Venns (compare winter adaptations for two animals)

Tracks and Tracking

Existing: Scent Track (OBIS); Tracks; Habitracks (Project WILD)
Teacher Developed: Reading Tracks (cards give students a "track task" to do in unbroken snow – hop on one foot; other students try to figure out); Keeping Track (select site and observe tracks over time); Mystery Tracks (decipher story depicted by tracks); Track Sheets (data sheets for observing tracks)

Winter Wildlife

Existing: School Yard Safari; A Field, a Forest and a Stream (Project Learning Tree); Wildlife is Everywhere; Microtrek Scavenger Hunt; Animal Poetry; Wild Words; Can Do! (Project WILD); Role Playing (Sharing Nature); Camera (Sharing Joy of Nature)
Teacher Developed: Small Animal Search (data sheet); read "Wildlife in Winter" (questions); Plants, Animals and Snow (task cards)

Aquatic Wildlife

Existing: Riparian Retreat; Water Canaries (Aquatic Project WILD)

Insects

Existing: Fallen Log (Project Learning Tree); Ants on a Twig (Project WILD)
Teacher Developed: Soil Sleuth (bring in "frozen" soil and observe); Galls Galore (investigation)

Habitat

Existing: Acorns (OBIS); Trees as Habitats; Did You Ever Eat a Pine Cone (Project Learning Tree); Everybody Needs a Home; My Kingdom for a Shelter; Oh, Deer!; The Thicket Game; Quick Frozen Critters (Project WILD)
Teacher Developed: To Do or Not To Do (debate the role of humans in feeding animals during winter); Highs and Lows (find warm home by taking temperature; data sheet); What's for Lunch (investigate animal eating habits); Home Shopping Guide (write ads telling features of different animal homes)

Birds

Existing: Birdfeeder (OBIS); Bird Song Survey (Project WILD)
Teacher Developed: Abandoned Nest (find and identify bird nests; map locations; observe site in spring for birds); Recycling Feeds Birds (use "trash" to make feeders); design investigation on bird food and feeding habits

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APPENDIX A

Ohio's Model Competency-Based Science Program

Key Components

The following outline briefly identifies and explains the key components of the model science program. Each section corresponds to Figure 1 (p. 8) of the science model and illustrates the relationship among the components.

I. Spirit and Intent (Philosophy)

1. Science is for all students.

2. Science content must actively engage learners.

3. Science programs should be articulated, preK-12, by means of organizing concepts.

4. Science content should be grounded in and connect the three domains of science - physical, living, and earth/space systems.

5. Science programs must adequately reflect all four strands of the Model—Scientific Inquiry, Scientific Knowledge, Conditions for Learning Science, and Applications for Science Learning.

6. Science instructional and performance objectives should emphasize higher order thinking skills and complex performances.

II. Five Goals (Goals)

1. **The Nature of Science.** To enable students to understand and engage in scientific inquiry; to develop positive attitudes toward the scientific enterprise; and to make decisions that are evidence-based and reflect a thorough understanding of the interrelationships among science, technology, and society.

2. **The Physical Setting.** To enable students to describe the relationship between the physical universe and the living environment, and to reflect upon and be able to apply the principles on which the physical universe seems to run.

3. **The Living Environment.** To enable students to describe the relationship between the structure and functions of organisms, to assess how organisms interact with one another and the physical setting, and to make decisions that ensure a sustainable environment.

4. **Societal Perspectives.** To enable students to analyze the interactions of science, technology and society, in the past, present and future.

5. **Thematic Ideas.** To enable students to use major scientific ideas to explore phenomena, inform their decisions, resolve issues, and solve problems; and to explain how things work.

III. Five Themes (Organizing Concepts)

1. **Systems**—any collection of things that have some influence on one another and appear to constitute a unified whole.

2. **Models**—a simplified imitation of something that helps people understand it better.

3. **Constancy**—ways in which systems do not change.

4. **Patterns of Change**—changes in systems that are steady trends, occur in cycles, or are irregular.

5. **Scale & Complexity**—ranges in magnitude in the universe and the relationship between magnitude of scale and levels of complexity.

IV. Four Strands (Instructional Objective Components)

1. **Scientific Inquiry**—the desired technical skills and abilities;

2. **Scientific Knowledge**—the big ideas of science to be studied;

3. **Conditions for Learning Science**—the strategies and activities for learning; and

4. **Applications for Science Learning**—ideas for how learners may use their learning.

V. Performance Objectives

1. Based on instructional objectives

2. Essential knowledge and skills expected of learners

MODEL COMPETENCY-BASED SCIENCE PROGRAM

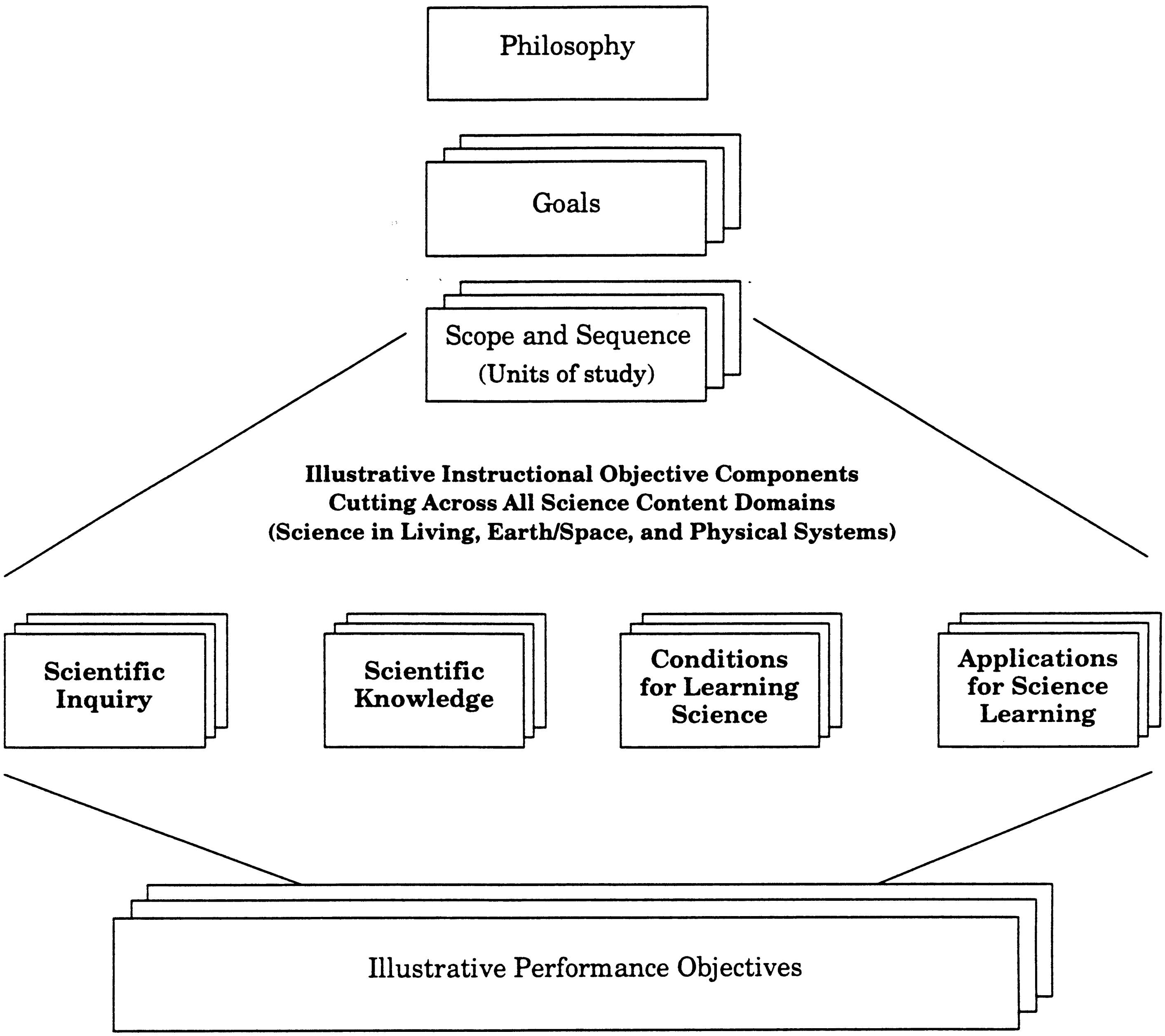

Figure 1. The diagram above is provided to communicate the structure and relationship of components of a local science curriculum based on Ohio's Model Competency-Based Science Program. It illustrates that the program begins with a Science Program Philosophy which is elaborated in the Science Program Goals. To achieve these goals, a scope and sequence framework of instructional units is designed. Units representing the three domains of science are organized on this framework and are enriched by blending components from the four instructional strands into instructional objectives. Finally, performance objectives are constructed from these instructional objectives.

APPENDIX B

Guidelines for Environmental Education Activities

Developed by

ENVIRONMENTAL EDUCATION COUNCIL OF OHIO

(Formerly Ohio Conservation and Outdoor Education Association)

The EECO Board of Directors believes that the following guidelines represent sound environmental education and that they apply to all EECO activities. The guidelines are grouped under three broad headings: 1) what is learned (content), 2) how it is learned (instructional processes), and 3) professional development.

1. What Is Learned (Content)

The guidelines for content address "what is learned" by learners, how it is organized and how it relates to learners. Content includes the knowledge, skills, attitudes and behaviors that are the subject matter of EECO's programs, products and services. Content should:

a. clearly show connections to the environment and/or environmental concerns.

b. include a balanced emphasis that includes all domains of learning.

Knowledge emphasizes conceptual understanding.

Skills include a full range of processes, higher level thinking and communication skills which encourage lifelong learning.

Attitudes and values involve analysis and clarification of individual and group attitudes and values rather than the acceptance of a particular set of attitudes and values.

Behavior refers to individual and collective actions that contribute to healthy and sustainable living in our global community, linking today's actions with future consequences. It includes an emphasis on the strategies that lead to responsible behavior and global stewardship.

c. emphasize an integrated thematic approach (interdisciplinary or transdisciplinary) where ideas are expressed through unifying themes and big ideas (holistic) rather than isolated parts (piecemeal).

d. relate learning to real world contexts, emphasizing personal relevancy and societal issues.

e. provide information that is accurate and that considers and values differing points of view.

2. How It Is Learned (Instructional Processes)

Learning is a lifelong process. The guidelines for instruction address how learners learn content, the role of learners and leaders of learners (educators), methods of instruction, and individual needs in learning. These guidelines need to be considered for all instructional strategies and in all learning environments. Instruction should:

a. be based upon constructivist theory which recognizes that learners build upon prior knowledge, experience, and predispositions and that learners construct knowledge and make meaning (build theories) through investigations, discussions, applications and other modes of active learning.

b. emphasize open-ended inquiry and experiential learning through an exciting hands-on, minds-on approach which includes physical involvement as well as problem solving, decision making, reasoning and creative thinking.

c. promote learner-centered learning where the learner is involved in all phases of learning from planning to assessment and the leader of learners acts as a facilitator, coach, and mentor.

d. include authentic assessment which focuses on learning outcomes.

e. encourage the use of cooperative and collaborative learning.

f. involve a mixture of whole group, small group and individual learning.

g. encourage multi-age teaching and learning.

h. include a variety of instructional strategies.

i. occur in a variety of learning settings.

j. meet the diverse needs of individual learners and leaders of learners taking into account multiple intelligences, different learning styles and developmental needs of the whole person (social, emotional, physical, mental, intellectual, aesthetic and spiritual).

k. encourage creative expression of personal connections to the environment.

3. Professional Development

The guidelines for professional development address the fact that becoming an effective leader of learners is a process that extends over a career and even a lifetime. We grow individually and personally as we develop our own abilities and we grow with our field as our ideas about what constitutes effective teaching and learning evolve. Therefore, professional development should:

a. model the best of what we currently know about teaching and learning as described by the guidelines.

b. address the need for different levels and types of professional development opportunities to meet the different needs and abilities of individuals.

c. encourage short term as well as comprehensive, long-range efforts which include follow-up activities.

d. be planned and carried out because of individual initiatives.

APPENDIX C-1

Learning Skills

The following lists are provided to illustrate the wide range of skills which individuals need as lifelong learners and are able to develop as a result of well designed learning episodes.

Science Process Skills

Observing
Classifying
Using space/time relationships
Using numbers
Communicating
Measuring
Predicting
Inferring
Formulating hypotheses
Controlling variables
Experimenting
Defining operationally
Formulating models
Interpreting data

Critical Thinking Skills

Observing
Comparing and contrasting
Classifying and categorizing
Sequencing/ordering
Distinguishing fact/opinion
Distinguishing relevant/irrelevant
Determining reliable/unreliable
Questioning
Inferring cause/effect
Identifying assumptions/ambiguous claims
Recognizing bias/points of view
Reasoning inductively/deductively

Problem Solving Skills

Identify and define the problem
Gather information and data
Organize and analyze information and data
Identify possible solutions
Analyze pros/cons of each
Choose solution and develop plan
Implement
Evaluate and revise

Decision Making Skills

Define the goal
Identify alternatives
Analyze positive and negative consequences
Rank alternatives
Evaluate the highest ranked alternatives
Act on the "best" alternative(s)

Communication Skills

Listening
Speaking
Writing
Discussing
Dramatizing
Drawing and symbolizing
Reading
Nonverbal

Research Skills

Conducting surveys, interviews, questionnaires
Searching databases, card catalogs, etc.
Using primary and secondary source documents
Using reference books and materials

Psychomotor Skills

Manipulating materials and equipment
Using fine/large motor skills

Mathematical Skills

Computing
Estimating
Graphing/Projecting trends
Problem solving
Determining probability
Analyzing data

Interpersonal Relations Skills

Cooperating
Building consensus
Developing group process skills
Improving leadership skills

Adapted from:

Ohio Department of Education. (1985). Energy and Resource Conservation. Columbus, OH.

APPENDIX C-2

Science and Environmental Education Themes Summary Chart

Earth Systems	Project 2061	California Framework	BSCS	NCISE Elementary	NAEP	Ohio Model	Sunship Earth	PLT	EE Learning Exp (PACID)
				Organization					Patterns
Aesthetics	Constancy	Stability	Cause & Effect	Cause & Effect		Constancy			
Interaction	Patterns of Change	Patterns of Change	Change & Conservation	Change	Patterns of Change	Patterns of Change	Change	Patterns of Change	Change
		Energy	Energy & Matter				Energy Flow		
	Scale	Scale & Structure	Time & Scale	Scale		Scale & Complexity		Structure & Scale	
Evolution	Evolution	Evolution	Evolution & Equilibrium				Adaptation		Adaptation
Scale & Systems	Systems	Systems & Interactions	Systems & Interactions	Systems	Systems	Systems	Cycles	Systems	
Nature of Science			Probability & Prediction						
			Structure & Function	Structure & Function					
Careers				Discontinuous & continuous properties (Variation)					
			Diversity & Variation	Diversity			Diversity	Diversity	Diversity
							Community		
	Models		Models & Theories	Models	Models	Models			
Human Impact							Inter-relationships	Inter-relationships	Inter-dependence

APPENDIX C-3

Traditional vs. Constructivist Classroom

The following summarizes one discussion of the attributes of traditional and constructivist classrooms. These types of comparisons, however, are complicated.

You are encouraged to pursue further readings.

Adapted from:
Brooks, J. G., & Brooks, M.G. (1993). The Case For Constructivist Classrooms. Alexandria, VA: ASCD.

	Traditional Classrooms	*Constructivist Classrooms*
Curriculum	Presented part to whole; emphasis on basic skills	Presented whole to part; emphasis on big concepts and thinking skills
	Fixed curriculum	Responsive to student questions and interest
	Relies heavily on textbooks and workbooks	Relies heavily on primary sources of data and manipulative materials
Role of Students	"Blank slates" onto which information is etched by the teacher	Thinkers with emerging theories about the world
	Works alone	Works in groups
Role of Teacher	Generally behaves in a didactic manner; disseminates information to students	Generally behaves in an interactive manner; mediates the environment for students
	Seeks the correct answer to validate student learning	Seeks the students' points of view in order to understand students' present conceptions for use in subsequent lessons
Assessment	Viewed as separate from teaching and occurs almost entirely through testing	Interwoven with teaching and occurs through teacher observations of students at work and through student exhibitions and portfolios

APPENDIX C-4

Authentic Assessment

The first part of this appendix contrasts traditional assessment with authentic assessment. This is followed by a brief overview of the nature of performance assessment tasks, elements to consider when getting started and types of strategies to use.

* Adapted from materials developed by Brian Tash, Consultant, P.O. Box 234027, Leucadia, CA 42023.

*I. Comparison Between Traditional and Authentic Assessment **

Traditional Assessment	**Authentic Assessment**
Based on premise that all children learn at the same rate and develop at the same time	Allows for individual learning styles and rates of growth
Skill specific	Looks at skills in the context of a greater problem
Leads to drill and practice of low level skills	Promotes higher level thinking skills and creative strategies for solving problems
Promotes memorizing for the test and then forgetting—short term rote learning	Promotes understanding of concepts
Generally, one right answer, one correct approach	Strategy and approach are as important as actual solution; allows for multiple approaches and different reasonable solutions
Leads to "teaching to the test"	Promotes creative, developmentally appropriate instructional practices
Students penalized for being slow	Time is not a factor
Teacher is the sole judge Assessment is generally weekly	Assessment is an on-going part of everyday classroom activities; the teacher, peers, and student are all part of the assessment process

II. Characteristics of Enriched Performance Assessment Tasks

- Grounded in real-world contexts
- Deal with "big ideas" and major concepts
- Broad in scope, integrating several principles and concepts
- Blend essential content with essential processes
- Present non-routine, open-ended and loosely structured problems requiring students to define problem and develop solution strategy
- Encourage group discussion and brainstorming
- Stimulate students to make connections and generalizations
- Require students to use a variety of skills for acquiring information and for communicating

III. Tips

- **Develop Clear Goals**
  - For the instruction
  - For the assessment
  - Involve students
  - Expectations communicated prior to activity
- **Use a Variety of Assessments**
  - Diversity of formats
  - Reflect the complexity of learning
- **Develop Method of Scoring**
  - As holistic as possible
  - Rubrics
  - Include student self-assessment

IV. Types of Assessment Strategies

- Multiple-choice questions
- Short answers
- Oral responses
- Pictorial responses
- Performance tasks: analysis & application
- Observational checklist
- Interviews
- Self-reports
- Portfolios
- Justified multiple-choice questions
- Essay responses
- Written responses
- Long-term projects
- Performance tasks: practical skills
- Poster sessions
- Participant observation
- Journals

APPENDIX C-5

Cooperative Learning

Although teachers frequently use group work in science, particularly in lab activities, those persons whose area of expertise is cooperative learning maintain that group work and cooperative learning are not synonymous. Cooperative learning is more than telling your class, "Get your desks moved into groups of four." This section provides additional information about the characteristics of cooperative learning and how it differs from other group work.

Why Cooperative Learning in Science?

Roger and David Johnson (1991) answer this question by pointing out that a quick look through the table of contents of scientific journals will illustrate the cooperative nature of most journal articles. In addition, observation in science classes in which hands-on activities are taking place will usually reveal students working in pairs or small groups.

Writing in *Science for All Americans,* Rutherford and Ahlgren (1990:189) in their discussion of effective teaching and learning of science, mathematics and technology say:

> The collaborative nature of scientific and technological work should be strongly reinforced by frequent group activity in the classroom. Scientists and engineers work mostly in groups and less often as isolated investigators. Similarly, students should gain experience sharing responsibility for learning with each other. In the process of coming to common understandings, students in a group must frequently inform each other about procedures and meaning, argue over findings, and assess how the task is progressing. In the context of team responsibility, feedback and communication become more realistic and of a character very different from the usual individualistic textbook-homework-recitation approach.

Johnson and Johnson consider the primary responsibilities of education to be learning and socialization, both of which are social processes (1987:69). However, Glasser says that, in today's typical classroom, students work alone and are frequently reminded not to talk and to keep their eyes on their own work (Gough, 1987:659).

Common approaches to instruction are competition, cooperation, and individual work. Johnson and Johnson (1987:67) contend ". . .There is clear evidence that American students see school as a competitive experience where it is vital to be at the top of your class and beat most of the other students. . ." Johnson and Johnson further hypothesize, based on their research and that of other individuals, that if the competitive and individualistic goal structures of American education were to be less dominant and if cooperative learning were used more widely and more often, students would learn more science and mathematics, like these subjects to a greater degree than they now do, come to feel better about themselves as science (or mathematics) students, and come to have a more healthy attitude toward the acceptance of differences in their classmates (1987:68).

Johnson and Johnson also assert that the research data on cooperative learning show that its use leads to students learning more material, feeling more confident and motivated to learn, exhibiting higher achievement, having greater competence in critical thinking, possessing more positive attitudes toward the subject studied, exhibiting greater competence in collaborative activities, having greater psychological health, and accepting differences among their peers (1984, 1987). They point out that patterns of student interactions in classes and the effects of these interactions on learning are vastly underestimated as a factor in learning (1987:46).

Some Characteristics of Cooperative Learning

David and Roger Johnson and Robert E. Slavin have published numerous articles and books on cooperative learning. The Johnsons (1984) have identified four basic elements in cooperative learning: 1) interdependence among students seeking mutual goals through combined efforts; 2) face-to-face interaction among students; 3) individual accountability for mastery of the material covered; and 4) appropriate use of interpersonal and small-group skills by students. The Johnsons say that effective implementation of cooperative learning involves specifying instructional objectives; placing students in appropriate learning groups; explaining to students the academic tasks and cooperative methods to be used in achieving these tasks; monitoring the progress of the groups and, when necessary, intervening to provide assistance; and evaluating student achievements with student input.

Slavin (1989) cautions that, in recent years, cooperative learning has been proposed as a solution to many problems in education. Slavin thinks that under certain circumstances, the use of cooperative learning can help educators achieve many of their goals. He points out, however, that all forms of cooperative learning are not equally effective for all goals. Because achievement is a frequently desired goal, Slavin stresses that two conditions must be present if achievement effects are to be produced: 1) a group goal that is important to the group must be present; and 2) individual accountability must be necessary—the success of the group must depend on the individual learning of all group members. If one condition is present, but not the other, the method is less effective in Slavin's opinion (1989:31).

Slavin is concerned that teachers do not really understand what is involved in cooperative learning. In his opinion, possibilities exist to oversell cooperative learning as well as to undertrain teachers in its use (1990:3). The Johnsons agree with Slavin's contention that training takes more than one three-hour inservice lesson. They say that teachers need to use cooperative learning procedures regularly for several years to become proficient and that teachers need to be given classroom assistance as they attempt implementation (1984:4).

To review, cooperative learning involves:

- positive interdependence
- face-to-face interaction among students
- individual accountability for mastering the assigned material
- appropriate use of interpersonal and small-group skills.

Figure 1 provides a comparison of cooperative learning and small group activities. (Adapted from Ellis and Whalen, 1990:15)

Some Varieties of Cooperative Learning

This appendix is not sufficiently long enough to accommodate detailed discussions of the more common varieties of cooperative learning. Readers who wish to

FIGURE 1

Cooperative Groups	Small Groups
Positive interdependence. Students sink or swim together. Face-to face verbal communication.	No interdependence. Students work on their own, often or occasionally checking their answers with other students.
Individual accountability; each pupil must master the material.	Hitchhiking; some students let others do most or all of the work, then copy.
Teachers teach social skills needed for successful group work.	Social skills are not systematically taught.
Teacher monitors students' behavior.	Teacher does not directly observe student behavior, often works with a few students or works on other tasks.
Feedback and discussion of students' behavior are integral parts of ending the activity before moving on.	No discussion of how well students worked together, other than general comments such as "Nice job," or "Next time, try to work more quietly."

learn more are advised to consult other publications and to conduct their own searches of the ERIC database for additional references and information. The following briefly describes three strategies.

Circles of Learning. In 1984, David and Roger Johnson described their process for cooperative learning. Its implementation involves 18 steps: 1) clearly specify instructional objectives; 2) limit group size to no more than six; 3) structure groups for heterogeneity relative to ability, sex, ethnicity; 4) arrange groups in circle to facilitate communications; 5) use instructional material to promote interdependence among students; 6) assign roles to ensure interdependence; 7) explain the academic task; 8) structure positive goal interdependence; 9) structure individual accountability for learning so that all group members must contribute; 10) structure inter-group cooperation; 11) explain criteria for success; 12) specify desired behaviors; 13) monitor students' behavior continually for problems with the task or with collaborative efforts; 14) provide task assistance; 15) intervene to teach collaborative skills, if necessary; 16) provide closure to lesson with summaries by students and teacher; 17) evaluate the students' work; and 18) assess group functioning through ongoing observation during lessons and discussion of group process after the lesson or units is completed (Johnson et.al., 1984: 26-40).

Jigsaw. This cooperative learning method was developed by Aronson (The Jigsaw Classroom, 1987) and adapted by Slavin and Kagan. (There are now two additional versions: Jigsaw II and Jigsaw III). In this method, each student in a group is given information or a topic that comprises part of the lesson. Each student in the group focuses on a different piece of the lesson. All students need to know all information to be successful. Students leave their original group and form an "expert group" in which all persons with the same piece of information get together, study it, and decide how to teach it to their peers in the original group. After this is accomplished, students return to their original groups, and each teaches his/her portion of the lesson to the others in the group. Students work cooperatively in two different groups, their group and the expert group.

Group Investigation. This method, developed by Sharan and others, emphasizes more student choice and control than do other cooperative methods. Students are involved in planning what to study and how to investigate.

Cooperative groups are formed on the basis of common interest in a particular aspect of a general topic. All group members help plan how they will research the topic and divide the work among themselves. Then each carries out her/his part of the investigation. The group synthesizes and summarizes the work and presents its findings to the class (Sharan and Sharan, 1990:17).

This method is an attempt to combine democratic process and academic inquiry. The teacher needs to adopt an indirect style of leadership, acting as a resource person while providing direction and clarification as needed. The teacher's task is to create a stimulating work environment.

Cooperative Learning: Benefits Revisited

Cooperative learning prepares students for today's society. It promotes active learning— students learn more when they talk and work together than when they listen passively. It motivates, leads to academic gains, fosters respect for diversity, and advances language skills (Mergedollar and Packer, 1989). It breaks down stereotypes and leads to an increase in self-esteem (Uscher, 1986). It builds cooperative skills, such as communications, interaction, cooperative planning, sharing of ideas, and synthesizing ideas (Sharan and Sharan, 1987: 24). It is a method of promoting academic achievement that is not expensive to implement (Lyman and Foyle, 1988).

Excerpted and adapted from:

Blosser, P.E. (1993, January). Using cooperative learning in science education. The Science Outlook (An informational bulletin from ERIC/CSMEE).

APPENDIX C-6

Variety of Teaching Strategies From Exposition To Inquiry

A wide variety of teaching strategies should be used to meet the diverse learning styles and needs of learners. These should encompass the full range along a continuum from exposition to inquiry.

Possible Strategies

(loosely organized from exposition to inquiry)

Exposition
  Textbooks, fiction, non-fiction, other print materials, audio-visuals, lecture, guest speakers, storytelling, dramatization
Computer-assisted instruction
Discussion
Demonstrations
Drill and practice
Recitation
Guided imagery/simulated field trips
Brainstorming
Sensory awareness/observation activities
Investigations and experiments (hands-on, minds-on)
  Directed laboratory
  Guided discovery
  Open inquiry
Concept mapping
Webbing
Writing process
Games and simulations
Role playing
Individual/group projects and performances*
  Examples: poster, mural, diorama, bulletin board, sculpture, skit, public service announcement, puppet show, bumper sticker, political cartoon, comic strips, parade, exhibit, video, slide show, photo essay, original song or musical piece, hyperlearning stack, journal, research report, poetry, newspaper article, graph, model, invention.
Peer teaching/multi-age teaching
Debates
Surveys, questionnaires, interviews
Case studies
Issue analysis and investigation
Moral dilemmas and value analysis
Community studies
Problem solving/decision making
Action projects aimed at problem solving and citizen participation
Open-ended inquiry

*These should take on many forms which are reflective of multiple intelligences (i.e., musical, bodily-kinesthetic, logical mathematical, linguistic, spatial, interpersonal, intrapersonal)

Helpful Teaching Aids

(The above teaching strategies can be greatly enhanced by the use of a variety of teaching aids)

Animals
Artifacts
Audio-visuals
Costumes
Equipment
Games
Manipulative
Maps
Models
Photographs
Plants
Print material
Props
Supplies/junk
Technology
Tools

APPENDIX C-7

Multicultural Education

The purpose of multicultural education is to enable staff to help all students:

- learn basic academic skills as a basis for enhancing critical thinking and problem-solving capabilities
- acquire a knowledge of the historical and social realities of U.S. society in order to understand racism, sexism and poverty
- overcome their fear of differences that lead to cultural misunderstandings and intercultural conflicts
- function effectively in their own and other cultural situations
- value cultural differences among people and to view differences in an egalitarian mode rather than an inferior-superior mode
- enhance their self-esteem
- understand the multicultural nation and interdependent world in which they live

Possible Areas of Focus for Multicultural Education

- Awareness (attitudes, beliefs, values) and knowledge building
- Curriculum (infusion of history, culture and perspectives of cultural groups historically omitted)
- Instruction (expanding instructional delivery systems to better accommodate diversity including the use of TESA, cooperative learning, learning/teaching styles, critical thinking skills and peer coaching)
- Other elements of school culture
- Structured experiences for students outside the school site setting

APPENDIX C-8

Teaching Outdoors

Learning in the outdoors will encourage learners to respect themselves and their natural environment. Skills that promote these understandings are developed by participating regularly in many outdoor activities. Whether learning the secrets of successful tree planting or the effects of water quality on organisms found in a stream, learners can become more engaged and successful through the use of hands-on experiences in the outdoors.

Several strategies can make outdoor learning experiences more rewarding for both the learner and the leader of the experience. The following strategies can help you as you explore the outdoors with the learners.

Preparing the Activity

- In the beginning, choose the curriculum area which is your greatest strength to use as the basis for designing outdoor activities.
- Use an activity with a high percentage of success for learners. A variety of answers, diverse opinions, and different perspectives will generate a positive attitude.
- For the first several times that learners study outdoors, investigations that are short and focused are very effective.
- Use procedures and structures that learners are familiar with (recording data, grouping, using equipment, reporting, etc.).
- Be familiar with the collection laws in the area. The Department of Natural Resources or local extension service should have this information.
- Plan adequate time including going to and from the outdoor site (even if just outside of the school building).

Preparing the Learners

- Understand that some learners may not have had outdoor learning opportunities and may be uncomfortable. Some misbehavior may be due to this discomfort.
- Give learners advance notice before going outdoors so that they may dress appropriately for that day (comfortable shoes, rain gear, jackets etc.).
- Establish with the learners the objectives for learning outdoors.
- Before going outdoors, help the learners set appropriate guidelines for behavior.
- Select a partner or small group with which the learner must stay.
- Have learners gather and bring all necessary equipment.
- Set boundaries, time limits, and a place to meet.
- Agree upon a signal to call the group back together (raising a hand, setting time limits, clapping several times, making a bird call, etc.).

Doing the Activity

- Introduce your activity and instructions appropriately and carefully. Choose the best spot. (You may be able to hold learners' attention better indoors).

- Allow learners time to explore the activity area with their group before actually beginning their time in the activity. This will help ensure that the learners are focused.

- When addressing the whole group outside, have them seated comfortably (dry, looking away from sun, not too hot/cold) and speak loudly.

- Respond to and encourage learner enthusiasm and curiosity. Share your own excitement whenever possible. Enjoy the outdoors with the learners!

- Understand that collecting plants or animals should only be done if necessary to observe over long periods of time.

- Model that all organisms are best observed in their natural environment without interference from observers.

Following the Activity

- Upon returning to the classroom, evaluate together the success of your outdoor experience. (What worked, what didn't work and why).

- Brainstorm and/or initiate extensions to continue the lesson.

- Clean and store the equipment used.

The more time learners spend in outdoor activities, the more appropriate their responses will be to the out-of-doors. Start out simple, and take learners outside regularly. Watch as the learners grow in respect and understanding of the outdoors.

Adapted from:

Szuhy, D.L., & Barron, P.A. (1982). Teaching outdoors: How to get started. Ohio Woodlands, (winter), 44-45.

American Forest Foundation. (1993). Project learning tree. Washington, DC.

APPENDIX C-9

Variety of Learning Environments

Learning can occur anywhere. Leaders and learners can benefit greatly from the rich opportunities provided by different learning environments. The following lists environments that have been used successfully.

Inside the Classroom

Learning centers
Listening centers
Reading areas
Touchy-feely table
Stream table
Sand table
Animal/plant area
Computer station

Inside the School Building

Other classrooms/offices
Kitchen/cafeteria
Maintenance
Water system
Energy system
Computer lab

Outside the School Building

Play ground
Outside of building (wall, roof)
Sidewalks and paved areas
Green space
Land laboratory/school forest

Outdoor Learning Sites

Parks
Forests
Lakes, streams, ponds, wetlands
Wildlife areas
Natural areas or preserves
Arboretums
Gardens/nurseries
Vacant lots
Neighborhoods
Agricultural lands
Caves/caverns

Field Trip Sites, Tours, and Community Resources

Zoos
Museums
Nature centers
Historical sites
Water treatment plants
Sewage treatment plants
Utility companies/Power plants
Industries
Universities/businesses
Government agencies
Libraries
Public services
Shopping malls/stores
Landfills/recycling centers
Strip mines/underground mines
Reclaimed mine lands
Laboratories
Botanical conservatories

Resident Environmental Education Programs

Camps
EE Centers
Zoos
Museums

APPENDIX D-1

Curriculum Resources

DELTA SCIENCE MODULES

Delta Education, Inc., P.O. Box 3000, Nashua, NH 03061-3000.

Delta Science Modules offer a means to accomplish problem-solving goals. Instruction proceeds with children manipulating materials designed to bring out process skills. The modules are clustered around the content areas of life, earth and physical science. Each module is a self-contained unit of work and includes hands-on materials, a teacher's guide and a storage system. Most activities are designed to be one class period. The lesson plans for that activity are usually one page in length. Units culminate in application and evaluation sessions. Delta provides experiences for developing inquiry skills, positive science attitudes, and understanding of science concepts.

ECO-NET

Institute for Global Communications, 18 DeBoom Street, San Francisco, CA 94107.

ECO-NET provides an inexpensive way to access the InterNet as well as access literally thousands of resources and electronic mail. Special conferences are available on a huge array of environmental issues in addition to environmental education and other topics of interest to both students and educators. Curriculum support materials as well as up-to-the minute information are available. Requires a computer and modem. A cost is involved for the monthly rate plus connect time charges for prime-time use.

ERIC / CSMEE, Environmental Education Activities Books

ERIC/CSMEE, The Ohio State University, 1929 Kenny Rd., Columbus, OH 43210.

The ERIC books provide suggestions for integrating environmental concepts into all subject areas. Each activity is classified according to appropriate grade level (K-12), subject area, and basic concept. The first three volumes contain activities on a variety of topics while later publications focus on a single topic (e.g., land use, wildlife, population, energy, urban setting, recycling, values, using local communities, basic skills, natural resource management, global education, hazardous and toxic materials, science/society/technology, teaching critical thinking, water, environmental mathematics). In addition, ERIC has many other publications of interest to educators.

GEMS (Great Explorations in Math and Science)

Lawrence Hall of Science, University of California, Berkeley, CA 94720.

GEMS consists of a series of teacher's guides designed for various grade levels. Each booklet focuses on a different topic (e.g., Acid Rain, Animals in Action, Earthworms, River Cutters, Fish Habitats, Global Warming & the Greenhouse Effect, Earth, Moon & Stars, Animals Movements, Buzzing a Hive, Tree Homes, and Animal Defenses) and includes 2-15 class sessions which can be integrated into the curriculum or stand on their own. The program emphasizes the integration of math and science and the development of concepts and process skills.

GREEN (Global Rivers Environmental Education Network)

School of Natural Resources, University of Michigan, Ann Arbor, MI 48109-1115.

GREEN provides a variety of curriculum related resources on water quality. Emphasizing student participation, GREEN also has assistance for international or cross-cultural projects, computer networking and low-cost equipment. Of particular interest to high school classes is a curriculum guide, Investigating Streams and Rivers, and a corresponding Field Manual for Water Quality Monitoring. This program is widely acclaimed and international in scope.

INSIGHTS: Hands-on Inquiry Science Curriculum

Improving Urban Elementary Science Project Education Development Center, 55 Chapel Street, Newton, MA 02160.

The EDC INSIGHTS Curriculum consist of 17 modules, each designed to be used at one of 2 grade levels (K-1, 2-3, 4-5-6). The module topics represent a balance of life, earth, and physical science and a continuous growth in experience and understanding of 6 major science themes: systems, change, structure and function, diversity, cause and effect, and energy. The INSIGHTS modules topics emerge from a review both of children's experiences and interests and of the basic science phenomena and concepts appropriate for each age level and are rich in potential for hands-on exploration. Many of the modules contain ideas from ESS units.

The Institute for Earth Education

P.O. Box 288, Warrenville, IL 60555.

Based upon the work of Steve Van Matre, Earth Education is the process of helping people build an understanding of, appreciation for, and harmony with the earth and its life. Publications and programs include Acclimatization (1972), Acclimatizing (1974), Sunship Earth (1979), Earthkeepers (1988), Earth Education: A New Beginning (1990), Earthwalks and Conceptual Encounters I & II.

National Geographic Kids Network Project

Technical Education Research Centers, National Geographic Society, Dept. 5351, Washington, DC 20036.

The National Geographic Kids Network Project is a series of exciting, flexible elementary science units that feature cooperative experiments in which students in grades 4-6 share data nationwide through the use of telecommunications. Topics will involve the students in issues of real scientific, social, and geographic significance. The Network project combines basic content from typical school curricula with guided inquiry learning. Kids Network can be used to supplement textbooks and existing materials or to form complete, year-long science courses.

Naturescope

National Wildlife Federation, 1412 Sixteenth St., N.W., Washington, DC 20036.

Naturescope is designed to improve the teaching of natural sciences. It includes hands-on activities and worksheets for elementary grades. Each issue focuses on a specific topic (e.g., birds, trees, geology, pollution, rain forests, weather, oceans, mammals, reptiles, arts and crafts, dinosaurs, astronomy, deserts, wetlands, endangered species, and insects).

Oceanic Education Activities for Great Lakes Schools (OEAGLS)

Ohio Sea Grant Education Program, The Ohio State University, 059 Ramseyer Hall, 29 W. Woodruff Ave., Columbus, OH 43210.

Thirty multidisciplinary classroom activities for grades 5-9 focus on the role of the oceans and the Great Lakes in the lives of Ohioans and address economic, political, social, scientific, and technological issues. Computer programs, primary activities and other publications are also available.

On the Trail of Nonpoint Source Pollution (1993)

Two Herons Environmental Consulting for the Soil and Water Conservation Districts of Butler, Clermont, Hamilton and Warren counties in Ohio.

This curriculum booklet provides a wide variety of activities aimed at grades K-6 and geared toward understanding nonpoint source water pollution, its sources, and ways to prevent its occurrence. Background information is provided as well as cross referencing by grade level and subject. Approximate cost $10 through Clermont Soil and Water Conservation District, 2400 Clermont Center Drive Suite 101, Batavia, OH 45103, (513) 732-7645.

Outdoor Biology Instructional Strategies (OBIS)

Delta Education, Inc., Box M, Nashua, NH 03061-6102.

This program, designed for youngsters ages 10-15, promotes the understanding of ecological relationships through hands-on activities which emphasize the managed environment. Activities are packaged into topical sets of folios (e.g., animal behavior, backyard, forest, ponds & lakes, school yard, streams & rivers, winter), or as a complete library set.

Portapark

Ohio Department of Natural Resources, Division of Parks and Recreation, Fountain Square, Bldg C-3, Columbus, OH 43224.

The Portapark is designed to increase awareness of Ohio State Parks through 38 activities that focus on plant and animal life, park environment, litter awareness, and games and activities. These easy to use ideas require few if any special environments.

Project AIMS (Activities to Integrate Mathematics and Science)

Fresno Pacific College, 1717 South Chestnut Ave., Fresno, CA 93702.

Project AIMS provides a series of topical activity books (grades K-9) which focus on the integration of mathematics and science (e.g., Critters, Down to Earth, Finding Your Bearings, Our Wonderful World, Overhead and Underfoot, Popping with Power, Primarily Plants, Seasoning Math & Science, Water Precious Water).

Each volume consists of two components: a teacher's manual with all the necessary information about the investigations and how to prepare them; and a student manual with all the recording sheets and directions.

Project Learning Tree (1993)

American Forest Foundation, 1111 19th St., N.W., Suite 780, Washington, DC 20036.

PLT is a multidisciplinary set of environmental education activities designed to help elementary and secondary students better understand the forest community and its relationship to other environments and the day-to-day lives of people. The materials are currently only available to individuals who attend a six hour PLT workshop. *In Ohio contact the Division of Forestry, Ohio Department of Natural Resources, 1855 Fountain Square Court H-1, Columbus, OH 43224-1327.*

Project WET (Water Education for Teachers) (1994)

201 Culbertson Hall, Montana State University, Bozeman, MT 59717.

Project WET is a national program designed to teach about water issues. The core of the program is a K-12 curriculum and activity guide containing approximately 100 multidisciplinary activities. This is available through inservice workshops. In addition, a variety of supplementary resources are being developed to complement and extend the guide including modules (e.g., wetlands, watersheds, ground water), demonstration models, children's literature books, and living history materials. All materials reflect a balanced and diverse approach to water issues, incorporate various cultural perspectives and accommodate many learning styles. *In Ohio contact the Ohio Water Education Program, c/o Division of Soil and Water Conservation, Ohio Department of Natural Resources, 1939 Fountain Square Court E-2, Columbus, OH 43224-1336.*

Project WILD (1992)

5430 Grosvenor Lane, Bethesda, MD 20814.

Project WILD is an interdisciplinary, supplementary environmental and conservation education program for educators of kindergarten through high school age youth which prepares students to make responsible decisions about wildlife and the environment. It includes a wide variety of instructional strategies which can be incorporated into different subjects. Aquatic Project WILD (1987) focuses on marine and aquatic education. It includes additional WILD activities as well as adaptations of activities from the original elementary and secondary WILD guides. These materials are only available through a six hour workshop. *In Ohio contact the Division of Wildlife, Ohio Department of Natural Resources, 1840 Belcher Drive G-1, Columbus, OH 43224-1329.*

The Rivers Curriculum

Southern Illinois University at Edwardsville, Box 2222, Edwardsville, IL 62026-2222.

The Rivers Curriculum was written by teachers and designed around six content units for high school students. Each unit is organized around field trips to the river and include curriculum for chemistry, biology, earth science, mathematics, geography, and language arts.

Sharing Nature with Children (1979) and Sharing the Joy of Nature (1989)

Joseph Bharat Cornell, Ananda Publication, 900 Allegheny Star Rd., Nevada City, CA 95959.

These books offer a collection of games and activities to teach children about nature and to involve them in nature. For each activity, a chart indicates the basic mood of the game, concepts taught, setting, number of players, appropriate age, and any special materials, that are needed. The second book also presents a system of learning involving four stages that flow from one to the other.

Super Saver Investigators (1988) and Investigating Solid Waste Issues (1994)

Ohio Department of Natural Resources, Division of Recycling and Litter Prevention, 1889 Fountain Square Court F-2, Columbus, OH 43224-1331.

These two comprehensive environmental activity books contain hands-on learning activities for grades K-8 and 7-12 respectively. They offer diverse interdisciplinary ideas to teach about solid waste issues, recycling, natural resources and environmental protection. These materials are available to Ohioans free of charge through a workshop.

WOW!: The Wonders of Wetlands, (1991).

Environmental Concern Inc., P.O. Box P., St. Michaels, MD 21663, (410) 745-9620.

This educator's guide provides a range of activities labeled from grades K-12, though most of them can be adapted for several grade levels. WOW! is designed so that lessons may be used individually or as an entire unit with much potential for integration with social studies, language, mathematics and other disciplines.

Zero Population Growth

1400 16th Street, N.W., Suite 320, Washington, D.C. 20036.

ZPG provides a wide variety of population education resource materials including newsletters, fact sheets, publications, curricula and videos. Teaching materials are cross-disciplinary, emphasize hands-on learning, and may be used alone or as part of a larger population unit. These include For Earth's Sake (6-10), USA By Numbers (9-12+), EdVentures in Population Education (4-12), Global 2000 Countdown Kit (9-12), and Elementary Population Activities Kit (K-6). Information and data are also available through Population Reference Bureau, Inc., 777 14th St., N.W., Suite 800, Washington DC 20005.

APPENDIX D-2

Teaching and Learning Resources

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APPENDIX E

Overview of Episodes

Title	Length		Grade Level Range				Main Focus	Environmental Issue	Predominant Site		
	Short-term	Long-term	Primary	Intermediate	Middle School	High School			Indoor	Outdoor	Both
Birds in the School Yard		x		x	x		animals (birds)	none			x
Day at the Creek		x	x	x	x	x	stream ecosystem	water quality		x	
Environmental Youth Congress		x		x	x	x	general	multiple			x
Everybody Needs a Home	x		x				habitat	none	x		
Habitat High-Low	x		x				habitat	none			x
Handful of Mud	x			x	x		soil	soil erosion			x
Investigating Browning Evergreens		x				x	plants chemistry	pollution			x
Land Resources		x			x	x	general	land use solid waste	x		
Let's Try Our Own Biosphere II		x			x	x	interrelationships on planet	futurism	x		
Not in Our School Yard		x		x	x	x	general	solid waste recycling	x		
Observing Birds in Their Habitats	x		x	x	x	x	animals (birds)	none		x	
Partnering for Elementary Environmental Science		x	x	x			geology	land use mining solid waste			x
Rescuing the Rain Forest		x		x			rain forests	biodiversity	x		
Resident Environmental Education Experiences		x		x	x	x	general	multiple		x	
Shopping Around a Mall for Environmental Activities		x		x	x	x	general	land use	x		
Taking Action Through Recycling		x			x	x	general	recycling	x		
Ups and Downs of Earth Changes	x			x	x	x	ecosystems	impact on ecosystem	x		
Urban Playground Investigation	x			x			general	land use		x	
Water, Water Everywhere		x		x	x	x	water	water quality			x
Wetlands and WasteWater		x		x	x	x	wetlands	water treatment	x		
What Can You Learn About a Leaf?	x		x				trees	none	x		
What to do with Millions of Gallons of Water in a Coal Mine		x			x	x	ecology chemistry	water quality	x		
What's Going on with the Weather? Global Climate Change		x		x	x	x	general	global warming	x		
Your City is Full of Rocks		x	x	x	x	x	geology	none			x

APPENDIX F

Linkages to Ninth Grade Proficiency Test Outcomes

The Learning Episodes in this document were not specifically written to achieve proficiency test outcomes, but they can still contribute to building the foundation of experiences that will most likely lead to a high degree of success on the ninth grade proficiency test.

Because it is the intent that students are proficient in the outcomes before entering the ninth grade, only learning episodes that are adaptable for grades 1-8 have been included. Additionally, many episodes that are not listed could be altered slightly to address the outcomes.

The science portion of the ninth-grade proficiency test emphasizes both content and process. Items developed for the test from the outcomes will emphasize the following three levels of science processes:

Acquiring Scientific Knowledge— observing, collecting, and organizing data; measuring, reading graphs and charts; and classifying.

Processing Scientific Knowledge— interpreting, inferring, analyzing, and recognizing patterns and trends in data; manipulating variables.

Extending Scientific Knowledge— developing models, making conclusions, asking evaluating questions, making predictions.

The outcomes which follow represent the content for the science portion of the ninth-grade test. The proposed learning outcomes are numbered. The information provided within the parentheses describes the outcomes in non-science terms.

Suggested Learning Episodes for 9th Grade Science Outcomes

The learner will:

1. Devise a classification system for a set of objects or a group of organisms. (Use common characteristics to group items)
   - Not in Our School Yard
   - What Can You Learn About a Leaf?

2. Distinguish between observation and inference given a representation of a scientific situation. (Tell the difference between facts and assumptions)
   - Birds in the School Yard
   - What to do with Millions of Gallons of Water in a Coal Mine
   - What's Going on with the Weather? Global Climate Change

3. Identify and apply science safety procedures. (Identify the safety precautions needed when doing an experiment)
   - All Learning Episodes

4. Demonstrate an understanding of the use of measuring devices and report data in appropriate units. (Choose an instrument to make a certain measurement)
   - Day at the Creek
   - Resident Environmental Education Experiences
   - What Can You Learn About a Leaf?

5. Describe the results of earth-changing processes. (Describe changes taking place in the earth's surface)
   - Day at the Creek
   - Handful of Mud
   - Ups and Downs of Earth Changes
   - Your City is Full of Rocks

6. Apply concepts of the earth's rotation, tilt and revolution to an understanding of time and season. (Explain how seasons change)

   None

7. Describe interactions of matter and energy throughout the lithosphere, hydrosphere, and atmosphere. (Explain materials cycles [water, carbon, nitrogen], currents, and weather on the land, in the water, and in the air)
   - Day at the Creek
   - Land Resources
   - Let's Try Our Own Biosphere II
   - Resident Environmental Education Experiences
   - Ups and Downs of Earth Changes
   - Water, Water Everywhere
   - Wetlands and Waste Water
   - What's Going on With the Weather?

8. Apply the use of simple machines to practical situations. (Describe how a lever or pulley can make a task easier)

   None

9. Apply the concept of force and mass to predict the motion of objects. (Describe the motion of a thrown ball)

   None

10. Apply the concepts of energy transformations in electrical and mechanical systems. (Describe how the energy in a flashlight battery is transformed into heat and light)

    None

11. Apply concepts of sound and light waves to everyday situations. (Describe how light and sound travel through different materials)
    - Shopping Around a Mall for Environmental Activities
    - What's Going on With the Weather?

12. Describe chemical and/or physical interactions of matter. (Describe how a cube of sugar dissolves in water, how metals rust, and how things burn)
    - Investigating Browning Evergreens
    - Land Resources
    - Let's Try Our Own Biosphere II
    - Partnering for Elementary Environmental Science
    - Ups and Downs of Earth Changes
    - Urban Playground Investigation
    - Water, Water Everywhere
    - Wetlands and Waste Water
    - What to do with Millions of Gallons of Water in a Coal Mine
    - What's Going on With the Weather?
    - Your City is Full of Rocks

13. Trace the flow of energy and/or interrelationships of organisms in an ecosystem. (Identify the food chain in a lake)
    - Day at the Creek
    - Land Resources
    - Let's Try Our Own Biosphere II
    - Observing Birds in Their Habitats
    - Rescuing the Rain Forest
    - Resident Environmental Education Experiences
    - Ups and Downs of Earth Changes
    - Urban Playground Investigation
    - Water, Water Everywhere
    - Wetlands and Waste Water
    - What to do with Millions of Gallons of Water in a Coal Mine

14. Compare and contrast the characteristics of plants and animals. (Tell how plants and animals are alike and different)
    - Everybody Needs a Home
    - Urban Playground Investigation
    - What Can You Learn About a Leaf?

15. Explain biological diversity in terms of the transmission of genetic characteristics. (Explain why there are different breeds of dogs or kinds of plants)
    - Investigating Browning Evergreens
    - Rescuing the Rain Forest

16. Describe how organisms accomplish basic life functions at various levels of organization and structure. (Describe a life function like digestion complete with the appropriate anatomy)
    - Investigating Browning Evergreens
    - Let's Try Our Own Biosphere II

17. Describe the ways scientific ideas have changed using historical contexts. (Describe how explanations of eclipses have changed over time)
    - What's Going on With the Weather?

18. Compare renewable and nonrenewable resources and strategies for managing them. (Compare oil and sunlight as sources of energy)
    - Handful of Mud
    - Let's Try Our Own Biosphere II
    - Ups and Downs of Earth Changes
    - Water, Water Everywhere
    - What's Going on With the Weather?

19. Describe the relationship between technology and science. (How do science and inventions affect each other?)
    - Let's Try Our Own Biosphere II
    - Partnering for Elementary Environmental Science
    - Shopping Around a Mall for Environmental Activities
    - Taking Action Through Recycling
    - Wetlands and Waste Water
    - What to do with Millions of Gallons of Water in a Coal Mine
    - What's Going on With the Weather?

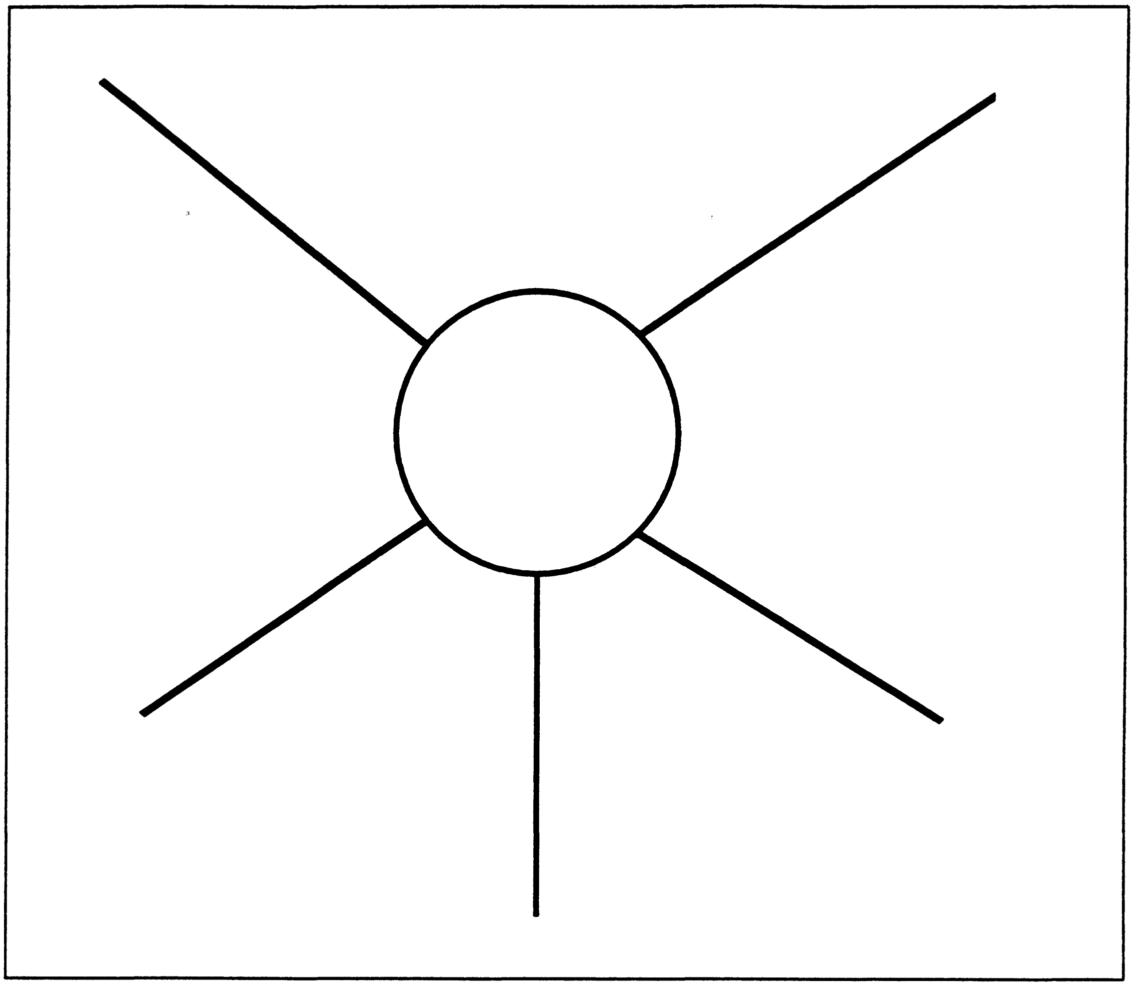
20. Describe how a given environmental change affects an ecosystem. (Describe how a flood or drought affects plant and animal life)
    - Day at the Creek
    - Environmental Youth Congress: Solving Environmental Problems
    - Habitat High-Low
    - Handful of Mud
    - Investigating Browning Evergreens
    - Land Resources
    - Let's Try Our Own Biosphere II
    - Not in Our School Yard
    - Rescuing the Rain Forest
    - Resident Environmental Education Experiences
    - Shopping Around a Mall for Environmental Activities
    - Taking Action Through Recycling
    - Ups and Downs of Earth Changes
    - Urban Playground Investigation
    - Water, Water Everywhere
    - What to do with Millions of Gallons of Water in a Coal Mine
    - What's Going on With the Weather?
    - Your City is Full of Rocks

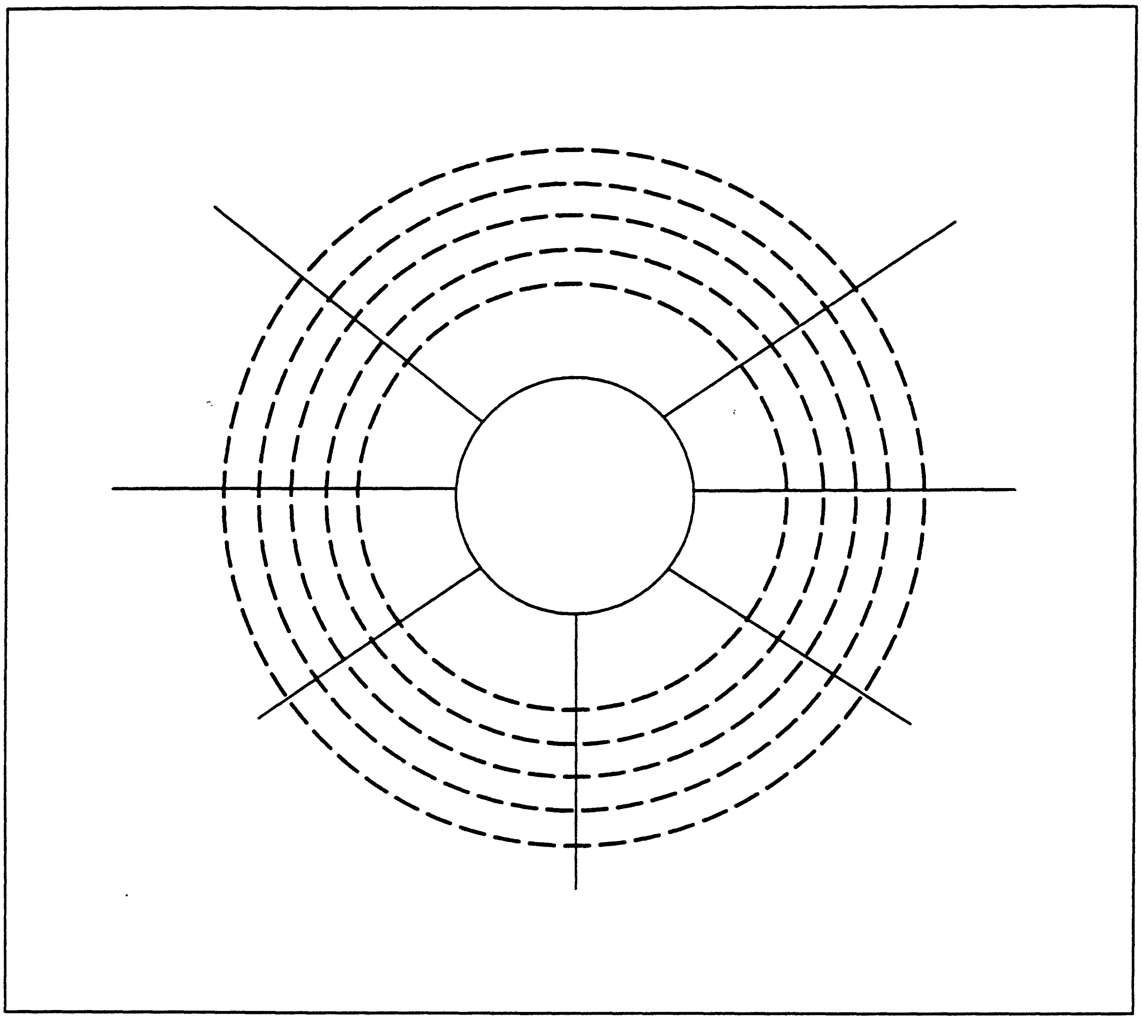
References

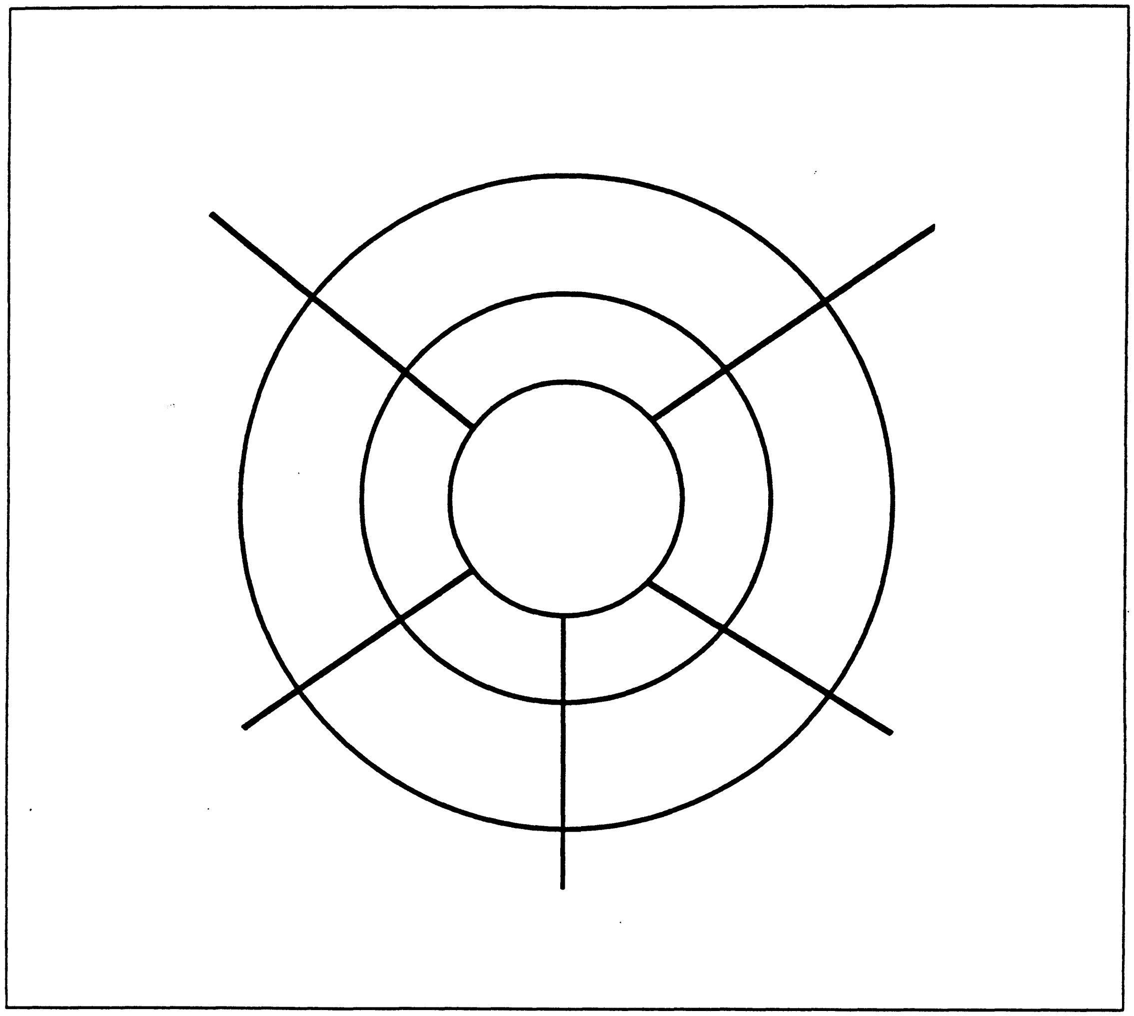
Ohio Department of Education, August 1994.

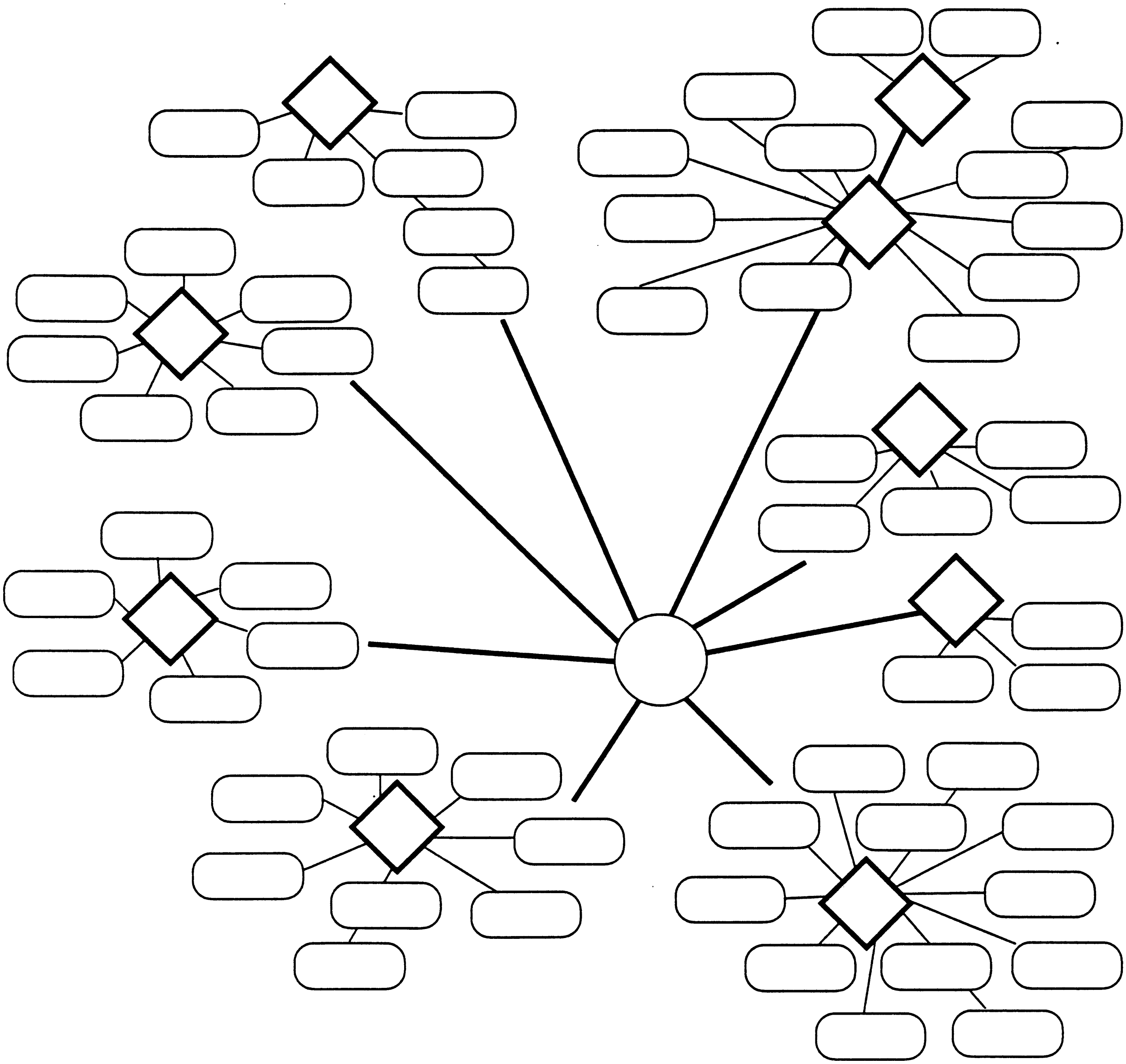
APPENDIX G

Blank Forms for Models and Webs









COLLABORATING ORGANIZATIONS

(continued from inside front cover)

Science and Mathematics Network of Central Ohio

The Network was established in 1992 as a coalition of school districts, businesses and educational support agencies dedicated to improving science/mathematics/technology education at the elementary school level. Its mission is to help elementary-level classroom teachers form collaborative partnerships with business professionals that focus on hands-on, real-world applications of science and mathematics. The Network currently supports classroom-based partnerships between business professionals and elementary teachers which bring a real-world perspective to science and mathematics. The goal of the partnerships is to increase student and teacher enthusiasm for active science and mathematics. The Network also provides innovative professional development opportunities in science and mathematics to elementary teachers and their business partners. For more information contact The Science and Mathematics Network of Central Ohio, 445 King Avenue, Columbus OH 43201.

The John T. Huston - Dr. John D. Brumbaugh Nature Center of Mount Union College

Brumbaugh Nature Center is a research and education center for ecology and environmental science. The Center was established in 1986 as a result of a generous gift from Dr. John D. Brumbaugh of Akron. The Center's three-fold mission is to provide 1) programs and support for undergraduate teaching and research, including pre-service teachers and students of environmental science; 2) non-traditional educational opportunities for schools, youth organizations and the general public; and 3) teacher enhancement programs in environmental sciences. For more information contact The John T. Huston - Dr. John D. Brumbaugh Nature Center, Mount Union College, 1972 Clark Avenue, Alliance, OH 44601.

American Electric Power and Columbus Southern Power/Ohio Power

The AEP Service Corporation is the management and technology arm of the seven-state American Electric Power System. Columbus Southern Power and Ohio Power are operating companies serving the AEP system's customers in Ohio. The companies are extensively involved in environmental and energy education and partnerships, for which they have earned national recognition. The companies provide information, conduct workshops and tours, and have employees serving as tutors and resource specialists. For more information contact Public Affairs Department, AEPSC, 1 Riverside Plaza, Columbus, OH 43215 or Public Affairs Department, CSP/OP, 215 N. Front Street, Columbus, OH 43215.

Partial Funding Provided by:
Ohio Environmental Education Fund (OEEF)

The Ohio Environmental Education Fund, a program of the Ohio EPA, was created by statute in October, 1990 to enhance public awareness about issues affecting environmental quality in Ohio. Grants are awarded to educators, organizations and others for projects that will help Ohioans understand and solve environmental problems in the state. Funded projects include curriculum and activity guide development, teacher professional development, and environmental education seminars for the general public and regulated community. For more information contact Ohio Environmental Education Fund, Ohio Environmental Protection Agency, 1600 WaterMark Drive, Columbus OH 43215-1034.

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Copies available within Ohio from:

Ohio Environmental Education Fund
Ohio Environmental Protection Agency
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Copies available nationally from:

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