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ABSTRACT

This guide for environmental science is intended to make students aware of the problems they will be facing in their environment, and of alternative measures to solve these problems. The course is designed to use scientific principles to study the processes of the environment; examine changes within the environment from a broad perspective; identify both natural and man-made activities that contribute to changes in the environment; and isolate the political, legal, economic, and social aspects. Nine basic process skills and five integrated processes are identified and described. Topic areas include: (1) "Ecology" (including general and human ecology); (2) "Resources" (containing units on soil, agriculture, water, land resources, forest, wildlife, air, and minerals); (3) "Energy" (major and alternative sources); and (4) "Pollution and Environmental Health" (water/air/heavy metal pollution, solid and hazardous wastes, pesticides, radiation, chemical mutagens, food additives, noise, and epidemiological effects). The objectives, concepts, and activities for each subtopic area are listed in the curriculum standards. A skills checklist for 221 identified objectives is provided. A bibliography and reference materials are listed, and evaluation techniques are discussed. (YP)

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STATE OF LOUISIANA
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ENVIRONMENTAL SCIENCE CURRICULUM GUIDE

Bulletin 1792
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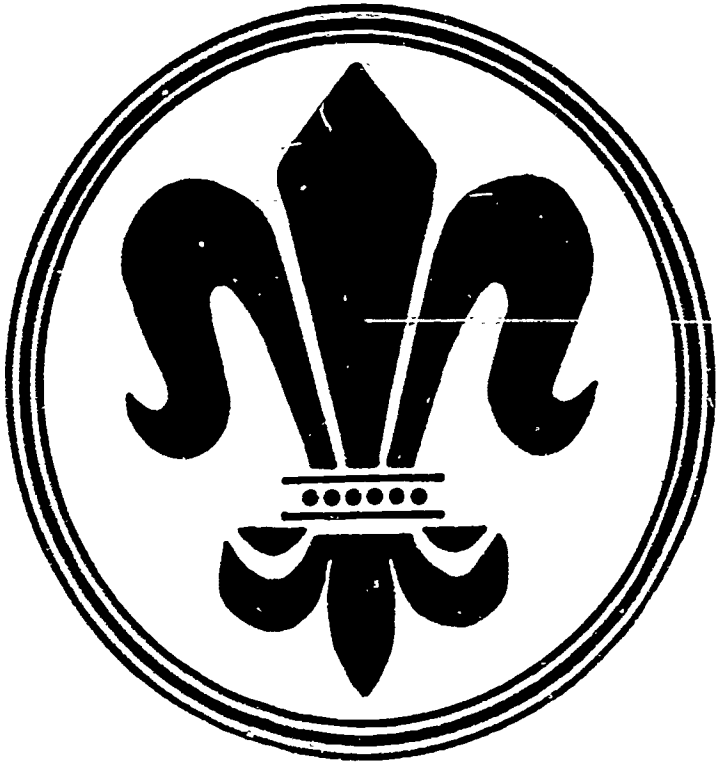

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STATE OF LOUISIANA

DEPARTMENT OF EDUCATION

ENVIRONMENTAL SCIENCE CURRICULUM GUIDE

Bulletin 1792

1986

Issued by

Office of Academic Programs

THOMAS G. CLAUSEN, Ph.D.

Superintendent

FOREWORD

Act 750 of the 1979 Louisiana Legislature (R.S. 17:24,4) established the Louisiana Competency-Based Education Program. One of the most important provisions of Act 750 is the mandated development and establishment of statewide curricular standards for required subjects. As reenacted and redefined by Act 146 of the 1986 Legislature, these curricular standards include "curriculum guides which contain grade appropriate skills and competencies, suggested activities, suggested materials of instruction, and minimum required time allotments for instruction in all subjects."

During the 1979-80 school year, curriculum guides were developed by advisory and writing committees representing all levels of professional education and all geographic areas across the State of Louisiana for the following science courses: Elementary Science K-6, Life Science, Earth Science, Physical Science, General Science, Biology, Chemistry, and Physics. Following established curricular development procedures, these curriculum guides were piloted in 1982-83 and were implemented statewide in the fall of 1984.

In 1985, a draft curriculum guide for Environmental Science was developed from nationally recognized objectives by environmental specialists representing both state and federal agencies, universities, industry, conservation organizations, and secondary schools. This guide was piloted in the spring semester of 1986 by teachers in school systems representing the different geographic areas of the state as well as urban, suburban, inner-city, and rural schools. The standard populations involved in the piloting reflect also the ethnic composition of Louisiana's student population. Based upon participants' recommendations at the close of the 1986 pilot study, the curriculum guide was revised to ensure that it is usable, appropriate, accurate, comprehensive, relevant, and clear. In keeping with the legislative mandates, the revised Environmental Science Curriculum Guide will be implemented statewide in the 1987-88 academic year.

The statewide implementation is not, however, the end of the curricular development process. A continuing procedure for revising and improving curricular materials has been instituted to ensure that Louisiana students have an exemplary curriculum available to them--a curriculum that is current, relevant, and comprehensive. Such a curriculum is essential if we are to provide the best possible educational opportunities for each student in the public schools of Louisiana.

Thomas G. Clausen

Thomas G. Clausen, Ph.D.

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Governmental agencies; various local, state, and national organizations; and business and industry--all have major concerns about the environment. This Task Force of concerned individuals listed below assisted the State Department of Education in identifying the goals of environmental science education. Their contribution was instrumental in developing a balanced program in environmental science.

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PREFACE

This we know. The earth does not belong to man;
Man belongs to the earth. . .
All things are connected, like the blood which unifies one family. . .
Man did not weave the web of life; he is merely a strand in it.
Whatever he does to the web, he does to himself.

Chief Seattle, 1854
Suquamish Tribe

Over the past two decades, concern for the environment has become both a major influence in the development of a new basic science and a major social and political issue. As the first pictures of Earth returned from the Apollo moon landing in the summer of 1969, some one billion people saw Earth as never before; our planet appeared to be an outpost of life in a sea of nonliving matter. People began to realize that the life-support processes that maintained man and all other forms of life were hinged on many interacting cycles. This realization spurred many people to become involved actively with the growing environmental movement of the 1970's. Today, the emotional fervor that propelled the environmental movement to the center of national attention has matured; and people are accepting the responsibility for maintaining the quality of life for future generations. In addition, business and industry; local, state, and federal governments; and concerned citizens are working together to improve the quality of the environment.

This Environmental Science Course for high school students is being implemented in an effort to raise the level of environmental literacy among Louisiana's citizens. It is unquestionably necessary for our present and our future physical, mental, and economic health that our citizens become so well-informed that they can make sound judgments on issues involving the environment of Louisiana and the world. The need clearly exists for a comprehensive statewide educational effort addressing the broad spectrum of our environmental interests and needs. Most educators agree that the development of a comprehensive multidisciplinary environmental education program is essential to assure that "environmental literacy" is developed and maintained.

This curriculum guide for Environmental Science is intended to make students aware of the problems they will be facing in their environment, as well as of alternative measures to solve these problems. The content of this course is presented within the framework of well-founded physical and biological principles. This course is designed to use basic scientific principles to study the processes of the environment; to examine changes within the environment from a broad perspective; to identify both natural and man-made activities that contribute to changes in the environment; and to isolate the political, legal, economic, and social aspects of the environment.

Environmental issues should always be presented in such a manner that critical thinking can be developed through reason rather than emotion. The suggested activities provide a basis for instruction; however, current national and local issues should be incorporated wherever possible.

RATIONALE

Developments in science technology have improved our way of living and have become a major influence on our culture. No one in our culture escapes the direct influence of science. Because of the impact of science on our social, economic, and political institutions, the education of every responsible citizen must include not only the basic principles of science but also the attitudes and processes of scientific thought.

The nature of science itself determines the way that it should be taught. The definition of science is a twofold one: It is (1) an unending method or process of seeking new knowledge, and (2) the body of knowledge which results from this search. Science is an intellectual, active process which involves an investigator of any age and something to investigate. The discipline of science taught by the process approach teaches the student how to learn, and that intellectual gain is a permanent one for the student.

The process approach develops the intellectual abilities of students. Some students develop thinking skills in the normal course of growing up in a complex world, but the acquisition of useful skills and attitudes is by no means automatic. Many students succeed in school by repeating what they are told in a slightly different form or by memorizing; such strategies are of little extended value. At present, relatively few students develop persistence in and zest for dealing with new concepts because they are not aware of their intellectual capabilities; thus, students need literally to experience the application of skills in scientific processes in different situations.

To be most effective, methods of science instruction must be based upon the development of skills in critical thinking. Guided practice in experimenting, observing, gathering information, organizing facts, and drawing conclusions will help to develop critical thinking skills. Laboratory techniques should be employed whenever possible, and inquiry teaching/learning situations using both deductive and inductive reasoning should be the predominant method used in all classroom activities. The teacher's role in a process-oriented science classroom includes being a provider of problems, a discussion leader, a supplier of clues (when necessary), and a skillful questioner, i.e., a facilitator of learning activities. Thus, the aim of an effective science program should be to equip each child with competencies in the basic processes and concepts of science through individual participation in activities and investigations specifically designed to develop such capabilities.

GOALS OF TEACHING ENVIRONMENTAL SCIENCE

Science Literacy

The primary goal of science courses in grades K-12 is to promote science literacy. Before determining what should be taught, science literacy should be defined. Science literacy is the ability to perceive, comprehend, interpret, explain, and predict natural phenomena and to demonstrate such ability technologically. Many science educators recommend that science literacy should be not a separate entity but an integral component of the total curriculum. The perception, comprehension, interpretation, explanation, and prediction of a phenomenon should be fused into every area of the curriculum.

According to most science educators, a scientifically literate citizen should be:

1. aware that science is concerned with the empirical universe.
2. able to read accounts of developments by the scientific community.
3. aware that knowledge developed in the scientific community is probable rather than absolute.
4. aware of the difference between theoretical and empirical concepts and laws.
5. aware of how both empirical and theoretical concepts and laws come into being.
6. aware of the scientifically accepted regulatory principles.
7. aware that theoretical and empirical laws may be descriptive, comparative, or quantitative.
8. able to use theoretical laws in unifying empirical laws.
9. able to use empirical concepts and laws in a constant adjustment to the environment.
10. able to explain and to predict events in the environment in a rational manner.
11. able to translate experience of the natural world into knowledge.
12. able to communicate with other citizens about knowledge and ideas about natural objects and phenomena.
13. able to communicate with other citizens about the use or control of natural objects or forces.

Specific Goals

Achieving science literacy involves attitudes, process skills, concepts, and social aspects of science and technology. This literacy is linked to a global awareness that knowledge is increasing at a tremendous rate and that this rapid increase affects society in a great variety of ways. Based upon this belief, the following major goals of science are stated:

1. Fostering Positive Attitudes Toward Science and the Scientific Process

Developing a deep appreciation of the role of science and the scientific process will influence the way students think about the environment and about their effect on the environment.

2. Developing Process Skills

The development of process skills is an integral part of science activities for students. Students should be given opportunities to develop those intellectual processes of inquiry and thought by which scientific phenomena are explained, measured, predicted, organized, and communicated. These experiences will serve to reinforce scientific concepts.

Basic Scientific Process Skills used in solving problems and making decisions include observing, inferring, classifying, using numbers, measuring, using space-time relationships, communicating, predicting, and designing experiments. Integrated Process Skills include controlling variables, defining operationally, formulating hypotheses, interpreting data, and experimenting.

3. Acquiring Knowledge

Included in the basic science curriculum are those scientific concepts, principles, theories, and laws that will enable the students to understand and interpret natural phenomena. Applying scientific concepts, principles, theories, and laws requires the understanding of cause-effect relationships; energy-matter relationships; time-space relationships; revolutionary, evolutionary, or catastrophic change; interaction of variables; systems; symmetry; and equilibrium.

4. Recognizing the Interaction of Science, Technology, and Society

The students should (a) understand the interrelationships of science, technology, and social and economic development, (b) recognize both the limitations and the usefulness of science and technology in advancing human welfare, and (c) understand the concept of global ethics when new technologies are used. Science and technology are difficult to separate because scientists often develop new technology and new technology produces new avenues for scientists to obtain new knowledge. Changes in science and technology may not always improve society and may be the subject of moral, religious, or ethical questions. Such controversial issues cannot be solved in a science classroom but may be discussed.

PRIMARY PROCESS SKILLS

Within the framework of environmental science, nine basic process skills are stressed: (1) observing, (2) inferring, (3) classifying, (4) recognizing number relations, (5) measuring, (6) recognizing space-time relationships, (7) communicating, (8) predicting, and (9) decision making. There is a progressive intellectual development with each process. A brief description of each basic process follows:

OBSERVING

Observing is the use of one or more of the five senses to perceive properties of objects or events as they are. Statements about observations should be (1) quantitative where possible, (2) descriptive regarding change(s) and rates of change(s), and (3) free of interpretations, assumptions, or inferences.

INFERRING

Inferring is making statements about objects or events based on observations which are not the result of direct perception. Inferences may or may not be accurate interpretations or explanations of observations. Inferences are based on (1) observation, (2) reasoning, and (3) past experience of the observer. Inferences require evaluations and judgment. Inferences based on one set of observations may suggest further observation which in turn requires modification of original inferences. Inferences lead to predictions.

CLASSIFYING

Classifying is the grouping or ordering of phenomena according to an established scheme. Objects and events may be classified on the basis of observations. Classification schemes are based on observable similarities and differences in arbitrarily selected properties. Classification keys are used to place items within a scheme as well as to retrieve information from a scheme.

RECOGNIZING NUMBER RELATIONS

Finding qualitative relationships is not adequate when solving problems. Quantitative relationships among data with symbols assist in verifying relationships.

MEASURING

Measuring is to find out the extent, size, quantity, capacity, etc., of something, especially by comparison with a standard. Once the concept of measuring is introduced and mastered in kindergarten and the first grade, the metric and or SI system should be used exclusively.

RECOGNIZING SPACE/TIME

Recognizing space-time relationships is the process that develops skills in the description of spatial relationships and their changes with time. It includes the study of shapes, time, direction, spatial arrangement, symmetry, motion, and rate of change.

COMMUNICATING

Communicating is to pass information from one person to another. Communications may be oral, nonverbal (e.g., gestures), written, or pictorial (pictures, maps, charts, and graphs). Communications should be concise, accurate, clear, and precise descriptions of what is perceived.

PREDICTING

Predicting is forecasting what future observations might be; it is closely related to observing, inferring, and classifying. The reliability of predictions depends upon the accuracy of past and present observations and upon the nature of the event being predicted.

DECISION-MAKING SKILLS

Decision-making skills are based on evaluation and synthesis. Decision-making is one link from science to other areas of the curriculum. Value judgments generally should be based on accurate information obtained scientifically. Evaluation implies value judgment based on many factors. Within the framework of environmental science, many evaluations must be made. Decisions, especially those having social, political, or economic consequences, are seldom made with only scientific considerations.

INTEGRATED PROCESSES OF SCIENCE

As basic progressive, intellectual development proceeds in each process skill, the interrelated nature of the processes is manifested in the five integrated processes: (1) controlling variables, (2) defining operationally, (3) formulating hypotheses, (4) interpreting data, and (5) experimenting. A brief description of each integrated process follows:

CONTROLLING VARIABLES TO ANALYZE SYSTEMS AND FORMULATE MODELS

A variable is any factor in a situation that may change or vary. Investigators in science and other disciplines try to determine what variables influence the behavior of a system by manipulating one variable, called the manipulated (independent) variable, and measuring its effect on another variable,

called the responding (dependent) variable. As this is done, all other variables are held constant. If there is a change in only one variable and an effect is produced on another variable, the investigator can conclude that the effect has been brought about by the changes in the manipulated variable. If more than one variable changes, there can be no certainty at all about which of the changing variables causes the effect on the responding variable.

DEFINING OPERATIONALLY BY GATHERING AND PROCESSING INFORMATION

To define operationally is to choose a procedure for measuring a variable. In a scientific investigation, measurements of the variables are made; however, the investigator must decide how to measure each variable. An operational definition of a variable is a definition determined by the investigator for the purpose of measuring the variable during an investigation; thus, different operational definitions of the same variable may be used by different investigators.

FORMULATING AND USING DEDUCTIVE-NORMATIVE EXPLANATIONS

To formulate a hypothesis is to make a guess about the relationships between variables. A hypothesis is usually stated before any sensible investigation or experiment is performed because the hypothesis provides guidance to an investigator about the data to collect. A hypothesis is an expression of what the investigator thinks will be the effect of the manipulated variable on the responding variable. A workable hypothesis is stated in such a way that, upon testing, its credibility can be established.

INTERPRETING AND COMMUNICATING SCIENTIFIC INFORMATION

The process of interpreting data may include many behaviors such as (1) recording data in a table, (2) constructing bar or line graphs, (3) making and interpreting frequency distributions, (4) determining the median, mode, and range of a set of data, (5) using slope or analytical equations to interpret graphs, and (6) constructing number sentences describing relationships between two variables. Interpreting data requires going beyond the use of the skills of tabulating, charting, and graphing to ask questions about the data which lead to the construction of inferences and hypotheses. Interpretations are always subject to revision in the light of new or more refined data.

EXPERIMENTING USING INTEGRATED PROCESS SKILLS

Experimenting is the process of designing a procedure that incorporates both the basic and the integrated process skills. An experiment may begin as a question for the purpose of testing a hypothesis. The basic components of experimenting are:

1. Constructing a hypothesis based on a set of data collected by the investigator from observations and inferences.
2. Testing the hypothesis. The variables must be identified and controlled as much as possible. Data must be collected and recorded.
3. Describing or interpreting how the data support or do not support the hypothesis, i.e., deciding whether the hypothesis is to be accepted, modified, or rejected.
4. Constructing a revised hypothesis if the data do not support the original hypothesis.

ENVIRONMENTAL SCIENCE CONTENT OUTLINE

ECOLOGY

RESOURCES

ECOLOGY

I. GENERAL ECOLOGY

A. Introduction

Animals, including man, plants, and the physical processes of nature (geological, meteorological, oceanographic, and others) all affect the environment. All of these components are interlocked in a perpetual process in time. The boundary that separates each organism, animal, or plant appears as a fragile membrane. An unbalance in any ecosystem may affect organisms within the community of the ecosystem. The primary goal of teaching general ecology is to show students the complexity of life and the interaction among all life and the environment.

OBJECTIVE	CONCEPT	ACTIVITY
1. The student will be able to define environment as a combination of external conditions that influence the life of an individual, organism, or population.	Environment; Definition	1. The students will individually list 5 or more external conditions that influence their lives. 2. Use the quote "when we try to pick out something by itself, we find it hitched to everything else in the universe," to stimulate class discusion about the importance of studying the environment. 3. As a class, students will discuss their individual lists of external conditions and compile a list representing the class as a population. 4. Stimulate a discussion as to how these external conditions would affect organisms such as trees, other plants, their pets, insects, and other organisms.

OBJECTIVE	CONCEPT	ACTIVITY
2. The student will be able to recognize that the definition of ecology is the inter-relationship of organisms and their environment.	Ecological Concept	1. Have students bring 10 pictures, 5 of different animals and 5 of different plants. This group would represent level one, the organism. Students will then divide the plants and animals into groups of similar organisms (2nd level-population). Then have students determine what populations do exist together and group these to form a community (3rd level). Continue this progression from community to ecosystem to the biome and biosphere level. Use old magazines.
3. The student will demonstrate an understanding of the relationship between environment and ecology by listing and discussing external conditions comprising their environment.	Ecological Concept	1. As a class, students will discuss their individual lists of external conditions. Compile the list. 2. Discuss how these external conditions affect other populations within the the community.
B. Ecological Organization		
4. The student will be able to describe the levels of ecological organization of: a. biosphere b. biome c. ecosystem d. community e. population f. organism	Ecological System	1. Have students examine examples of each level. At the biome and ecosystem level, students might bring slide pictures from home showing different kinds of habitats. 2. Students may use globes or world maps to demonstrate location of various biomes.
5. The student will be able to define biosphere as the portion of the earth and its atmosphere capable of supporting life.	Ecological System: Biomes	1. Have students draw a parallel between the skin of an apple and the biosphere.

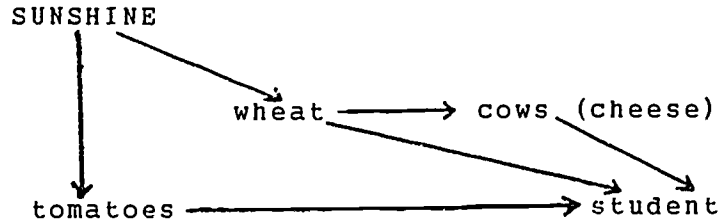
OBJECTIVE	CONCEPT	ACTIVITY
6. The student will be able to list the major biomes. a. marine (oceanic) b. estuarine c. freshwater d. polar e. alpine (tundra) f. taiga (coniferous forest) g. deciduous forest h. desert i. rainforest j. grasslands	Ecological System: Biomes	1. Show films, slides, or pictures of each. Students should be asked to identify the characteristics of eacn.
7. The student will be able to define an ecosystem as a natural community of organisms interacting with one another and with their environment.	Ecological System: Ecosystem	1. Ask students to identify a component in the environment (like mosquitoes) that we could live without. Encourage the students to consider what other population in their environment migh require that component. (An example might be the dependence of small fish on mosquito larvae for food.) 2. Examine the school "ecosystem" as a small community and identify its interacting components.
8. The student will be able to define and identify a community as a group of populations occupying a particular habitat or area.	Ecological System: Community	1. Students may conduct a field trip either in school or for homework and identify communities found.
9. The student will be able to define population as a group of organisms of the same species.	Ecological System: Population	1. Students may conduct a field trip either in school or for homework and identify various populations of organisms found.

OBJECTIVE	CONCEPT	ACTIVITY
10. The student will be able to distinguish the difference between the terms "habitat" and "niche."	Ecological System: Habitat and niche	1. Students may conduct a field trip either in school or for homework and identify various habitats and the niche of certain organisms living in those habitats.
11. The student will be able to recognize and identify various kinds of habitats and niches.	Ecological System: Habitat	1. Discuss various types of habitats and niches showing films and pictures. 2. Collect plants and animals that are typical of the various habitats found in Louisiana. 3. Assign students the study of various habitats and have them report on them.
C. Components of an Ecosystem		
12. The student will be able to differentiate between biotic and abiotic factors. a. Aiotic factors are the living components of the ecosystem. b. Abiotic factors are the nonliving components of the ecosystem.	Ecological System: Biotic and Abiotic Factors	1. Ask students to list various biotic factors that maintain them as living beings. 2. Ask students to list various abiotic factors that are necessary to maintain life. 3. Ask students to list various biotic and abiotic factors not necessary to maintain life. Are these necessary for other species?

OBJECTIVE	CONCEPT	ACTIVITY
13. The student will be able to identify autotrophs, heterotrophs, and chemotrophs. a. Autotrophs produce their own food using small, inorganic compounds and light as the energy source. b. Heterotrophs are organisms which cannot produce their own food. c. Chemotrophs are organisms that can produce food from inorganic compounds using chemical energy.	Energy Production	1. Present examples of autotrophs, heterotrophs, and chemotrophs. Use examples on laboratory practicum. 2. Have students bring to class 4 examples of autotrophs and heterotrophs collected from their home community.
14. The student will be able to identify the abiotic factors of the environment such as light, soil, space, air, nutrients, temperature, water, and topography.	Abiotic Factors	1. Examine several habitats, identify, and describe. Have students measure the abiotic factors. 2. Following the identification of abiotic factors, determine the level of influence each has on the habitat.
15. The student will be able to understand that the sun is the ultimate source of energy for ecosystems.	Energy Sources	1. Using a flow chart, demonstrate how energy flows through an ecosystem. 2. Introduce the concept of measuring energy in the form of Kcal (joules).
16. The student will be able to recognize that a basic function of an ecosystem is to capture and tranfer energy.	Energy Transfer	1. Introduce the concept of energy transfer.

OBJECTIVE	CONCEPT	ACTIVITY
17. The student will be able to recognize the process by which the photosynthetic organisms (autotrophs) convert solar energy to food and produce oxygen.	Photo-synthesis	1. Review process of photosynthesis using traditional photosynthesis laboratory. 2. Experiment with plants by placing colored tape over parts of the leaves to demonstrate effects of different light.
18. The student will be able to recognize that as organisms feed on each other, the transfer of food energy is not 100 percent efficient.	Energy does not cycle	1. How big is your food web? Where does your food come from? Purpose: Demonstrate to students that the transport of food items often results in their eating an international meal. Materials: Cookbooks, reference books Procedure: a) Have the class work in groups. Each decides what kind of pizza it is going to make and lists ingredients needed, such as tomato sauce, pepperoni, mozzarella cheese. b) Have the students consult a cookbook to find the missing ingredients. c. Have each group of students list each ingredient and its origin. Some of the origins can be determined from the labels on containers or from the reference materials. d) Discuss the information gathered. Spanish olive oil, black pepper from Java or Sumatra, Italian cheese, and fish (anchovies) from South America, are possible items. e) Lead a discussion beginning with the origin of each ingredient, resources needed to grow the vegetables (soil, water and sunlight). Encourage discussion of resources used in the processing and transportation of these food items.

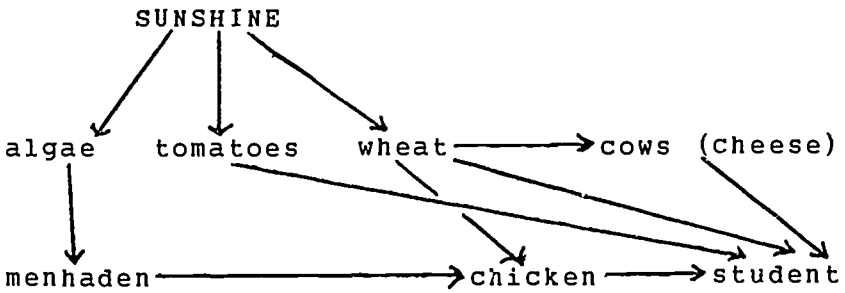
OBJECTIVE	CONCEPT	ACTIVITY
		f. Discuss alternative "meals." Point out that the high cost of shrimp "po-boys" reflects transportation cost of the shrimp. Discuss the use of fish (menhaden or "pogies") in chicken feed for commercial chicken farmers who sell to fried cnicken chains.
		g. Discuss information about how energy-intensive American fast foods are when compared with foods found in some other countries. How have we been able to afford this?
19. The student will demonstrate an understanding that matter and energy can neither be created nor destroyed but simply transformed.	First Law of Thermodynamics	1. Discuss why matter or energy can not be destroyed. Discuss some science-fiction or fantasy ideas that are theoretically unsound, such as perpetual motion machines.
20. The student will demonstrate an understanding that in every energy transformation, some energy is always lost in the form of heat.	Second Law of Thermodynamics	1. Demonstrate the transfer of energy by showing the loss of heat when a cup of hot water is transferred to another cup.
21. The student will be able to define the terms food chain and food web and describe the flow of energy through an ecosystem.	Energy Flow	1. Have students take lists they made of pizza ingredients and try to construct a food web.



ACTIVITY

2. Have the students develop their own food web as if they lived in a primitive setting.

3. Ask the students to include "fried chicken" in their food web.



4. Are there any carnivores in our pizza and fried chicken food web besides the student? Define: carnivore, herbivore, omnivore or detritivore, primary producer, primary consumer, and secondary consumer.

5. Why does it cost more to eat a lobster dinner than a catfish dinner? Discuss the loss of energy at each trophic level and the concept that the catfish is an herbivore or detritivore and the lobster is a carnivore.

OBJECTIVE	CONCEPT	ACTIVITY
22. The student will be able to describe the flow path of energy through the trophic levels of an ecosystem. a. producers b. primary consumers 1) omnivores 2) detritivores 3) herbivores c. secondary consumers	Energy Flow	1. Use a food web to illustrate where the matter and energy comes from and goes. Do not forget respiratory energy loss. 2. Using a food web, have students identify the producers, primary consumers.
23. The student will be able to explain how certain chemicals become more highly concentrated in the bodies of organisms at the upper level of a food chain.	Biological Magnification	1. Review chemical solubility concepts. Conduct an experiment using alcohol, soap, water, and oils to show solubility. Then discuss how some materials not passed out of the body are degraded into other materials. 1. The teacher should introduce the plight of the brown pelican by tracing DDT through the food chain. water ⟶ algae ⟶ larvae ⟶ fish ⟶ pelican 2. Have students represent each member of a food chain and use marbles to represent a pesticide. Use this scenario to introduce biological magnification.

OBJECTIVE	CONCEPT	ACTIVITY
24. The student will be able to recognize that biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles.	Dynamic Systems	1. Show flow charts of each cycle. Ask students (within groups) to describe to the class how each part of the cycle functions. 2 Use seasons, lifetime of organism, or life cycles to demonstrate the concept of cycles.
25. The student will be able to recognize that inorganic materials and energy become a part of organic matter and subsequently are broken down into basic compounds.	Carbon Cycle	1. Use Sea Grant publications and transparencies showing flow of carbon in a salt marsh. 2. Food webs in the Salt Marsh are featured in the Maryland Sea Grant publication "Food Webs in an Estuary" and the Washington Sea Grant "Marshes, Estuaries and Wetlands." See "Environmental and Marine Science Resource Guide" for other publications which feature food webs, including "Bird Island Basin" Texas A&M Sea Grant, and "Food Webs in the Marine Habitat" Delaware Sea Grant.
26. The student will be able to recognize that since the supply of matter is finite, the continuation of life depends upon a cyclic flow of nonliving materials between organisms and their environments.	Interdependence: Nonliving and Living Matter	1. Have students consider what happens to a closed fish tank (closed system) and an open fish tank (open system). 2. Experiment with open and closed systems by making small aquaria out of jars. 3. Discuss the earth as a closed system and the body as an open system.

OBJECTIVE	CONCEPT	ACTIVITY
27. The student will be able to recognize that the natural cycles and systems on Earth have limited capacity to cycle or disperse natural and/or manufactured pollutants.	Limited Resources of Earth	1. Have students consider the limits of the classroom: rules, space, and food. 2. Have students consider the limitation of numerous other animals. Use examples such as polar bears and tropical fish. 3. Have students consider other environmental factors limiting life: temperature, pressure, and atmosphere. 4. Examine the course of eutrophication of a pond. 5. Many scientists and economists believe that in less than a thousand years life will be very different because of a limited supply of clean water and oxygen. Have students discuss what changes will be needed to adapt and survive.
D. Population Dynamics		
28. The student will demonstrate an understanding of the early ideas of population growth.	Over-population	1. Assign students material to read about Malthus' Theory. 2. Discuss Malthus' predictions and why they have not come to pass. 3. Discuss why eventually his predictions could come to pass.

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OBJECTIVE	CONCEPT	ACTIVITY
29. The student will be able to list several principles pertaining to the organization of population levels. These would include: a. density--population size in relation to some unit of space b. natality--inherent reproduction ability of a population c. mortality--death of individual of a population d. age distribution--range of groups within the population e. fecundity--capability of reproducing offspring (females).	Population Group Properties	1. Study population structures of different organisms. a. ants, termites, bees b. roaches c. birds (starlings, California condor) d. grizzly bears e. humans 2. Study the demographic structures of Western Europe, Egypt, India, Japan Malaysia, Canada, and the United States. Draw bar charts to show distributions. 3. Obtain quantitative information about shifts in population: age shifts, ethnic shifts, and nationality shift. Discuss how these alter populations.
E. Life Span and Life Expectancy		
30. The student will be able to draw and interpret an idealized population growth curve, a logarithm curve, exponential growth, and "plateau effect."	Population Density	1. Use a calculator to demonstrate the concept of exponential growth with the analogy of the increase of money in an interest-bearing savings account. 2. Discuss the "Tragedy of the Commons" and how it relates to the global picture.
31. The student will be able to understand that the rate of change in an environment may exceed the rate of organism adaptations.	Environmental Adaptation	1. Discuss possible changes that might have caused extinction of the dinosaur, mammoth, saber-toothed tiger, auk, passenger pigeon, and possibly the ivory-billed woodpecker. 2. Examine how the Superbowl typifies the concept of extinctions. Consider: a. How teams adapt each week. b. How unsucessful teams are eliminated. c. How teams must adapt to each others' weather conditions.

OBJECTIVE	CONCEPT	ACTIVITY
32. The student will be able to recognize that the more specialized an organism becomes, the less adaptable it is and the less able it is to survive environmental change.	Specialization	1. Compare the reproduction of a German cockroach with that of a figwasp. 2. Compare the feeding patterns of a racoon with those of a koala bear of Australia. 3. Discuss job specialization in various industries, such as the oil and gas industry, and how the decline of an industry has caused job "extinctions."
33. The student will be able to list limiting factors of a population, including: a. space b. food c. clean water d. other resources	Limiting Factors of a Population	1. Discuss the difference between limiting factors of humans and those of all other vertebrates. 2. Have students list the most important things that keep them alive and maintain their quality of life. Use Maslow's chart of needs. Discuss how the removal of any of these "things" would affect their lives. 3. Conduct an exercise that demonstrates the limiting factors of any organism. Use a spaceship to another planet to stimulate interest. Ask the students to prepare for the trip and to bring the most critical items needed to colonize a new planet. Use lists, or pictures and drawings of these items for discussion.

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OBJECTIVE	CONCEPT	ACTIVITY
34. The student will be able to describe geometric population growth and contrast it with arithmetic growth.	Growth Patterns of a Population	1. Draw a graph showing examples. Use data to graph accurately examples to be used: - growth of a bean plant - growth of an insect population of locusts - growth of a population of hawks 2. Conduct a "modeling exponential growth" laboratory. Use graph paper to demonstrate the concept of exponential growth.
35. The student will be able to explain how to estimate a population growth by using: a. extrapolation b. prediction	Estimating Population Growth	1. Using the predicting methods, estimate a population growth or change if global nuclear war took place--rat population, roach population, human population.
36. The student will be able to demonstrate that the carrying capacity is determined by the availability of materials and conditions necessary for maintaining a particular kind of organism and that the earth's carrying capacity is limited for all species, including man.	Carrying Capacity	1. Estimate the carrying capacity of the city or town in which the students live. Estimate how many students could live in an area the size of their class room. Discuss waste disposal, food, water and other resources. 2. Discuss the maximum number of persons who could live for a limited period of time in a student's home. Determine the square footage.

II. HUMAN ECOLOGY

OBJECTIVE	CONCEPT	ACTIVITY
A. Human Population		
37. The student will be able to draw and interpret the human population growth curve.	Population Growth	1. Have students plot the population change from 5,000 years ago to the present on a graph.
38. The student will demonstrate an understanding that our increasing population is one of the world's greatest problems.	Population Growth	. Examine the sources of the world's problems: wars, disease, and starvation, etc. 2. Ask students to identify what they think are the world's greatest crises. Discuss each. Emphasize population as a major factor within third world nations.
39. The student will explain that man has the biological capability of reproducing faster than he can provide food.	Carrying Capacity	1. Have students discuss how the following factors can help man avoid exceeding his carrying capacity. a. population control b. new farmlands c. better agricultural yield d. better food crop storage e. new types of food crops f. global cooperation

OBJECTIVE	CONCEPT	ACTIVITY
40. The student will be able to recognize the effect increasing population has on the individual.	Effect of Population Growth on the Individual	1. Have students study changes in human population over the past 60 to 100 years. Ask students how these changes have affected their grandparents, parents, and themselves. 2. Examine changes in transportation, development of shopping centers, reduction of farms, size of schools, and housing.
41. The student will be able to identify the effect increasing population has on resources.	Effect of Population Growth on Resources	1. Have students study changes in human population growth and how it has affected the consumption of resouces. Compare periods such as World War II, the Vietnam War, or other periods when consumption was accelerated. Discuss shortages of rubber, food, and fuel.
B. Human Population and Food		
42. The student will be able to compare the food availability in developed countries with that of the less developed countries.	World Distribution and Consumption of Food	1. Have students compare the consumption in the United States with that of the less-developed countries. Use calories to compare quantitatively. 2. Have students debate the question: "Does the United States have the responsibility to feed starving nations?" Include in the debate the political, socio-economic, and moral issues. Consider inviting representatives from varicus interest groups. These might include persons from third world countries, international religious missionaries, former Peace Corps workers, sociologists, and medical persons. Conduct a panel to allow the greatest interaction to occur.

OBJECTIVE	CONCEPT	ACTIVITY
43. The student will be able to describe factors affecting major changes in human population which include these factors. a. climate b. early tool-making revolution c. agricultural revolution d. scientific revolution e. medicine--health f. space research	Population Growth	1. Discuss controversies surrounding predicted trends. Assign students readings about various industrial periods that may have affected the present population, and point out what specific factors may have directly altered population growth.
44. The student will be able to discuss cultural, social, and psychological factors affecting human population density. a. pestilence b. warfare c. birth control d. social attitudes e. mental stress	Population Growth	1. Discuss social factors and assign students topics to report on them. 2. Examine which factors are more prevalent in industrial nations and in third world nations. 3. Discuss the pros and cons of assisting nations such as Ethiopia with food relief.
45. The student will discuss biological factors affecting population. a. nutrition b. disease c. famine d. death rate e. birth rate	Population Growth	1. Discuss biological factors and how they affect a population and the individual.
46. Students will recognize that their attitudes and actions can affect population control.	Awareness of Responsibility of Humans for Their Offspring	1. Discuss the ability of all living organisms to reproduce and how higher organisms, especially mammals, have fewer offspring. Discuss factors that affect mammalian reproduction and survival of young, especially care.

OBJECTIVE	CONCEPT	ACTIVITY
47. The student will be able to recognize why the world's population increases despite a simultaneous decrease in the birth rate.	Total Fertility Rate	1. Show students how a decrease in the birth rate affects only one of the factors affecting population growth. Use a matrix to show various factors.
48. The student will be able to recognize the effect increasing population has on the social structure of a civilization.	Effect of Population Growth on Social Structure	1. Have students make a comparative demographic study of countries which have a high population density, moderate population density, and low population density (China, United States, and Australia).
49. The student will be able to recognize the cultural factors affecting population levels.	Cultural Factors and Population	1. Have students discuss issues that might reduce population growth. Have students examine population growth patterns of Western Europe, North America, Latin America, Africa, and Asia to determine differences that might affect their growth.
50. The student will be able to discuss the effect of urbanization on population levels.	Urbanization	1. Examine how urbanization affects population levels, then predict trends in population growth.
51. The student will be able to recognize that all organisms have the capability of reproducing beyond the availability of food resources.	Population and Food Supply	1. Have students conduct the Drosophila melanogaster experiment that simulates population growth under specific conditions.

RESOURCES

I. INTRODUCTION

Our civilization rests upon our resources. All societies are dependent upon water, land, forest, minerals, renewable and nonrenewable energy sources, and air. How we use these resources influences our standard of living, our pursuit of happiness, and our future. The domain of Resources includes all resources used by both plants and animals and their importance to mankind. The primary goal of teaching concepts related to resources, resource conservation, and resource management is to show the many components that are required to maintain life on earth as we see it. In addition, we must create an awareness of the responsibility to preserve, maintain, or use wisely resources critical to the processes of life.

II. SOIL

A. Production

OBJECTIVE	CONCEPT	ACTIVITY
52. The student will demonstrate an understanding of soil formation by describing the physical, chemical, and biological processes involved in the formation of soil.	Soil Formation	1. Physical--Pour water into a small crack in a rock; place in dry ice. This will cause the rock to break open. 2. Chemical--Place a piece of limestone (calcium carbonate) into extremely diluted HCL to show the decomposition of limestone. 3. Biological- Show different stages in materials from a compost heap or create your compost heap in a jar. 4. Use a topography map for comparison and determine types of local soil and their origin.

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OBJECTIVE	CONCEPT	ACTIVITY
		5. Use the U. S. Dept. of Agriculture Forest Service packet, "Investigating Your Environment", Stock Number 001-001-00446-4. 6. Use soil conservation packet resource material from local soil and water conservation districts. 7. Making soil: Students can demonstrate how the forces of nature break rocks into smaller particles by using the following demonstrations: a. Take two pieces of limestone or sandstone and rub them together. It will take awhile to accumulate even a small amount of particles. (If you do not have natural stones you can use bricks or concrete.) b. Heat a piece of limestone on a hot plate or directly over a flame. Drop it into a pan of ice water immediately. The rock should fracture as it contracts. c. Completely fill a small glass jar with water and cap it tightly. Freeze it in the refrigerater. Note what happens to the air. d. Place small pieces of limestone in vinegar. Heat the mixture. Notice the bubbles of carbon dioxide that are released by the chemical change in the rock. Eventually all the limestone will dissolve.
53. The student will be able to identify, using drawings, the dominant organisms found in the soil.	Soil Organisms	1. Using a rich humus soil, use a Berlese funnel (funnel, light set-up) to separate organisms found in the soil.

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OBJECTIVE	CONCEPT	ACTIVITY
		2. Have students bring in soil samples and observe types of living organisms. Use both dissecting and compound microscopes to observe life forms. Dissolve a small amount of soil in water and look for nematodes.
54. The student will cite examples of ways in which living organisms in the top part of the soil affect the soil.	Soil Formation	1. Use soil transparency to discuss soil formation.
		2. Have students bring soil samples. Use a microscope to observe life forms. Take a small amount of soil; dissolve it in water to observe nematodes or protozoa. Students may also culture bacteria from soil.
		3. Obtain three soil samples: humus, sandy soil, and clay. Determine the acidity of each either by using a soil test kit or by dissolving small amounts of soil in distilled water and using pH paper. Observe nematodes, protozoa.
B. Productivity		
55. The student will identify the characteristics of a soil profile. These would include texture, pH, temperature, and color.	Soil Formation	1. Homework--Determine different layers of soil from home area.
		2. Draw or make a model of typical soil profile.
		3. Demonstration--Dissolve soil sample in water. Let various layers settle. Time sedimentation rate.
		4. Use "Investigating Your Environment". (see reference on previous page.)

OBJECTIVE	CONCEPT	ACTIVITY
		5. Conduct activity to determine if all soil particles are the same size. Activity: Fill several jars about two-thirds full of water. Pour each of the samples into one of the jars. (Samples should contain various amounts of clay, sand, silt, and pebbles.) Replace covers and shake jars vigorously. Allow soil and water mixture to settle for a day. Each sediment will separate to form layers. Ask the students to draw the layers and label them.
		6. Conduct activity to determine soil profile. Activity: Bake a cake with different colored layers. Use an ordinary cake mix. Add different colors to several separated portions of the cake mix. Gently stir the mix together. Then pour into muffin cups. Cook and cool the cakes. Ice muffins (icing serves as the topsoil). Have the students use large wax-coated straws to take 5 core samples straight across the muffins. Samples can be removed from the straws with a razor blade by slitting the straw. Using graph paper, carefully align samples next to each other and have the students draw and label the layers in order to reconstruct the arrangement of layers from sample one to sample five. Cut the muffin in half and compare the actual layering with the drawings from the samples.
56. The student will describe various factors affecting soil productivity.	Soil Productivity	1. Determine soil acidity, nutrients, and moisture with soil test kit.

OBJECTIVE	CONCEPT	ACTIVITY
		2. Contact guest speakers from: a. Cooperative Extension Services b. Corps of Engineers c. Soil and Water Conservation District
C. Erosion		
57. The student will give evidence to show how man has contributed to soil erosion, comparing agricultural practices in some other regions with ours.	Man-made Erosion	1. Demonstration: Build a stream table. 2. Film on wind erosion and/or dust bowl (1930's) 3. Homework--Cite one area in the community where erosion is evident. a. Identify area. b. Draw a conclusion about probable cause. c. Suggest solution to correct cause. 4. Construct wooden boxes about 4 inches deep, 16 inches long and 12 inches wide. Make sure they are water tight. Use silicone caulk or glue to water-proof the seams. Cut a V-notch about 1 to 2 inches deep to draw the runoff water into a container below. Fill one box of soil with growing grass. Fill the other box with the same soil but no grass. Raise the ends of the box which are opposite the V-notch. Use 2 large watering cans with sprinkler ends and pour over the boxes simultaneously. Check for run-off sediment in each container below.
58. The student will give examples, causes, and results of natural erosion especially along the coast of Louisiana.	Natural Erosion	1. Discuss Great Lake formation. 2. View films of Mt. St. Helens' aftermath.

OBJECTIVE	CONCEPT	ACTIVITY
coast of Louisiana.		3. Obtain speaker from State Levee Board or U.S. Army Corps of Engineers, or Coastal Zone Management to talk about land loss and its causes in Louisiana. 4. Have students develop a graph showing changes in the growth of deserts throughout the world.
59. The student will explain the necessity for erosion control by emphasizing the amount of soil lost annually.	Soil Management	1. Use various visual methods. 2. Obtain graphs, charts, or pictures demonstrating loss of soil per year. 3. Given the rate of soil loss by erosion, have students calculate the time required to replace the lost soil demonstrating loss of soil per year. 4. Determine how much mulch is needed to reduce soil loss. a. Construct two stream tables from the same type of soil. b. Place the tables at an angle. c. Cover one table of soil with a thin layer of grass, wood savings, or other ground cover. d. Sprinkle water on both boxes at the same time. e. Collect the run-off water in a graduated cylinder. Compare total amount from each table. Calculate the time it takes to fill a graduated cylinder to determine rate of flow.

OBJECTIVE	CONCEPT	ACTIVITY
		5. Determine what effect contouring has on erosion. a. Construct two stream tables from the same type of soil. b. On one table, create contour rows horizonal to the bottom. On the second table create parallel rows to depict another method of contouring. c. Collect the run-off water in a graduated cylinder. Calculate the time it takes to fill the cylinder. 6. Show students how to measure slope. Slope is expressed in percent and is a function of how the land rises and falls. a. Use a yardstick, a straight stick exactly 100 inches long, and a carpenter's level. b. Find an area that has a visible slope and place one end of the 100 inch stick horizonally on the slope. Put the level on the stick and move the stick until it is level. c. Use the yardstick to measure the distance the free end of the stick is off the ground. The number of inches is the slope of the land in percent.
III. AGRICULTURE		
A. Food Crisis		
60. The student will contrast the amount of available food supplies with the present world population.	Food Crisis: Supply/ Demand	1. Use the film - "Trunkline LNG-- Phillips Petroleum Supply and Demand." 2. Have students prepare a graph or chart comparing food production to population growth in developed or undeveloped countries.

OBJECTIVE	CONCEPT	ACTIVITY
61. The student will summarize the importance of U.S. agriculture meeting world food needs.	Agricultural Methods and Issues	1. Have class divide into three groups based on the ideas that agricultural products should be distributed equally throughout the world to feed starving people. Group A should propose this concept. Group B should oppose. Group C should modify the proposal. Give students time to conduct library research.
62. The student will become aware of problems between distribution, production and consumption.	Agricultural Methods and Issues	1. Students should discuss what problems are associated with regions where food is needed and the difficulty of getting food to those regions.
63. The student will compare the amount of land used for agriculture since 1900.	Availability of Agricultural Lands	1. Graph the acreage of agricultural land in 10-year intervals since 1900. 2. Compare the population of the urban area of the U.S. with that of the rural area during the same period.
64. The student will be able to interpret the effect of poor nutrition on health.	Food Crisis: Nutrition	1. Homework--Have students obtain daily food requirements, and discuss the calories and nutrients listed. 2. Obtain pictures of children suffering from Kwashiorkor, infantile marasmus. 3. Have each student record daily food intake for a week and analyze for calories, protein, fat, and carbohydrate content. Compare the percent of fat, protein, and carbohydrate of the student's diet with the diet of a person from an impoverished country.

OBJECTIVE	CONCEPT	ACTIVITY
65. The student will demonstrate an awareness of the social, political, and economic factors affecting food production.	Agriculture Methods: Domestic Practices vs. Foreign	1. Obtain booklet with current articles and pamphlets concerning world food crisis. 2. Have students visit local grocery stores to survey the source of various produce, meat products, etc. to determine the problems associated with shipping and distribution in order that food arrive in edible condition. 3. Have students research the cost of shipping grain by various methods from the midwest to different foreign countries (consult railroad, barge transportation, and freighter shipping companies).
B. Agricultural Methods		
66. The student will compare American farming practices and yield with those of underdeveloped countries. These could include: strip, plowing rotation, conservation, slash and burn.	Agricultural Methods: Fertilizers	1. Use films, pictures, and graphs to compare yields, agricultural methods and machinery, and irrigation practices.
67. The student will describe the value of competent use of fertilizer to prevent crop yield decline.	Agricultural Methods: Fertilizers and Yield	1. Class project--Use bean or pea plants. Vary amount of fertilizer from 0 to over-fertilization and record and analyze data.
68. The student will recognize the cost of energy in producing artificial fertilizers.	Agricultural Fertilizers and Energy	1. Research source, energy cost, and production costs of artificial fertilizers.
69. The student will list ways in which food production is destroyed by pests (undesirable organisms).	Pests: Need for Control	1. Prepare survey of grocers, farmers, parents, and cafeterias to estimate food loss because of pests and approximate cost.

OBJECTIVE	CONCEPT	ACTIVITY
70. The student will trace uses of pesticides since 1900.	Pest Control: History	1. Consult old Farmer's Almanacs on early uses of natural pesticides. Suggested readings: Silent Spring and Since Silent Spring. 2. Contact CIBA GEIGY about the safety procedures used in processing pesticides. 3. Research early history of organic chemistry during World War II. 4. Discuss the rationale behind the development of chlorinated hyrocarbons.
71. The student will define and differentiate between persistence and resistance in use of pesticides.	Pest Control: Persistence	1. Local speaker a. Exterminator topic--resistance in insects found in residences b. Entomologist topic--resistance in insects found in various crops
72. The student will recognize that pesticides must be carefully used since they are detrimental to many unintended species when used improperly.	Pest Control: Use of Pesticides	1. Determine which insects are beneficial and detrimental. Compare list to insects which will be killed by various pesticides. 2. Research vertebrate and invertebrate examples that have been injured by the overuse and misuse of pesticides. 3. Homework: Each student will-- a. Name a pesticide b. List ingredients c. List appropriate instructions d. Cite insects targeted e. Cite side effects to pets and humans f. Antidotes

OBJECTIVE	CONCEPT	ACTIVITY
73. The student will list types of natural pest control methods and compare the effects to those of artificial pesticides.	Pest Control Methods	1. Refer to publications such as Organic Gardening and Mother Earth News and publications by Ortho, Ciba-Geigy, or Monsanto Chemical. 2. Contact Cooperative Extension to obtain information about natural pest control.
74. The students will define biological magnification and describe how it is harmful to organisms.	Pest Control: Biological Magnification	1. Make a diagram tracing DDT through a food web. 2. List organisms now endangered or extinct because of biological magnification (peregrine falcon, brown pelican) 3. Discuss the dangers of eating contaminated liver.
75. The student will list and define new trends in food production, including the green revolution, new food sources, hydroponics, and aquaculture.	Trends: Sources of food	1. Research current articles on use of hydroponics (Contact EPCOT Center or the National Space Technologies Lab). 2. Contact Sea Grant Program or the Agriculture Center at LSU.
IV. WATER		
A. Water Habitats		
76. The student will list and describe various water habitats and values of each.	Water Habitats	1. Students will list various organisms found in each habitat using posters, pictures, etc. and specimen when available. 2. Invite a speaker from Wildlife and Fisheries to discuss estuaries and the destructive effect of disturbing them (economic and biological).

OBJECTIVE	CONCEPT	ACTIVITY
		3. Conduct a field trip to a water habitat. Suggested units that include excellent activities and resource materials for field trips include the "Bird Island Basin" from Texas Sea Grant, "A Guide to Field Studies for the Coastal Environment," Dare County, North Carolina Project Cape), the Jekyll Island material from Georgia and the Washington Sea Grant "Marine Biology Activities."
77. The student will be able to describe disturbed or endangered water habitats.	Disturbed Water Habitats	1. Research Topics: a. Shell dredging b. Salt water intrusion c. Brine line 2. Use the Nova Film--"Good Bye Louisiana," about the changing course of of the Mississippi River. 3. Check with the U.S. Army Corps of Engineers for information on preventing river erosion along the changing course of the Mississippi River.
B. Characteristics of Water		
78. The student will describe the biological and economic reasons for protecting water habitats.	Habitat Destruction	1. Have the students make a list of diseases that are primarily associated with polluted water. 2. Contact a resource person from the Department of Health and Human Resources to talk about oyster contamination.
79. The student will name and define unique characteristics of water.	Physical Characteristics	1. Conduct conductivity and solubility tests using various liquids and solutions.

OBJECTIVE	CONCEPT	ACTIVITY
		2. Compare temperature of inland and coastal land areas. 3. Discuss frozen pipes in winter. 4. Have class construct hydrometers. Use them to demonstrate changes in density of water due to salt content, to compare density of different liquids and of liquids of different temperatures. Materials: Plastic soda straws, lead shot, tape, graduated cylinder or tall jar. Procedures: a. Seal the end of the soda straw so that it is water tight. b. Hold the straw, sealed end down, in a graduated cylinder or tall jar which is 3/4 full of water. Add a few (2 or 3) pellets of lead shot until the sraw sinks down about 4 cm into the water. Mark the water level on the soda straw with a waterproof marker. c. Now place the straw in a cylinder 3/4 full of alcohol. Why does the straw float lower? d. Dissolve as much salt as possible in the water in the first container used. Float the soda straw hydrometer in it. Make another water level mark. It is above or below the first? Why? e. Ask someone to look up Plimsoll lines in an encyclopedia or a large dictionary. Why are "summer lines" distinguished from "winter lines"? f. Ask the class to think of a way to demonstrate the differences in density caused by temperature changes (float hydrometers in hot water, and ice water).

OBJECTIVE	CONCEPT	ACTIVITY
		g. How would this affect shipping? (You can transport more weight in a ship in the winter, but storms make it less safe. Will increased profits make up for increased risks?)
C. Availability of Water		
80. The student will describe the hydrologic cycle.	Availability of Water	1. Use transparency to show water cycle. 2. Review concepts presented in previous section on general ecology. 3. Demonstrate a cloud simulation with a cloud chamber.
81. The student will contrast the total amount of water on earth with usable amounts. This will include available water supplies with those of various regions of the country.	Availability of Water	1. Use globe to show water on earth and statistics to show amount of fresh water. 2. Examine maps of coastal states and show how water affects the development of cities. 3. Chart water supplies available in U.S. today and designate areas of concern. 4. Contrast amount of water used in industrial areas, agricultural areas, and urban areas. 5. Have students find out how the water from the Colorado River is allocated according to the population. 6. Contact these sources for information: a. Department of Housing and Urban Development

OBJECTIVE	CONCEPT	ACTIVITY
		b. California Water Project (Department of Agriculture) c. Federal Water Quality Control d. Ohio River Valley Sanitation Commission e. Tennessee Valley Authority f. Cousteau Society
82. The student will describe the availability of water in Louisiana.	Availability of Water	1. Locate all available suface waters in Louisiana. 2. Contact these sources for additional information: a. Louisiana Department of Health and Human Resources b. Department of Transportation and Development c. Local Water Companies d. Department of Natural Resources e. U.S. Army Corps of Engineers f. Louisiana Geological Survey
83. The student will differentiate between ground water and surface water.	Availability of Water	1. Obtain Department of Transportation information on aquifers in Louisiana. 2. Locate sites where most aquifers are found and determine geological processes that caused them. 3. Discuss aquifers in your area and problems with polluting ground water as opposed to surface water. 4. Discuss saltwater intrusion along the Gulf of Mexico. 5. Contact the U.S. Water Resources Council or U.S. Geological Survey.

OBJECTIVE	CONCEPT	ACTIVITY
84. The student will list two ways usable water is obtained.	Availability of Water	1. Give location of surface fresh water. 2. Where does the community obtain supply? 3. Question each student as to his water supply.
85. The student will compare present and future water demands.	Availability of Water	1. Activity--Use New Orleans Water supply as an example. 2. Discuss impact of proposed water diversion projects. Examples: a. Mississippi River water to Arizona b. Tennessee diversion c. Sabine diversion system d. Toledo Bend
D. Water use		
86. The student will list different instream uses of water, e.g. recreation, transportation, commercial fishing.	Water Use	1. Have students outline instream uses of water within their community. Have them contact their city water department to determine where the greatest use occurs. 2. Create a bulletin board using pictures to illustrate instream uses and withdrawal uses.
87. The student will give examples of different withdrawal uses of water.	Water Use	1. Have students outline withdrawal uses of water within their community. Have them contact their city water department to determine where the greatest use occur. 2. Research and draw a model of aquifers in the U.S.

OBJECTIVE	CONCEPT	ACTIVITY
88. The student will give evidence to show that there is a conflict between instream and withdrawal uses of water.	Water Use	1. Determine if any conflicting uses of water exist in Louisiana. Have students contact the Department of Transportation and Development. 2. Have students choose a body of water and list benefits of using it for recreation, industry, agriculture, and river transportation and decide if water can accommodate all kinds of uses or should it have limited use.
89. The student will evaluate the reasons determining the importance of reservoirs.	Water Use	1. Examine state map showing lakes and rivers in Louisiana that are used as principal water sources. 2. Have the class debate the pros and cons of creating a reservoir in their area.
E. Water Treatment		
90. The student will diagram a flow chart tracing water through a water treatment plant.	Water Treatment	1. Visit a local water treatment plant. 2. Invite a speaker from local treatment plant or Public Health Unit. 3. Perform tests on water samples from different local areas for various trace materials, e.g. calcium, magnesium, chlorides (kits also available). 4. Test for coliforms. 5. Demonstration--Set up simple filtering system using cotton and sand and pour polluted water through a funnel. 6. Have a jar of muddy water and observe settling of large particles.

OBJECTIVE	CONCEPT	ACTIVITY
F. Pollution		
91. The student will list various chemicals that are water pollutants. He will identify sources and state effects of the chemicals on the environment.	Water Pollution	1. Individual research on local industrial pollution 2. Film of Livingston train derailment 3. Speaker--Department of Environmental Quality 4. Speaker--Industry and Public Utilities 5. Use Nova video "The Black Tide." 6. Discuss phenol spill in Mississippi. 7. Discuss oyster bed contamination in Louisiana. 8. Assign each student a chemical to research.
92. The student will list various sources of domestic water pollution and state the effects those materials have on plant and animal life and public health.	Water Pollution	1. Speaker--Department of Public Health 2. Speaker--Person from Sewage Treatment 3. Using four samples of pond water, add high phosphate detergent to one, low phosphate detergent to another, and fertilizer to the third. Observe over a two-week period for algae growth. 4. Test various types of water for biochemical oxygen demand. 5. Research recent fish kill in area. 6. Research bodies of water which are extremely polluted.

OBJECTIVE	CONCEPT	ACTIVITY
		7. Examine possible remedies for cleaning up and overcoming this problem. 8. Survey household products and rank according to environmental damage. 9. Test for hard and soft water. 10. Use one of the films listed in Bulletin 1406. 11. Demonstrate to the students how an increase in temperature of water decreases carbon dioxide dissolved in water. Activity: Take cold water, water at room temperature, and boiling water. Add several drops of bromthymol blue to each container to show the presence or absence of carbon dioxide.
93. The student will locate various sources of agricultural water pollutants and state effects of the materials on the environment.	Pollution Sources	1. Contact a farmer or someone from cooperative extension to discuss issue. 2. Investigate steps necessary to become a registered pesticide applier. 3. Interview a cropduster amd ask him to describe the safety precautions in applying pesticides. 4. Write Lake Providence City, Louisiana, to obtain information about the health and history of Lake Providence (lake).

OBJECTIVE	CONCEPT	ACTIVITY
		5. Research the new methods of recycling animal wastes. 6. Research--Go to store and determine toxicity of various pesticides and fertilizers. 7. Have students construct graphs or charts to show parts per thousand, per million, and per billion, and explain detrimental effects of minute amounts.
G. Controlling Pollution		
94. The student will differentiate between point source and nonpoint source.	Controlling Pollution	1. Cite various local sources of pollution and classify as to point source or nonpoint source.
95. The student will recognize that chemicals, raw sewage, oil, and agricultural waste can contribute to the pollution of surface water and groundwater.	Controlling Pollution	1. Research--Identify a particular pollutant and trace it from source to ultimate destination.
96. The student will recognize that groundwater injection is a method of waste disposal and is is prevalent in Louisiana.		1. Contact local industry to determine if injection wells are used in their area. 2. Contact local environmental groups to determine number and safety of injection wells in your area.
H. Trends and Sources		
97. The student will discuss new trends to increase availability of usable fresh water.	Water Availability	1. Examples of new trends: a. Prevention of groundwater pollution b. Reclamation c. Icebergs d. Desalination e. Rainmaking

OBJECTIVE	CONCEPT	ACTIVITY
98. Students will understand the basic principles and operation of septic systems.		1. Contact a local septic installation company to come and discuss their products.
99. Students will locate their primary source of drinking water and the sewage treatment facility.	Water Availability	1. Students should be assigned to locate their source of water and sewage outfall.
V. LAND RESOURCES		
A. History		
100. The student will discuss briefly the history of land use in the United States from the discovery of the new world to the present.	Trends in Land Use	1. Develop a line chart showing when various changes in agricultural practices occurred. Include: a. Farming and hunter-gathering societies prior to Columbus b. Trends shifting to farming until the turn of the 20th Century c. Urban growth and how it has threatened many farming areas 2. Divide students into groups of 3 or 4. Present each group with a category for land use. Include such uses as: a. Recreation b. Industry c. Utilities d. Housing e. Commercial f. Government g. Public Service h. Sanitation and sewerage i. Agriculture

OBJECTIVE	CONCEPT	ACTIVITY
		Have students take half a period to list as many uses for their land, in their assigned category, as possible. Have each group present the possible uses to the class. These can be discussed. The teacher can also draw a plan of the topography of the entire area available for development and make copies for the class. Following the discussion sessions a plan can be made on the blackboard for the arrangement of various categories. (Some pieces of land may be split and bartered, traded, or sold in order to make the best arrangement.)
101. The student will discribe the origin of the conservation and environmental protection movement.	Trends in Social Sciences	1. Contact a history teacher to give a perspective of the late 1800's on conservation. Discuss the early beginning of the National Park System, national forests and the protection of wildlife (buffalo). Include Theodore Roosevelt's efforts, as well as those of John Muir.
102. The student will understand our national policy toward wilderness areas, national forests, and national parks and seashores.	Preservation Movement	1. Using maps, have students locate wilderness areas and national forest and obtain addresses to write for information to develop a resource file for the class. 2. National Geographic Special: "National Parks" 3. Contact various national parks and forests in the U.S. for maps and information regarding regulations within forests, parks, wilderness areas.

OBJECTIVE	CONCEPT	ACTIVITY
B. Recreational Use		
103. The student will explain how improper and excessive use of recreational areas causes land problems and costs taxpayers money.	Recreational Overuse/ Misuse	1. Research--Yellowstone or other national parks. Check salaries of park rangers. Discuss efforts to keep park clean, comparing July 4 to November 10. Relate number of people to cost.
104. The student will explain how recreational activities can be limited by pollution.	Recreational Overuse	1. Use current articles on limits to recreation because of pollution. Discuss warnings on eating fish, or swimming in polluted waters. 2. Talk about individual experiences of man's polluting the environment.
105. The student will recognize the problems of exploitation of recreational resources.	Exploitation of Land	1. Compare and contrast an area (lake) as to private and public use. 2. Study the impact of commercialization of public recreational areas. 3. Debate--one side for development of beaches and one side against development of beaches.
106. The student will define conservation as the wise use and protection of national resources to ensure an adequate supply for the present and future.	Definition of Conservation	1. Research--History of conservation acts in U.S. 2. Research the Punic Wars. Discuss the destruction of natural resources (farmland) and the decline of the war.

OBJECTIVE	CONCEPT	ACTIVITY
C. Wilderness and Protected Areas		
107. The student will identify that a natural area is any place where the biotic elements and organisms are undisturbed and are held in this state for the benefit of all mankind.	Definition of Natural Areas	1. Discuss the economic and ecological aspects of oil exploration and drilling in Alaska. 2. Discuss the importance of barrier islands in protecting the coastal zone.
VI. FORESTS		
A. Ecological Importance		
108. The student will explain that plants (including trees) purify air, provide cover to hold soil in place, protect the water supply, provide raw materials, and add beauty to the landscape.	Biological Benefits of Plants	1. Speaker--U.S. Forestry Service 2. Obtain films on use of plants. 3. Industrial speaker--paper mills, lumber companies 4. Research all products available from trees or forests. 5. Trace what happens to a tree from cutting to final product. 6. Make paper in class.
B. Forest Management		
109. The student will discuss the concept of multiple use in forest management. This will include managing trees as a crop, techniques (clear-cut, selective cut, shelterwood, artificial and natural regeneration, and pest control).	Forest Management	1. Use films from forest management companies like Boise or Crown Zellerbach. 2. Use a map of Louisiana to identify wildlife management areas and national forests. 3. Take a field trip to a natural area.

OBJECTIVE	CONCEPT	ACTIVITY
		4. Research the effects of the pine tree beetle on Louisiana's forests. 5. Conduct a local survey of pests and diseases affecting the local area.
110. The student will discribe how forests can be economically, scientifically, and recreationally used.	Forest Use	1. Use a forest map of the U.S., and locate national parks and forest areas within the boundaries of the U.S. Ask students, "Why are they concentrated in the West?"
C. Conservation		
111. The student will describe the consequences of eliminating endemic species of plants for the sole purpose of monoculture and commercial exploitation.	Forest Conservation	1. Field trip to a wilderness area in Louisiana (Kisatchie). 2. Use Film "Forests Are for People."
112. The student will describe the consequences of the loss of tropical forests in South America, Asia, and Africa.	Forest Management Conservation	1. Use special programs by NOVA. 2. Use special film by the Cousteau Society on the Amazon River.
113. The student will describe the relationship of Louisiana forests to the state's geography, history, and economy.	Recycling Paper	1. Have students discuss the idea that the recycling of paper products, such as computer paper, can be a means of helping to conserve our forests for other uses. 2. Bring in different paper products made from recycled paper. 3. Have a paper drive and sell paper.

OBJECTIVE	CONCEPT	ACTIVITY
VII. WILDLIFE		
A. Importance		
114. The student will summarize reasons that show the value of certain natural plant and animal species to man and to the environment.	Awareness and Appreciation of Wildlife	1. Discuss medicines obtained from plants (examples might include reserpine, vincristine). 2. Discuss economical importance of bees, wasps, labybird beetles, snakes, birds, and mammals (such as deer). 3. Discuss the importance of species within the food web. 4. Obtain Classroom Copies of the Louisiana Conservationist. 5. Discuss why Indians a. hunted for food b. moved around by season c. did not hunt in every season and compare to today's hunting-management program. 6. Discuss the economic impact of wildlife in your local area. (trapping, crabbing, crawfishing, fishing, etc.) 7. Contact an Audubon Society speaker, Louisiana Wildlife and Fisheries Biologist, or wildlife manager from another agency.

OBJECTIVE	CONCEPT	ACTIVITY
		8. Discuss the economic benefit of wildlife using photography, hunting, and travel agencies as examples. 9. Have students make a list of decorative uses of wildlife. Bring examples from magazines or catalogs of porcelains, needlepoint, woodcarvings, etc.
B. Management		
115. The student will realize that wildlife must be conserved and often controlled to prevent extinction or overpopulation, and that direct exploitation by man can hasten the process.	Wildlife Management	1. Make a list of endangered species,and probable reasons why they are endangered. 2. List rates of extinction. Support your position with articles. 3. Explain how overprotection could be harmful--(e.g. alligators).
116. The student will describe how natural processes can also hasten extinction or cause overpopulation.	Natural	1. Discuss why extinction of any animal or plant is considered a loss to humans. 2. Discuss theories about the extinction of dinosaurs. 3. Have students research causes of extinction or reduction of species (ex. passenger pigeon, buffalo, tiger, auk, ivorybilled woodpecker).
117. The student will describe how wildlife is economically and aesthetically important. This would include: a. Wildlife has scientific and ecological values.	Importance of Wildlife	1. Discuss and show examples of international disputes over wildlife (Example, fur industry of Hudson Bay Company, whaling industry, and fishing industry).

OBJECTIVE	CONCEPT	ACTIVITY
b. Wildlife has social and political values. c. Wildlife has commercial and economic values.		2. Discuss why wildlife refuges and special management areas have been set aside for little or no hunting. Write a wildlife refuge and find out how it functions. 3. Invite a wildlife photographer/artist to speak. Report on American Indian beliefs and religion involving animals. Invite an American Indian or an authority on Indian culture to speak on the role of animals in native culture.
118. The student will recognize that wildlife is one of our basic natural resources and can be managed and conserved. a. Management practices are based on ecological applications and natural laws. b. Conservation of wildlife promotes the protection and the preservation of wuldlife.	Wildlife Conservation Management	1. Invite a professional wildlife manager from Louisiana Wildlife and Fisheries to discuss the science of wildlife management. 2. Invite a person currently conducting research in wildlife management, a graduate student or researcher to discuss his project. 3. Invite representatives from the Louisiana Wildlife Federation to speak on activities individuals can do to help manage and protect wildlife.
119. The student will describe how the regulated harvest of wildlife by recreational hunting and fishing is a management method of removing surpluses which might be removed naturally.	Wildlife Management: Hunting	1. Discuss pro-hunting and anti-hunting. 2. Discuss hunting season limits, etc. and how they are set. 3. Discuss why poaching is harmful. 4. Contact members of Ducks Unlimited. and have them speak on hunting. 5. Identify laws concerned with wildlife.

OBJECTIVE	CONCEPT	ACTIVITY
		6. Gather information on preserves or refuges in your area. 7. Contact the Department of Wildlife and Fisheries for a speaker. 8. Research necessary criteria for becoming a game warden or having a career in wildlife management. 9. Discuss the anthropological aspects of hunting.
VIII. AIR		
A. Atmosphere		
120. The student will list the major components of the atmosphere.	Atmos-phere	1. Draw a circle graph of c onents of atmosphere. 2. Use a transparency on photosynthesis to show oxygen output. 3. Use cold and warm water to show the clarity of cold compared to warm---air is visible (less soluble) in warm water. 4. Draw a diagram of the atmosphere and discuss each of the layers.
121. The student will recognize that the largest percentage of oxygen comes from the ocean, while the remaining oxygen come from the extensive forested regions around the world.	Oxygen Cycle	1. Have students draw a diagram of the oxygen cycle. 2. Discuss other gas cycles.

OBJECTIVE	CONCEPT	ACTIVITY
122. The student will diagram different layers of the atmosphere and list the characteristics and importance of each.		1. Discuss the importance of the ozone layer. Ask students to research problems presently known about the destruction of the ozone. 2. Discuss the health hazards associated with ultra-violet radiation. 3. Discuss the greenhouse effect and why (or whether) this is occurring.
B. Climate on Earth		
123. The student will categorize the different climates on earth.	Climate differences	1. Conduct an activity reviewing the various biomes previously discussed in General Ecology. 2. Use a resource book to determine the amount of rainfall and temperature in different areas of the world. Discuss how these areas affect the world's climate.
124. The student will provide evidence to support the global changes in climate by natural and human influences.	Climate Changes: Causes	1. Discuss the greenhouse effect, volcanic eruptions, the depletion of tropical rain forests, and solar activity. 2. Discuss the potential effects of both a limited and large scale nuclear war on the earth's climate.
125. The student will describe the complexity of the tropical rain forest and its impact on both local and global climate.	Impact of Tropical Rain forests	1. Discuss how large forested areas affect the local microclimate. 2. Use the video "Planet Earth."

OBJECTIVE	CONCEPT	ACTIVITY
C. Pollution		
126. The student will provide evidence that pollutants and contaminants are produced by natural and man-made processes which can upset climate and atmosphere.	Production of Pollutants	1. Film and discussion on Mount St. Helens (volcanoes) 2. Discuss El Nino (ocean currents). 3. Discuss "greenhouse effect," nuclear winter, aerosol propellants.
127. The student will define air pollution as atmospheric contamination from many sources that can be detected and measured.	Air Pollution	1. Observe cigarette filters, air conditioner filters, and air filters on automobiles. 2. Students should collect pictures of smog and air pollution. 3. Observe air quality data on local T.V. weather reports and correlate with wind direction on the same days. Students should determine origination of poorest quality direction and source. 4. Spread Vaseline on a slide and place outdoors for one day in various parts of the city. Observe and compare results.
128. The student will show how air pollution contributes to the deterioration of different materials and has a negative effect upon animals and plants.	Effects of Pollution	1. Using sulfuric acid in different test tubes, add iron filings, copper filings, calcium carbonate (marble), aluminum, and cotton cloth. Observe deterioration. 2. Discuss causes of the Statue of Liberty renovation. 3. View NOVA tape on acid rain. 4. Discuss various historical examples of air pollution. Example: London fog

OBJECTIVE	CONCEPT	ACTIVITY
129. The student will list various controls used in reducing air pollution.	Air Pollution Controls	1. Trace the history of emission controls on automobiles and their effectiveness. 2. Compare the cost of scrubbers added to smoke stacks to the amount of pollution that would be controlled. 3. Obtain the Surgeon General's report on the effect of smoking on health.
IX. MINERALS		
A. Renewable and nonrenewable		
130. The student will differentiate between renewable and nonrenewable resources.	Resources Renewable/ Nonrenewable	1. The students will estimate the length of time the known reserves of zinc, copper, tin, petroleum, etc. will be depleted at today's consumption rate. 2. Use everyday products such as jewelry, cooking utensils, vitamins, etc., and trace back to original mineral makeup.
131. The student will distinguish between element, compound, and mineral deposits.	Resource Identification	1. Show students samples of materials that are examples of elements and compounds. Examples in Louisiana are sulfur, coal, salt, and oil. Contact Freeport Sulfur Company for samples of sulfur. Refer to Freeport Sulfur Company curriculum guide for experiments.
132. The student will demonstrate an understanding of how dependent the nations of the world are on many resources.	Dependence of World on Resources	1. Investigate what minerals are classified as critical or strategic. 2. Have students discuss what changes in lifestyles may be necessary in developing countries in order to achieve a more even distribution of the world's nonrenewable resources.

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OBJECTIVE	CONCEPT	ACTIVITY
		3. Choose a mineral that the United States imports from another country and determine what consequences will ensue if the United States can no longer obtain this mineral (consider the economic, political, and social consequences). 4. Use a world map that shows the location of various natural resources. Compare the economic aspects of the countries with the natural resources available. 5. Discuss the shifting economic value of minerals as technology expands.
B. Mining Practices		
133. The student will discuss various methods used in mining.	Mining Resources	1. Write various mining companies in Louisiana to obtain information on methods used. Sources: SWEPCO/CLECO Avery Island Salt Mine Freeport Sulfur Midcontinental Oil & Gas gravel/shell companies
134. The student will compare advantages and disadvantages of subsurface mining and surface mining.	Methods of Mining Resources	1. Discuss whether all methods are usable for extracting all minerals. What factors are involved in selecting a method?
135. The student will discuss methods used to reclaim land that has been mined.	Methods of Mining Resources	1. Research Surface Mining Control Reclamation Act (1977). 2. Research the Federal Coal Leasing Act (1976).

OBJECTIVE	CONCEPT	ACTIVITY
		3. Research the Minerals Leasing Act. 4. Research the Resource, Conservation, and Recovery Act (1976).
136. The student will recognize that ecologically sound ways of mining and recycling can help conserve our mineral resources.	Conservation of Resources	1. Have students recycle aluminum cans to fund a local field trip or project. 2. Use films on mining practices. 3. Have students report on various types of mining and the techniques used in conservation. 4. Compare the cost of producing one pound of aluminum from bauxite ore to producing one pound of aluminum from recycled aluminum. 5. Have students bring different products made from recycled materials.
137. The student will list some of the effects of mining and processing on the environment and on health.	Health Problems of Mining	1. Investigate the effects of mining on water in West Virginia, North Louisiana, and Southern Illinois. 2. Discuss environmental and health effects of the uranium mines on the Navajo Indian reservations. 3. Discuss black lung disease. 4. Discuss the effects of mining asbestos (obtain the NOVA special program on asbestos).

ENERGY

I. INTRODUCTION

Renewable and nonrenewable energy resources provide a mix of energy alternatives that feed the huge human demand. About 400 years ago, a renewable resource, wood, was the primary source of energy. A rapid transition took place in which coal replaced wood. Eventually another transition occurred because of the increased use of oil and gas. Now new alternatives are available. The goal of this domain is to provide students with facts on all forms of energy and present both advantages and disadvantages of each.

OBJECTIVE	CONCEPT	ACTIVITY
138. The student will define energy as the ability to do work.	Definitions of Energy	1. Discuss the definition of energy and have class members describe its many forms, (kinetic, potential, heat, electrical, chemical, nuclear, solar, light, sound) giving specific examples of each. 2. Define power (the rate at which energy is expended). Students may measure the power they can develop in running up stairs. The work done is the student's weight, the number of steps, and the height of the risers. 3. Have pupils calculate their power in watts by multiplying their weight in newtons by the height of the stairs in meters, and dividing the product by the time in seconds.

OBJECTIVE	CONCEPT	ACTIVITY
		4. If a 165 lb. student climbed a flight of stairs a vertical distance of 39 feet in 15 seconds, the power developed in horsepower would be calculated as follows: Multiply the weight in newtons by the height in meters. 165 lb = 75 kg (2.2 lb = 1 kg) 75 kg = 735 newtons (1 kg = 9.8 newt.) 735 newt. x 12 m = 8820 newt.-m Then, divide the product by the time in seconds. 8820 newt.-m / 15 sec = 588 newt.-m / sec = 588 watts (1 newton-meter = 1 joule, 1 joule/sec= 1 watt, 746 watts = 1 horsepower) thus, 588 watts = 4/5 horsepower (appr)
II. MAJOR SOURCES OF ENERGY		
A. Sun as the Primary Energy Source		
139. The student will demonstrate an understanding that the sun is the primary source of energy for all living things.	Energy Source	1. Construct and use a solar still to demonstrate the water cycle. Discuss how what is happening in the solar still is similar to the water cycle in nature. Define and discuss evaporation, condensation, and distillation. 2. Demonstrate the construction and use of a solar collector. Measure the increase in the temperature of water recirculating through the collector and discuss advantages and disadvantages of heating water by this method. Lead the students to the realization that "mixed methods" are sometimes optimal. Discuss preheating water with solar collectors before it enters a hot water heater.

OBJECTIVE	CONCEPT	ACTIVITY

3. Find out how a heat engine works. Could a solar collector be used as the high temperature source for a heat engine?

4. The Gulf Stream acts as a giant solar collector. That is why the Gulf Stream is a good location for use of a heat engine to produce electric power. Note: A year-round difference of about 40 degrees exists between the surface water and water 1000 feet below the surface.

5. Investigate efforts by the French government to build a sea thermal power plant.

6. Investigate the possible effects of a thermal power plant in the Gulf Stream. (Cold water brought up from the bottom would be beneficial to marine life. The greatest concentrations of marine life in the world are in areas where currents bring nutrient-rich cold water to the surface).

7. Investigate how electricity produced could be used to produce hydrogen for a hydrogen-based energy system. (Instead of sending electricity ashore, it would be used to make hydrogen by electrolysis of water. This hydrogen could be transported in existing gas pipelines to local fuel cell plants to make electricity.)

OBJECTIVE	CONCEPT	ACTIVITY
B. Photosynthetic: Wood		
140. The student will demonstrate the understanding that energy from the sun enters living systems through green plants.	Major Source of Energy	1. Discuss how much of the world's population still depends on wood for fuel. 2. Another use for plant materials is fuel; other than wood or charcoal there is the use of ethyl alcohol as fuel. Investigate the production of alcohol as fuel in, for example, Brazil. List the advantages and disadvantages.
C. Photosynthetic: Fossil Fuel		
141. The student will describe how fossil fuels are trapped sunlight.	Fossil Fuels: Plants	1. Investigate how fossil fuels such as coal are formed from plants. A. Have students examine samples of ferns, peat, and coal. Show the students geologic time charts and describe the physical condition of the earth during the coal-forming processes. Then simulate the conditions in the aquarium. B. Fill the aquarium with tap water. Add enough peat moss to make a one-inch layer. Allow one week to elapse. What is the condition of the water? Include such things as pH, odor, turbidity, decomposition of peat, etc. Have any changes occurred in the peat? Suggest reason for the changes or explain why changes did not occur. C. Sift moderately fine sand over the peat to a depth of one inch. After the sand settles, add an equal depth of peat. Repeat the process for as long as desired or until several successive layers have formed. Is coal being formed today naturally?

OBJECTIVE	CONCEPT	ACTIVITY
		2. The student will observe the difference between the types of coal, such as lignite, bituminous coal, and anthracite coal by examining samples. Instruct the students to do the following: a. Examine the samples carefully, using a hand lens if necessary. Answer the following questions: 1) Which sample looks most like plants? 2) Which sample looks least like plants? 3) Arrange the samples in order of hardness. 4) Arrange the samples in order of luster. 5) Which sample looks as if it has the most carbon it it? 6) Which sample looks as if it has very little carbon in it? b. Hold each sample with the crucible tongs and light it with the Bunsen burner. Note how long each takes to ignite. Also note any odors or smoke and how rapidly each burns.
D. Finite Nature of Fossil Fuels		
142. The student will investigate some of the estimates of the known reserves of crude oil available to the United States and be able to predict the number of years these reserves will last at the present rate of consumption.	Fossil Fuel: Oil	1. Have the students use the resources of their school and local libraries. Encourage them to contribute clippings from newspapers or magazines that discuss this subject. 2. Use a world map, locate and mark the known reserves and predicted resources of crude oil.

OBJECTIVE	CONCEPT	ACTIVITY
143. The student will investigate the estimates of the known reserves of natural gas available in the United States and predict the number of years these reserves will last at the present rate of consumption.	Fossil Fuel: Natural Gas	1. Use the school resources, local libraries, newspaper and magazine articles that the students bring from home to investigate this topic. 2. Use a world map and mark the crude oil reserves and natural gas reserves.
144. The student will investigate the estimates of the known reserves and predict the resources of coal available to the United States and the number of years the reserves will last.	Fossil Fuel: Coal	1. Use the school resources, local libraries, magazine and newspaper articles, to investigate the topic. 2. Use a world map and mark the known reserves of coal.
145. The student will investigate the worldwide energy resources of fossil fuels and be able to state where these resources are presently located.	Fossil Fuel: Geographic Location	1. Once the energy resources have been located, have the students decide which countries have the greatest demand for those energy fuels. Discuss what problems result in this supply/demand imbalance.
146. The student will be able to: (1) list some manufactured items for which fossil fuels serve as raw materials and (2) describe the "petro-chemical crisis" in terms of the "energy crisis."	Fossil Fuel: Other Uses	1. Students may make a list of those things for which fossil fuels are used. Discuss the difference between using fossil fuel as an energy source to power a process (such as transportion) and its use as a raw material in the manfactured item (such as tires). 2. Using this list, have students speculate how our life styles may be forced to change as the abundance of fossil fuels dwindles.

OBJECTIVE	CONCEPT	ACTIVITY
D. The Effects of Using Fossil Fuels		
147. The student will determine the effects of gases emitted from the burning of coal in a closed aquatic ecosystem.	Fossil Fuel: Effects	1. Into two one-gallon jars, add two inches of aquarium gravel. Add water to the top of the vertical column. Add several strands of Anacharis (Elodea sp.). These may be floating or rooted in the gravel. Let the aquaria sit for one week. Introduce a male and a female Guppy. Feed the Guppies for several days and then seal the jars with paraffin-coated lids. (The jar lids should have a hole large enough to admit a glass tube.) Put one gram of finely ground coal with a known sulphur content into a 22 x 180 mm test tube. Plug with a one-hole rubber stopper. Insert a short section of glass tubing through the stopper. Place a long (25cm) glass tube through the hole in the lid of one jar. Connect the glass tubing with an aquarium hose. Burn the coal using an external flame. As the coal burns down, be careful that water is not drawn back into the test tube--this could cause the glass to break. Repeat the process daily or weekly for several weeks. Have students record any changes which occur in the two jars. Make sure the jars are kept near each other, under the same conditions, and out of direct sunlight. 2. Ask students to determine what effect the burning of coal has on this closed aquatic ecosystem. Ask how this system compares to the biosphere. Ask if the burning of coal could have a potential effect on the aquatic portion of the biosphere.

OBJECTIVE	CONCEPT	ACTIVITY
148. The student will determine the effects of gases emitted from the burning of coal in a closed terrestrial ecosystem.	Production of Carbon Dioxide and Carbon Monoxide	1. Into two one-gallon jars, add pea gravel to a depth of one inch. Make sure the soil is free from fungi and add a minimum of 1-2 inches of soil. Plant two species of a succulent in each jar. Make sure specimens in the two jars are as similar in size and vigor as possible. Drill a hole in the lid and insert a thin rubber diaphragm such as the plugs used in blood-clotting vacuum tubes. As an added protection against unwanted contaminants, use a paraffin seal between the lid and the jar. Add sufficient water to moisten the soil. Screw the lids on and place in indirect sunlight. (Direct sunlight will cook the plants.) Keep both jars together and allow the jars to reach equilibrium. Finally, grind one gram of high sulfur coal (or coal used in your area). Place the coal in a large test tube. Insert a small glass tube into a one-hole stopper. Connect the rubber tube to the protruding glass tube. Then insert the entire apparatus into the end of the tube. To the end of the rubber tubing attach a hypodermic needle of sufficient size and length. Insert the needle into the diaphragm, making sure the opening is not blocked. Heat the test tube containing the coal until all the coal has burned. Observe the growth rates of the plants in each jar. Daily measurements should be taken. The gases from the coal should be administered daily for two weeks. 2. Ask students what effects the burning of the coal have on the closed ecosystem.

OBJECTIVE	CONCEPT	ACTIVITY
149. The student will compare and contrast the effects of burning fossil fuels on an aquatic and a terrestrial ecosystem (as demonstrated in the two previous objectives) and relate that to descriptions of the effects of "acid rain."	Fossil Fuel: Effects	1. Using notes from the two previous activities and material from the school library and from local libraries, and newspaper and magazine articles from home, the students can relate the effects of burning fossil fuels to the described effects of "acid rain."
150. The student will demonstrate an understanding that petroleum and natural gas are critical to the chemical industry.	Fossil Fuel: Alternative Uses	1. Ask students to list all products they know of that are produced from fossil fuels. 2. In the interests of conservation of a critical resource, alternate sources of energy must be utilized. Have the students list as many as possible and prepare brief descriptions.
III. ALTERNATIVE ENERGY SOURCES		
A. Water Power		
151. The student will survey alternate energy sources using water power.	Water Power	1. Have the students construct model of early water wheels showing the development of this power source for mills. 2. Have the students construct a miniature "power station" with a turbine in a model dam which can be operated with a garden hose in the school yard to light a flashlight bulb. 3. Investigate the extent to which hydroelectric power is still used and list the advantages and disadvantages.

OBJECTIVE	CONCEPT	ACTIVITY
B. Wind Power		
152. The student will describe and investigate the use of wind power for generating electricity.	Wind Power	1. Which came first, the windmill or the water wheel? Have the students explore the development of the windmill from early (250 B.C.) sail-shapes to present day Savonius and Darrieus rotors, and the advanced designs proposed by Heronemus and by NASA.
C. Tidal Power		
153. The student will investigate the use of the tidal power of the ocean for generating electricity.	Tidal Power	1. How does tidal power differ from the previously investigated hydroelectric power sources? Build a small model using two reservoirs (one representing the ocean; the other, the associated basin) to demonstrate the hydraulic head developed by the oscillatory flow of water during the semidiurnal rise and fall of oceanic tides. 2. Where do these power plants occur? Plot their locations on a world map which has cotidal lines. What generalizations can be made? Can we use a plant like this in Louisiana?
D. Power From Geothermal Energy		
154. The student will describe the use of sources of geothermal energy.	Geothermal Energy	1. Describe how the subterranean reservoirs of water and steam which are the source of geothermal energy could be developed. 2. Make a map showing the location of geothermal power plants, indicating the presence of fault lines in the area.

OBJECTIVE	CONCEPT	ACTIVITY
E. Use of Organic Wastes or Biomass		
155. The student will describe the production of fuels from organic materials.	Biomass Production	1. Find examples of organic wastes burned directly as fuel to generate energy. 2. Find examples in which organic wastes or biomass is digested to form methane as a fuel to generate electricity. 3. How do we get energy from "trash"? Purpose: Build a small demonstration methane generator. Procedure: 1) THIS IS A TEACHER DEMONSTRATION. There is a very strong chance that a dangerous explosion could occur if suitable precaution is not taken. 2) The production of methane gas from biomass (aquatic plants, forestry and agricultural residues, and animal wastes) has been suggested as a means of lessening the demand for natural gas. Use a mixture of finely chopped grass clippings, or vegetable residues such as potato or carrot peelings; aged manure, hard-wood sawdust, fine woodchips (not too much wood-- perhaps a tablespoon--it slows the anaerobic digestion process), and water. 3) Mix the biomass material with the water until a slurry forms. It should have the consistency of cream. 4) Add the slurry to a one-gallon jug. Leave a 4- to 6-inch space between the slurry and the bottom edge of glass tubing and a rubber stopper. Add a tablespoon or two of vinegar to make the slurry more acidic, to encourage a favorable environment for methane producing bacteria. Assemble the generator and fill the manometer with water.

OBJECTIVE	CONCEPT	ACTIVITY
		Do not exceed 8 inches of water in the tubing. This will give you 8 inches of pressure. More pressure could result in blowing the jug apart. 6) The burner-tip should be quite long as a practical precaution against the possibility of a flashback. 7) The generator should be placed in a warm place, between 90'F and 100'F, for greatest production. If the temperature falls below 70'F, the generation of the methane will be slowed or stopped. If the temperature rises, the risk of the jug blowing apart increases. 8) Start the generator with all the valves (clamps) closed. The water in the manometer will move upward in the long arm when pressure begins building. This may take 2 to 3 weeks. Test the gas generated by holding a lit match at the burner clamp and opening the clamp. The gas produced first will be carbon dioxide, which will not burn. When the gas being generated ignites, you can assume that methane production has begun. 9) Open the clamp to the collecting bag (a large, sturdy plastic bag). When it is full, you should open the clamp to the burner-tip, place a book or other weight on the bag, and demonstate energy production from biomass. This is an activity based on material in: McMahon, R.C. "Modest Experiment Methane Gas Production," The Mother Earth News No.20, March, 1973 pp. 48, 49; Enterprise for Education, Inc. from "Biomass" Teaching About Energy, Vol.3, pp. 5-60. Christensen, John W. "A Demonstration Model Methane Generator" in Energy Resources Environment, Kendall Hunt Co., Dubuque, Iowa, pp. 153-155.

OBJECTIVE	CONCEPT	ACTIVITY
F. Energy Conserved by Recycling		
156. The student will discuss what kind of energy conservation can be realized by recycling waste products.	Recycling	1. Investigate the energy savings realized by recycling aluminum and other scrap. 2. Discuss scrap metal recycling efforts with respect to renewable and non-renewable resources. 3. What other methods of conserving energy with relation to waste can the students discover and are these cost-effective? (Hint: What information can you gather on legislation on returnable containers or "bottle" bills?)
G. Nuclear Fission Reactor		
157. The student will develop an understanding of nuclear power and its use in producing electricity.	Nuclear Power	1. Contact local public utility companies regarding information on nuclear power. 2. Have students conduct library research and contact organizations to learn about the operation of a nuclear reactor and its potential use in the future. 3. Have students research incidents in which problems associated with nuclear energy occurred. Include Three-Mile Island, Chernobyl, and other power plants.

OBJECTIVE	CONCEPT	ACTIVITY
H. Futuristic Sources of Energy		
158. The student will be able to predict alternative kinds of energy sources that are not presently in use, but are possible future sources of energy as technology advances.	Fusion Power	1. The students will use the resource of the school and local libraries, newspaper and magazine articles at home to explore such "futuristic" topics as nuclear fusion generators, solar microwave reception, and any others. Encourage creative but serious consideration of the fact that present energy sources, other than the sun, are finite.

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POLLUTION AND ENVIRONMENTAL HEALTH

I. Historic Perspective

A. Introduction

Pollution is often distinguished as a waste product. Wastes are generally defined as resources out of place. All systems produce some type of waste product. The law of thermodynamics seems to dictate that nothing runs at 100 percent efficiency. The lost materials often become waste products. Waste is produced not only by humans but also by every other living thing and by many nonliving reactions. This domain will cover components that relate primarily to pollution caused by these misplaced resources.

OBJECTIVE	CONCEPT	ACTIVITY
B. Natural Pollution		
159. The student will be able to describe various types of pollution over the past several thousand years. These include sources of air pollution, water pollution, and chemical pollution.	Natural Pollution	1. Examine sources of extinction of dinosaurs and other forms of life. Describe what has happened over the past several thousand years within the Tigris-Euphrates Valley. Describe the volcanic eruptions of Mount Vesuvius, Krakatoa. and more recently, of Mount St. Helens. See issues of National Geographic or other related articles. Videotapes on Mount St. Helens and Krakatoa are available.

OBJECTIVE	CONCEPT	ACTIVITY
C. Man-Made Pollution		
160. The student will be able to describe various types of man-made pollution over the past thousand years. These include sources of air pollution, water pollution, and chemical pollution.	Man-made Pollution	1. Discuss sources of pollution found in ancient caves and irrigation sites and the contamination of food and water during the medieval period. 2. Describe what has happened concerning pollution over the past several hundred years since the industrial revolution, and how changes in man's life style have precipitated much of today's attitude about the environment and pollution. 3. Contact local environmental organizations and industries to discuss local man-made pollution.
II. Water Pollution		
A. Types and Sources of Water Pollution		
161. The student will be able to state eight major types of water pollutants. Types include: a. oxygen demanding wastes b. disease-causing agents c. inorganic chemicals d. synthetic organic chemicals e. plant nutrients f. sediments g. radioactive substances h. thermal loading	Types of Water Pollution	1. Have students obtain newspaper articles about water pollution in Louisiana and surrounding states and have students classify each type of pollution into the various categories. 2. Contact the Department of Environmental Quality regarding types and sources of water pollution in Louisiana.

OBJECTIVE	CONCEPT	ACTIVITY
162. The student will be able to state major sources of water pollution and match them with the type of pollution. These include: natural and agricultural run-off, erosion, sewage, thermal pollution from electrical power plants, hypersaline water from oil wells and petrochemicals, and heavy metals from industry.	Water Pollution Sources	1. Refer to information from the Department of Transportation on sources of water pollution in Louisiana. 2. Contact the Department of Environmental Quality to obtain a ranking of environmental problems in Louisiana. 3. See Science Digest, June 1986. 4. See "Not a Drop to Drink" and "Trouble in Paradise," PBS specials.
B. Effects of Water Pollution on Man and the Environment		
163. The student will be able to classify the various effects of water pollution. These include: a. aesthetic damage b. property damage c. plant or animal damage d. human health hazards e. human genetic and/or reproductive damage f. ecosystem damage	Water Pollution Effects	1. Have the students locate areas around their community where each of the six classes of pollution could occur. 2. Show slides of various types of water pollution and discuss the effects of each type. 3. Have students obtain newspaper articles or magazine articles on pollution of these types occurring elsewhere in the United States. 4. Arrange a visit to a pulp paper mill or sewage treatment plant. Examine the river or oxidation pond that receives the effluents. Test water quality at suitable sites. 5. Have students research the effects of water pollution on shellfish in this state and in other states (Chesapeake Bay area). 6. See National Geographic article on Thames River restoration.

OBJECTIVE	CONCEPT	ACTIVITY
C. Surface Pollution		
164. The student will identify and explain three indicators of water quality. These are dissolved oxygen, biological oxygen demand, and fecal coliform bacteria.	Water Pollution Indicators	1. Have local health department representative discuss how coliform bacterial concentrations in drinking water are determined. 2. If there is access to an oxygen meter, its use in examining water quality can be demonstrated. 3. See BOD experiment in Biology and You or another text book. 4. See activity in Objective 83
165. The student will recognize the various characteristics of a lake.	Lake Characteristics	1. Have the students examine pictures or visit various bodies of water. 2. Have the students draw a picture of a lake or pond and label the parts of the body of water. 3. Show students pictures, slides or films of ponds and lakes and discuss their characteristics and their components.
166. The student will demonstrate an understanding of the concept of eutrophication.	Eutrophication	4. Using jars of algae with various amounts of phosphate detergents or commercial fertilizers, demonstrate increased algal growth. Be sure to use a control.
167. The student will be able to describe the effect thermal pollution has on rivers and lakes.	Thermal Pollution	1. Obtain computer infra-red enhanced aerial photographs of lakes and streams in Louisiana showing thermal pollution.

OBJECTIVE	CONCEPT	ACTIVITY
D. Groundwater Pollution		
168. The student will understand how aquifers develop and how they can become contaminated.	Groundwater Pollution	1. Have students locate on a geological map several critical aquifers. Show why these aquifers are where they are.
169. The student will be able to identify at least seven sources of groundwater contamination. Seven sources of groundwater pollution with which the student will become familiar are: a. Leaks from underground pipes, sewer, or other lines b. Chemical or oil spills c. Discharge of sewage wastes from domestic or commercial sources d. Run-off of fertilizers e. Run-off of pesticides and herbicides f. Injection of chemicals into abandoned wells g. Waste dumps and fills	Groundwater Pollution	1. Have students locate on a geological map several critical aquifers and identify potential problem areas that may affect groundwater. 2. Obtain copies of the publication, "Groundwater," from Chemical Manufacturers Assoc., 2501 M. St. NW, Washington, DC 20037. 3. Make a model showing the cross section of the earth's surface layers, illustrating groundwater movement through aquifers. 4. See related activity, Objective 75. 5. Make posters or 3-dimensional models illustrating current methods of landfill.
170. The student will explain how groundwater pollution problems may be mitigated.	Groundwater Pollution	1. Invite a representative from a business that opperates a waste-site to discuss what is done to prevent groundwater pollution. 2. Contact the Department of Environmental Quality to determine what controls and laws exist to protect groundwater.

OBJECTIVE	CONCEPT	ACTIVITY
E. Ocean and Estuarine Pollution		
17.. The student will describe why the ocean is the final sink for both natural and human wastes.	Marine Pollution	1. Draw a flow chart showing the route of all waste water, treated or untreated, for your area and for other areas in the state. 2. Find out if there is legal dumping of waste in Louisiana coastal waters. 3. Using a map, show the water drainage system of your area (river basin), and identify by name each tributary that eventually flows into the Gulf of Mexico.
F. Water Pollution Control		
172. The student will describe the various zones within a marine ecosystem and explain the overall dynamics of the systems.	Marine Ecosystem	1. Draw a profile of a coast including the neritic, estuarine, oceanic, euphotic, and bathyal zones. Discuss activities that might be harmful to these zones.
173. The student will describe the importance of the estuarine zone and the protective nature of habitats found within it.	Estuarine Ecosystem	1. How can critical areas such as estuaries and coastal wetlands best be managed? Simulation studies have been developed for a few estuaries. "Decision Making and the Chesapeake Bay," U. of Maryland Sea Grant, is one of the best. Others include: "Squalls on Nisqually" from Washington Sea Grant, and Delaware's "Super Port." (See Resource Guide for more complete information.) Procedure: Use the study materials to develop an understanding of the ecological and political concerns involved in coastal zone management in other areas. Do we have similar problems in Louisiana? Can we begin assembling materials for a "Decision Making in Louisiana" unit?

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OBJECTIVE	CONCEPT	ACTIVITY
		2. Gather information from many sources on the economic value of Louisiana estuarine areas. (The Department of Natural Resources, Wildlife and Fisheries, or others).
174. The student will recognize the critical nature of coastal zone management.	Coastal zone Management	1. Invite personnel from the Office of Coastal Zone Management to speak. Write to the Office of Sea Grant Development or Office of Coastal Zone Management to obtain information on barrier islands and protection techniques used in the wetlands.
175. The student will explain problems with ocean dumping and pollution from oil and other chemicals.	Ocean Pollution	1. Invite personnel from the Coast Guard to speak, or obtain films on how specific techniques are used to monitor ocean dumping and to contain oil spills. 2. Obtain materials on major oil spills throughout the world. Mark these on a world map. Does the concentration of known spills relate to population patterns or to relative wealth of the populations? 3. Discuss effects of oil on birds and other wildlife.
176. The student will describe several basic control measures that improve water quality. These will include the use of water, sewage disposal, drainage, filters, treatment tanks, holding tanks or ponds, and others.	Water Quality Control	1. Have students visit a sewage treatment plant. 2. Have students visit a paper mill or chemical plant to see the various controls used to protect the environment. 3. Investigate the use of green plants to treat residential and commercial sewage. Consult National Space Technology Lab.

OBJECTIVE	CONCEPT	ACTIVITY
III. Air Pollution		
A. Types and Sources of Air Pollution		
177. The student will identify major air pollutants. These include: hydrocarbons sulfur oxides nitrous oxides photochemicals particulate matter (dust) radioactive materials carbon dioxide ammonia hydrogen sulfide asbestos carbon monoxide pesticides	Air Pollution	1. Contact the nearest weather bureau to determine what the major sources of air pollution are for the local area. 2. Use filters and a vacuum cleaner to collect dust and material from air to demonstrate air pollution. 3. See Nova special, "Asbestos." 4. Examine the connection between auto mechanics (asbestos brake liners), insulation workers, and asbestosis.
178. The student will be able to describe the difference between a primary air pollutant and a secondary air pollutant.	Air Pollution	1. Have the students determine how the pollution standards index (PSI) is calculated.
179. The student will be able to identify four major sources of air pollution, such as: a. Incomplete combustion: carbon monxide nitrous oxide b. Chemical industry: fertilizers petroleum c. Natural sources: volcanoes forest fires d. Combustion: photochemicals	Air Pollution Sources	1. Have representative from Forest Service discuss effects of forest fires as sources of air pollution. 2. Demonstrate incomplete combustion by adjusting Bunsen burner between yellow and blue flame, showing deposition of products of incomplete combustion on a glass plate.

OBJECTIVE	CONCEPT	ACTIVITY
B. Smog and the Effects of Climate		
180. The student will describe the characteristics of an industrial smog and a photochemical smog.	Air Pollution	1. Students will examine historical information about smogs in their area and classify what type of smog it might be.
C. Effect of Air Pollution		
181. The student will be able to state six possible effects of air pollution.	Air Pollution Effects	1. Have students bring to class either examples of things that have been altered by air pollution or photographs which show this effect.
182. The student will describe kinds of air pollution damage that can occur on property, plants, and wildlife.	Air Pollution	1. Simulate corrosive damage by showing what the long term effects of dilute acids or alkali have on certain substances. This can be done using aerosol sprays or painting the surface of metals or plastics and allowing them to sit and react over several days or weeks. 2. Experiment: Collection of solid pollutants from the air Equipment: cellophane tape glass slides microscope wood square, 4" scissors Procedure: Wrap strips of tape around several 4" squares of wood or cardboard with the sticky side up.

OBJECTIVE	CONCEPT	ACTIVITY
		Expose the slides for 24-48 hours in different places (desk, outside classroom, near fireplace, near kitchen). This may be done at different times of the week or month. Record the time and place. Cut 2" lengths of the exposed tape, mount on glass slides and examine under a microscope at 10X. Use a grid to count the number of particles.
183. The student will list and describe types of injury to human health such as lung cancer, pulmonary emphysema, bronchial asthma and others.	Air Pollution, Human health	1. Experiment: Collection of solid pollutants from the air. Equipment: (vacuum cleaner, Kleenex tissue, glass jar, and water) Procedure: Place a clean bag in vacuum. Place a piece of tissue paper over the outlet and over the inlet inside the vacuum. Run the vacuum, pick up dust from various areas. Stop vacuum and remove tissue paper. Place paper in jar of water. Examine particles, noting variety of types and sizes. 2. Contact the American Cancer Society for information on lung disease.
D. Industrial and Domestic Pollution and Control		
184. The student will explain the various kinds of industrial air pollution control measures.	Air Pollution Control	1. Have students contact any utility company or plant that discharges wastes into the air and obtain information on what is discharged and how it is controlled. 2. Make a model of an electrostatic precipitator.

OBJECTIVE	CONCEPT	ACTIVITY
185. The student will describe the various kinds of domestic air pollution control measures.	Air Pollution Control	1. Have students contact an automobile company to determine how catalytic converters work. 2. Investigate the use of house plants (golden pothos, spider plants) in removing indoor air pollution.
IV. SOLID WASTES		
A. Types and Sources of Solid Wastes		
186. The student will identify types and sources of solid wastes.	Solid Waste: Sources	1. List the approximate proportions of various materials contained in municipal wastes.
187. The student will be able to identify past and present means of disposing of solid wastes.	Solid Waste: Disposal	1. Locate in your community areas where some older form of disposing of waste still may be found. 2. Make a chart listing the advantages and disadvantages of solid waste disposal and resource recovery.
B. Effect of Solid Wastes		
188. The student will be able to explain several effects of solid waste.	Solid Waste: Effects	1. Take photographs of areas that have visible problems with solid waste.
C. Industrial and Domestic Wastes and Control		
189. The student will list and explain several methods of waste disposal and the advantages of each method.	Solid Waste: Disposal	1. Contact a waste disposal company in your area and have a representative speak or describe how wastes are properly disposed of. This should include how landfills operate and where they are located.

OBJECTIVE	CONCEPT	ACTIVITY
		2. Have students collect solid wastes from the classroom for one week. Store in garbage bags. Weigh and calculate the amount of trash per month per school year. Separate the recyclable portion and calculate the percent.
190. The student will describe the laws that are currently being enforced in Louisiana and how they affect the average citizen.	Solid Waste: Laws	1. Contact the Department of Environmental Quality regarding waste disposal laws. 2. Contact local public and commercial waste disposal units to determine what guidelines they follow.
V. HAZARDOUS WASTE		
191. The student will definee hazardous waste as any discarded material that may pose a threat or hazard to human health or the environment when improperly handled.	Hazardous Waste	1. See American Chemical Society publication, "Hazardous Waste Management." 2. Contact the Louisiana Chemical Manufacturers' Association and the Department of Energy regarding the disposal of hazardous wastes.
A. Types and Sources of Hazardous Wastes		
192. The student will identify and explain the types and sources of hazardous wastes. These are: a. ignitable b. corrosive c. dangerous e. toxic	Sources and Types	1. Contact the Department of Transportation to obtain vehicle labeling codes for hazardous materials. 2. Have students monitor traffic past a site. Determine the number and type of hazardous materials being transported. 3. Make a scrapbook of newspaper articles directly related to hazardous waste over a nine-week period. 4. Have students make lists of hazardous materials found in their homes. Discuss ways to dispose of them safely.

OBJECTIVE	CONCEPT	ACTIVITY
193. The student will be able to compare hazardous wastes. These include a. dioxin b. polychlorinated biphenyls (PCB) c. agent orange d. mercury	Sources and Types	1. Have the students obtain information on the "Love Canal" incident and the "Times Beach" incident. 2. Look at the legal ramifications of Agent Orange.
B. Effects of Hazardous Wastes		
194. The student will describe the effect of various hazardous wastes on living things.	Sources and Types: Effects	1. See video "Bitter Harvest" and discuss what alternative decisions could have been made. 2. Compare economics of use of these materials versus the risks involved. 3. Discuss terms such as parts per million (ppm) and parts per billion (ppb). Use pamphlet from Chemical Manufacturers Association.
C. Controlling Disposal of Hazardous Wastes		
195. The student will explain current methods for dealing with hazardous wastes.	Hazardous Waste Disposal	1. Make a model of a landfill for storage of hazardous waste or visit landfill. 2. Have speakers from local waste disposal or chemical companies come to discuss their methods of disposal. 4. Have students investigate how solid waste is collected and disposed of in their community.
196. The student will describe legislation designed to control hazardous waste.	Hazardous Waste Legislation	1. Investigate the Superfund and its effectiveness. Determine if any local sites are on the Superfund list.

OBJECTIVE	CONCEPT	ACTIVITY
		2. Obtain copies of local ordinances or state laws concerning hazardous waste disposal.
VI. PESTICIDES AND RELATED COMPOUNDS		
A. Types and Sources of Pesticides		
197. The student will identify major types of pesticides.	Pesticide Types	1. Have students list pesticides found in the home and classify by type.
198. The student will have an understanding of why pesticides are needed and used.	Pesticide use	1. Contact a pesticide company to obtain information on why pesticides are necessary. 2. Contact a local farmer or cooperative extension agent.
199. The student will demonstrate an understanding of the term "persistence" as it relates to pesticides.	Persistence	1. Have students debate or discuss some of the environmental and economic trade-offs involved in the use of pesticides in forests, on food crops, etc.
B. Effects of Pesticides		
200. The student will identify the exposure routes by which pesticides move into an organism.	Effects of Pesticides	1. Have a pest control operator discuss safety precautions in use of pesticides.
C. Control and Use of Pesticides and Related Compounds		
201. The student will demonstrate an understanding of how pesticides are regulated.	Regulations	1. Consult the EPA for information on pesticide regulations.

OBJECTIVE	CONCEPT	ACTIVITY
202. The student will describe pesticides used on crops in Louisiana.	Pesti-cides Used	1. Contact your county agent for information on pesticides used in your area. 2. Find out why Mirex was banned for use for fire ants.
203. The student will describe alternative methods of pest control including biological control, pheromones, and hormones.	Alternative Control	1. Discuss the use of lady bugs in control of insects. Discuss parasitic wasps as control for Louisiana sugarcane borer. 2. Find out which alternate methods have been used in Louisiana. 3. Experiment with caffeine as a method of insect control by using fruit flies grown in media contai.. ng various concentrations of finely ground coffee beans. Try other materials, such as oil from orange peels, etc.
VII. HEAVY METAL POLLUTION		
A. Types and Sources of Heavy Metal Pollution		
204. The student will describe three types of heavy metal pollution and sources of each.	Heavy Metal Pollution	1. Ask a speaker from the Department of Environmental Quality (DEQ), Wildlife and Fisheries, and Louisiana State University to speak on sources of pollution by heavy metals.
B. Effects of Heavy Metals		
205. The student will be able to describe both physical and biological effects of heavy metals.	Heavy Metal Pollution	1. Write to DEQ,EPA,and DHHR to request information on this topic. 2. Have students research the "lead shot" controversy concerning duck hunting. 3. Discuss lead poisoning from paint. 4. Find out the origin of the term "Mad Hatter."

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OBJECTIVE	CONCEPT	ACTIVITY
C. Control and Use of Heavy Metals		
206. The student will describe how heavy metal pollution can be reduced.	Heavy Metal Pollution Control	1. Contact DEQ or EPA about how heavy metal pollution can be reduced.
VIII. RADIATION		
A. Types and Sources of Radiation		
207. The student will describe what radiation is and what sources exist.	Nuclear Education Sources	1. Ask a speaker from the Department of Energy, Department of Transportation and Development, Department of Environmental Quality, and a utility company to speak on radiation. 2. Have food technologist discuss current use of radiation in food preservation. Contact Food Science Dept. at nearest college or University. 3. Obtain irradiated seeds from a supply company and conduct growth studies. 4. Have students research ongoing biological effects of the Chernobyl incident.
B. Effects of Radiation		
208. The student will demonstrate an understanding of the biological effects of radiation.	Biological Effects of Radiation	1. Contact the State Office of Civil Preparedness to obtain information about biological effects of radiation.

OBJECTIVE	CONCEPT	ACTIVITY
C. Control and Use of Radiation		
209. The student will be able to discuss the appropriate use of radiation in medicine and in industry.	Use of Radiation	1. Contact an industry or medical laboratory that uses radioisotopes and request a speaker or obtain information.
210. The student will describe the global dangers of nuclear war and how it would affect all life.	Mutagenic Effects on Life	1. Contact the State Office of Civil Preparedness to obtain information about the biological effects of radiation and nuclear war. 2. Study what were the initial effects of the atomic bomb on Japan and compare those effects with the long-term effects of fallout. 3. The teacher could suggest appropriate books or films to illustrate the long-range effects of nuclear war.
211. The student will describe the global dangers of nuclear war. and how it might affect the the environment.	Nuclear War Effects on Environment	1. Contact the Nuclear Regulatory Commission for special films concerning nuclear science and the effects of nulcear weapons. 2. Consult the "Post Attack Study" conducted by the Department of Defense. Define EMP blast effect, initial radiation, neutron activation, fallout, and heat wave.
IX. CHEMICAL MUTAGENS		
A. Types and sources of chemical mutagens		
212. The student will describe examples of chemical mutagens.	Mutagenic Chemicals	1. Ask a doctor or other qualified person to speak on how these enter and are incorporated into the body.

OBJECTIVE	CONCEPT	ACTIVITY
B. Effects of chemical mutagens		
213. The student will describe the effects of chemical mutagens.	Mutagenic Chemicals: Effects	1. Have students bring in newspaper article on carcinogens and update the ongoing issue of high cancer rates in Louisiana.
X. FOOD ADDITIVES AND PRESERVATIVES		
A. Types and Uses of Food Additives		
214. The student will be able to differentiate between a direct and an indirect additive.	Direct/ Indirect Additives	1. Students can discuss why chemicals are added to foods. Examine food labels and list additives. 2. Discuss how indirect additives (pesticides, metal fragments) get into foods. Note newspaper or related articles. 3. Research botulism; emphasize that botulism toxin is lethal at 1/50,000 of a drop.
215. The student will identify uses of direct additives.	Uses of Additives	1. Students can make a chart which includes the names of specific additives, use of these additives, and foods in which each might be used. See Chemical Manufacturer's Assoc. publication "Food Additives, who needs them?"
B. Control of Food Additives		
216. The student will demonstrate an understanding of specific law designed to protect consumers.	Laws	1. Students can bring in packages of cosmetics and compare ingredients. 2. Research the Delaney Clause and the work of Rep. James Delaney of New York in getting the clause passed.

OBJECTIVE	CONCEPT	ACTIVITY
		3. Bring in foods that contain warning labels, such as saccharin, and discuss the risks or benefits of such additives. 4. Discuss how our life styles and culture are related to the use of additives.
XI. NOISE		
A. Types and Sources of Noise		
217. The student will be able to describe types of noise pollution.	Noise Pollution Types and Sources	1. With meter stick and loudly ticking watch, have students calculate the distance from their ear where they can no longer hear the watch. Then, after listening to a "walkman" for 15 minutes, determine the hearing range. 2. Make a list of the 5 most distressing noises you hear in a day. Discuss how each one can be reduced or eliminated.
B. Effects of Noise		
218. The student will be able to describe how noise pollution might affict organisms.	Noise Pollution: Effects	1. Have students discuss the idea that some damage to hearing may be "inevitable" to people living in a developed society.
XII. EPIDEMIOLOGICAL		
A. Types and Sources of Epidemic Diseases		
219. The student will state examples of diseases associated with pollution, a high population density, and unsanitary practices.	Disease	1. Contact DHHR on types of local epidemic diseases. Identify symptoms, methods of transmission, and treatment.

OBJECTIVE	CONCEPT	ACTIVITY
		2. Have students research one or more vector-borne diseases responsible for the epidemics, or "plagues," during the Middle Ages. Compare to non-vector contagious diseases.
220. The student will be able to explain the difference between infectious and noninfectious disease.	Infectious Disease	1. Have students find out what childhood diseases they have had. Compare these with those suffered by their parents and grandparents (if possible). 2. Review methods of spread of diseases and past and present methods of control.
B. Incidence of Cancer		
221. The student will describe cancer and discuss its nature and effect, incidence and geography, and risk factors.	Non-infectious Diseases	1. Have students try to define cancer and list what they believe to be its causes. 2. Discuss current accepted theories of the origin of cancer. 3. Consult local American Cancer Society for current data on incidence and geographical association of cancer. Compare Louisiana statistics with national statistics. See "Prosperity in Paradise," supplement to April 25, 1986, issue of the Morning Advocate. 4. Discuss the risk factors associated with smoking. Have students bring in empty cigarette packages and discuss warning labels. 5. Discuss statistics linking specific dietary habits to specific types of cancer. Have students keep a food diary. Compare it to a recommended diet.

SKILLS CHECKLIST

ENVIRONMENTAL SCIENCE	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB.† PAGE #
1. The student will be able to define environment as a combination of external conditions that influence the life of an individual, organism, or population.	*	*		
2. The student will be able to recognize that the definition of ecology is the interrelationship of organisms to their environment.	*	*		
3. The student will demonstrate an understanding of the relationship between environment and ecology by listing and discussing external conditions comprising their environment.	*	*		
4. The student will be able to describe the levels of ecological organization of: a. biosphere b. biome c. ecosystem d. community e. population f. organism	*	*		
5. The student will be able to define biosphere as the portion of the earth and its atmosphere capable of supporting life.	*	*		

†This column is to be used for individual teacher's references.

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
6. The student will be able to list the major biomes. a. marine (oceanic) b. estuarine c. freshwater d. polar e. alpine (tundra) f. taiga (coniferous forest) g. deciduous forest h. desert i. rainforest j. grasslands	*	*		
7. The student will be able to define an ecosystem as a natural community of organisms interacting with one another and with their environment.	*	*		
8. The student will be able to define and identify a community as a group of populations occupying a particular habitat or area.	*	*		
9. The student will be able to define population as a group of organisms of the same species.	*	*		
10. The student will be able to distinguish the difference between the terms "habitat" and "niche."	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
11. The student will be able to recognize and identify various kinds of habitats and niches.	*	*		
12. The student will be able to differentiate between biotic and abiotic factors. a. Biotic factors are the living components of the ecosystem. b. Abiotic factors are the nonliving components of the ecosystem.	*	*		
13. The student will be able to differentiate between autotrophs, heterotrophs, and chemotrophs. a. Autotrophs produce their own food using small, inorganic compounds and light as the energy source. b. Heterotrophs are organisms which cannot produce their own food. c. Chemotrophs are organisms that can produce food from inorganic compounds, using chemical energy.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
14. The student will be able to identify the abiotic factors of the environment such as light, soil, space, air, nutrients, temperature, water, and topography.	*	*		
15. The student will be able to understand that the sun is the ultimate source of energy for ecosystems.	*	*		
16. The student will be able to recognize that basic function of an ecosystem is to capture and transfer energy.	*	*		
17. The student will be able to recognize the process by which the photosynthetic organisms (autotrophs) convert solar energy to food and produce oxygen.	*	*		
18. The student will be able to recognize that as organisms feed on each other, the transfer of food energy is not 100 percent efficient.	*	*		
19. The student will demonstrate an understanding that matter and energy can neither be created nor destroyed but simply transformed.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
20. The student will demonstrate and understand that in every energy transformation, some energy is always lost in the form of heat.	*	*		
21. The student will be able to define the terms food chain and food web and describe the flow of energy through an ecosystem.	*	*		
22. The student will be able to describe the flow path of energy through the trophic levels of an ecosystem. a. producers b. primary consumers 1) Omnivores 2) Detritivores 3) Herbivores c. secondary consumers	*	*		
23. The student will be able to explain how certain chemicals become more highly concentrated in the bodies of organisms at the upper level of a food chain.	*	*		
24. The student will be able to recognize that biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
25. The student will be able to recognize that inorganic materials and energy become a part of organic matter and subsequently are broken down into basic compounds.	*	*		
26. The student will be able to recognize that since the supply of matter is finite, the continuation of life depends upon a cyclic flow of nonliving materials between organisms and their environments.	*	*		
27. The student will be able to recognize that the natural cycles and systems on Earth have limited capacity to cycle or disperse natural and/or manufactured pollutants.	*	*		
28. The student will demonstrate an understanding of the early ideas of population growth.	*	*		
29. The student will be able to list several principles pertaining to the organization of population levels. These would include: a. density--population size in relation to some unit of space b. natality--inherent reproduction ability of a population	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
c. mortality--death of individual of a population d. age distribution--range of groups within the population e. fecundity--capability of reproducing offspring (females)				
30. The student will be able to draw and interpret an idealized population growth curve, a logarithm curve, exponential growth, and "plateau effect."	*	*		
31. The student will be able to understand that the rate of change in an environment may exceed the rate of organism adaptations.			*	
32. The student will be able to recognize that the more specialized an organism becomes, the less adaptable it is and the less able it is to survive environmental change.			*	
33. The student will be able to list limiting factors of a population, including: a. space b. food c. clean water d. other resources	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
34. The student will be able to describe geometric population growth and contrast it with arithmetic growth.			*	
35. The student will be able to explain how to estimate a population growth by using: a. extrapolation b. prediction			*	
36. The student will be able to demonstrate that the carrying capacity is determined by the availability of materials and conditions necessary for maintaining a particular kind of organism and that the earth's carrying capacity is limited for all species, including man.	*	*		
37. The student will be able to draw and interpret the human population growth curve.	*	*		
38. The student will demonstrate an understanding that our increasing population is one of the world's greatest problems.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
39. The student will explain that man has the biological capability of reproducing faster than he can provide food.		*	*	
40. The student will be able to recognize the effect increasing population has on the individual.		*	*	
41. The student will be able to identify the effect increasing population has on resources.			*	
42. The student will be able to compare the food availability in developed countries with that of the less developed countries.		*	*	
43. The student will be able to describe factors affecting major changes in human population which include these factors. a. climate b. early tool-making revolution c. agricultural revolution d. scientific revolution e. medicine--health f. space research		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
44. The student will be able to discuss cultural, social, and psychological factors affecting human population density. a. pestilence b. warfare c. birth control d. social attitudes e. mental stress			*	
45. The student will discuss biological factors affecting population. a. nutrition b. disease c. famine d. death rate e. birth rate	*	*		
46. The student will recognize that their attitudes and actions can affect population control.			*	
47. The student will be able to recognize why the world's population increases despite a simultaneous decrease in the birth rate.		*	*	
48. The student will be able to recognize the effect increasing population has on the social structure of a civilization.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
49. The student will be able to recognize the cultural factors affecting population levels.			*	
50. The student will be able to discuss the effect of urbanization on population levels.		*	*	
51. The student will be able to recognize that all organisms have the capability of reproducing beyond the availability of food resources.	*	*		
52. The student will demonstrate an understanding of soil formation by describing the physical, chemical, and biological processes involved in the formation of soil.		*	*	
53. The student will be able to identify, using drawings, the dominant organisms found in the soil.		*	*	
54. The student will cite examples of ways in which living organisms in the top part of the soil affect the soil.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
55. The student will identify the characteristics of a soil profile. These would include texture, pH, temperature, and color.		*	*	
56. The student will describe various factors affecting soil productivity.		*	*	
57. The student will give evidence to show how man has contributed to soil erosion especially along Louisiana's coastline.	*	*		
58. The student will give examples, causes, and results of natural erosion especially along the coast of Louisiana.	*	*		
59. The student will explain the necessity for erosion control by emphasizing the amount of soil lost annually.		*	*	
60. The student will contrast the amount of available food supplies with the present world population.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
61. The student will summarize the importance of U. S. agriculture meeting world food needs.			*	
62. The student will become aware of problems between distribution, production and consumption.			*	
63. The student will compare the amount of land used for agriculture since 1900.		*	*	
64. The student will be able to interpret the effect of poor nutrition on health.		*	*	
65. The student will demonstrate an awareness of the social, political, and economic factors affecting food production.			*	
66. The student will compare American farming practices and yield with those of underdeveloped countries. These could include: strip, plowing rotation, conservation, slash and burn.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
67. The student will describe the value of competent use of fertilizer to prevent crop yield decline.			*	
68. The student will recognize the cost of energy in producing artificial fertilizers.			*	
69. The student will list ways in which food production is destroyed by pests (undesirable organisms).		*	*	
70. The student will trace uses of pesticides since 1900.			*	
71. The student will define and differentiate between persistence and resistance in use of pesticides.			*	
72. The student will recognize that pesticides must be carefully used since they are detrimental to many unintended species when used improperly.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
73. The student will list types of natural pest control methods and compare the effects to those of artificial pesticides.		*	*	
74. The student will define biological magnification and describe how it is harmful to organisms.	*	*		
75. The student will list and define new trends in food production, including the green revolution, new food sources, hydroponics, and aquaculture.			*	
76. The student will list and describe various water habitats and values of each.		*	*	
77. The student will be able to describe disturbed or endangered water habitats.		*	*	
78. The student will describe the biological and economic reasons for protecting water habitats.	*	*		
79. The student will name and define unique characteristics of water.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
80. The student will describe the hydrologic cycle.	*	*		
81. The student will contrast the total amount of water on earth with usable amounts. This will include available water supplies with those of various regions of the country.			*	
82. The student will describe the availability of water in Louisiana.		*	*	
83. The student will differentiate between ground water and surface water.	*	*		
84. The student will list two ways usable water is obtained.	*	*		
85. The student will compare present and future water demands.			*	
86. The student will list different instream uses of water, e.g., recreation, transportation, and commercial fishing.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
87. The student will give examples of different withdrawal uses of water.			*	
88. The student will give evidence to show that there is a conflict between instream and withdrawal uses of water.			*	
89. The student will evaluate reasons determining the importance of reservoirs.			*	
90. The student will diagram a flow chart tracing water through a water treatment plant.		*	*	
91. The student will list various chemicals that are water pollutants. He will identify sources and state effects of the chemicals on the environment.		*	*	
92. The student will list various sources of domestic water pollution and state the effects those materials have on plant and animal life and public health.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
93. The student will locate various sources of agricultural water pollutants and state effects of the materials on the environment.			*	
94. The student will differentiate between point source and non-point source.		*	*	
95. The student will recognize that chemical, raw sewage, oil, and agricultural waste can contribute to the pollution of surface water and groundwater.			*	
96. The student will recognize that groundwater injection is a method of waste disposal and is prevalent in Louisiana.		*	*	
97. The student will discuss new trends to increase availability of usable fresh water.			*	
98. The student will understand the basic principles and operation of septic systems.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
99. The student will locate their primary source of drinking water and the sewage treatment facility.		*	*	
100. The student will discuss briefly the history of land use in the United States from the discovery of the new world to the present.			*	
101. The student will describe the origin of the conservation and environmental protection movement.		*	*	
102. The student will understand our national policy toward wilderness areas, national forests, and national parks and seashores.		*	*	
103. The student will explain how improper and excessive use of recreational areas causes land problems and costs taxpayers money.			*	
104. The student will explain how recreational activities can be limited by pollution.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
105. The student will recognize the problems of exploitation of recreational resources.			*	
106. The student will define conservation as the wise use and protection of national resources to ensure an adequate supply for the present and future.		*	*	
107. The student will identify that a natural area is any place where the biotic elements and organisms are undisturbed and are held in this state for the benefit of all mankind.	*	*		
108. The student will explain that plants (including trees) purify air, provide cover to hold soil in place, protect the water supply, provide raw materials, and add beauty to the landscape.	*	*		
109. The student will discuss the concept of multiple use in forest management. This will include managing trees as a crop, techniques (clearcut, selective cut, shelterwood, artificial and natural regeneration, and pest control).		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
110. The student will describe how forests can be economically, scientifically, and recreationally used.		*	*	
111. The student will describe the consequences of eliminating endemic species of plants for the sole purpose of monoculture and commercial exploitation.	*	*		
112. The student will describe the consequences of the loss of tropical forests in South America, Asia, and Africa.	*	*		
113. The student will describe the relationship of Louisiana forests to the state's geography, history, and economy.		*	*	
114. The student will summarize reasons that show the value of certain natural plant and animal species to man and to the environment.		*	*	
115. The student will realize that wildlife must be conserved and often controlled to prevent extinction or overpopulation, and that direct exploitation by man can hasten the process.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
116. The student will describe how natural processes can also hasten extinction or cause overpopulation.	*	*		
117. The student will describe how wildlife is economically and aesthetically important. This would include: a. Wildlife has scientific and ecological values. b. Wildlife has social and political values. c. Wildlife has commercial and economic values.		*	*	
118. The student will recognize that wildlife is one of our basic natural resources and can be managed and conserved. a. Management practices are based on ecological applications and natural laws. b. Conservation of wildlife promotes the protection and the preservation of wildlife.			*	
119. The student will describe how the regulated harvest of wildlife by recreational hunting and fishing is a management method of removing surpluses which might be removed naturally.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
120. The student will list major components of atmosphere.	*	*		
121. The student will recognize that the largest percentage of oxygen comes from the ocean, while smaller amounts of oxygen come from the extensive forested regions around the world.	*	*		
122. The student will diagram different layers of the atmosphere and list the characteristics and importance of each.	*	*		
123. The student will categorize the different climates on earth.	*	*		
124. The student will provide evidence to support the global changes in climate by natural and human influences.		*	*	
125. The student will describe the complexity of the tropical rain forest and its impact on the local and global climate.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
126. The student will provide evidence that pollutants and contaminants are produced by natural and man-made processes; these can upset climate and atmosphere.		*	*	
127. The student will define air pollution as atmospheric contamination from many sources that can be detected and measured.	*	*		
128. The student will show how air pollution contributes to the deterioration of different materials and has a negative effect upon animals and plants.		*	*	
129. The student will list various controls used in reducing air pollution.		*	*	
130. The student will differentiate between renewable and nonrenewable resources.	*	*		
131. The student will distinguish between element, compound, and mineral deposits.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
132. The student will demonstrate an understanding of how interdependent the nations of the world are on many resources.			*	
133. The student will discuss various methods used in mining.		*	*	
134. The student will compare advantages and disadvantages of subsurface mining and surface mining.		*	*	
135. The student will discuss methods used to reclaim land that has been mined.		*	*	
136. The student will recognize that ecologically sound ways of mining and recycling can help conserve our mineral resources.			*	
137. The student will list some of the effects of mining and processing on the environment and on health.		*	*	
138. The student will define energy as the ability to do work.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
139. The student will demonstrate an understanding that the sun is the primary source of energy for all living things.	*	*		
140. The student will demonstrate the understanding that energy from the sun enters living systems through green plants.	*	*		
141. The student will describe how fossil fuels are trapped sunlight.	*	*		
142. The student will investigate some of the estimates of the known reserves of crude oil available to the United States and be able to predict the number of years these reserves will last at the present rate of consumption.			*	
143. The student will investigate the estimates of the known reserves of natural gas available in the United States and predict the number of years these reserves will last at the present rate of consumption.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
144. The student will investigate the estimates of the known reserves and predict the resources of coal available to the United States and the number of years the reserves will last.			*	
145. The student will investigate the worldwide energy resources of fossil fuels and be able to state where these resources are presently located.			*	
146. The student will be able to: (1) list some manufactured items for which fossil fuels serve as raw materials and (2) describe the "petro-chemical crisis" in terms of the "energy crisis."			*	
147. The student will determine the effects of gases emitted from the burning of coal in a closed aquatic ecosystem.		*	*	
148. The student will determine the effects of gases emitted from the burning of coal in a closed terrestrial ecosystem.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
149. The student will compare and contrast the effects of burning fossil fuels on an aquatic and a terrestrial ecosystem (as demonstrated in the two previous objectives) and relate that to descriptions of the effects of "acid rain."		*	*	
150. The student will demonstrate an understanding that petroleum and natural gas are critical to the chemical industry.			*	
151. The student will survey alternate energy sources using water power.			*	
152. The student will describe and investigate the use of wind power for generating electricity.		*	*	
153. The student will investigate the use of the tidal power of the ocean for generating electricity.			*	
154. The students will describe the use of sources of geothermal energy.			*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
155. The student will describe the production of fuels from organic materials.	*	*		
156. The student will discuss what kind of energy conservation can be realized by recycling waste products.		*	*	
157. The student will develop an understanding of nuclear power and its use in producing electricity.		*	*	
158. The student will be able to predict alternative kinds of energy sources that are not presently in use, but are possible future sources of energy as technology advances.			*	
159. The student will be able to identify and explain the various types of pollution over the past years. These include sources of air pollution, water pollution, and chemical pollution.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
160. The student will be able to describe various types of man-made pollution over the past thousand years. These include sources of air pollution, water pollution, and chemical pollution.	*	*		
161. The student will be able to state eight major types of water pollutants. Types include: a. oxygen demanding wastes b. disease-causing agents c. inorganic chemicals d. synthetic organic chemicals e. plant nutrients f. sediments g. radioactive substances h. thermal loading		*	*	
162. The student will be able to state major sources of water pollution and match them with the type of pollution. These include: natural and agricultural run-off, erosion, sewage, thermal pollution from electrical power plants, hypersaline water from oil wells and petrochemicals, and heavy metals from industry.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
163. The student will be able to classify the various effects of water pollution. These include: a. aesthetic damage b. property damage c. plant or animal damage d. human health hazards e. human genetic and/or reproductive damage f. ecosystem damage		*	*	
164. The student will identify and explain three indicators of water quality. These are dissolved oxygen, biological oxygen demand, and fecal coliform bacteria.		*	*	
165. The student will recognize the various characteristics of a lake.		*	*	
166. The student will demonstrate and understanding of the concept of eutrophication.		*	*	
167. The student will be able to describe the effect thermal pollution has on rivers and lakes.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
168. The student will understand how aquifers develop and how they can become contaminated.	*	*		
169. The student will be able to identify at least seven sources of groundwater contamination. Seven sources of groundwater pollution with which the student will become familiar are: a. leaks from underground pipes, sewer, or other lines b. chemical or oil spills c. discharge of sewage wastes from domestic or commercial sources d. run-off of fertilizers e. run-off of pesticides and herbicides f. injection of chemicals into abandoned wells g. waste dumps and fills		*	*	
170. The student will explain how groundwater pollution problems may be mitigated.			*	
171. The student will describe why the ocean is the final sink for both natural and human wastes.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
172. The student will describe the various zones within a marine ecosystem and explain the overall dynamics of the systems.		*	*	
173. The student will describe the importance of the estuarine zone and the protective nature of habitats found within it.		*	*	
174. The student will recognize the critical nature of coastal zone management.	*	*		
175. The student will explain problems with ocean dumping and pollution from oil and other chemicals.		*	*	
176. The student will describe several basic control measures that improve water quality. These will include the use of water, sewage disposal, drainage, filters, treatment tanks, holding tanks or ponds and others.			*	
177. The student will identify major air pollutants. These include: hydrocarbons sulfur oxides		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
nitrous oxides photochemicals particulate matter (dust) radioactive materials carbon dioxide ammonia hydrogen sulfide asbestos carbon monoxide pesticides				
178. The student will be able to describe the difference between a primary air pollutant and a secondary air pollutant.		*	*	
179. The student will be able to identify four major sources of air pollution, such as: a. incomplete combustion: carbon monoxide nitrous oxide b. chemical industry: fertilizers petroleum c. natural sources: volcanoes forest fires d. combustions: photochemicals		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
180. The student will describe the characteristics of an industrial smog and a photochemical smog.		*	*	
181. The student will be able to state six possible effects of air pollution.		*	*	
182. The student will describe kinds of air pollution damage that can occur on property, plants, and wildlife.		*	*	
183. The student will list and describe types of injury to human health such as lung cancer, pulmonary emphysema, bronchial asthma and others.		*	*	
184. The student will explain the various kinds of industrial air pollution control measures.			*	
185. The student will describe the various kinds of domestic air pollution control measures.		*	*	
186. The student will identify types and sources of solid wastes.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
187. The student will be able to identify past and present means of disposing of solid wastes.		*	*	
188. The student will be able to explain several effects of accumulation of solid waste.		*	*	
189. The student will list and explain several methods of waste disposal and the advantages of each method.		*	*	
190. The student will describe the laws regarding solid waste that are currently being enforced in Louisiana and how they affect the average citizen.			*	
191. The student will define hazardous waste as any discarded material that may pose a threat or hazard to human health or the environment when improperly handled.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
192. The student will identify and explain the types and sources of hazardous wastes. These are: a. ignitable b. corrosive c. dangerous e. toxic		*	*	
193. The student will be able to compare hazardous wastes. These include a. dioxin b. polychlorinated biphenyls (PCB) c. agent orange d. mercury		*	*	
194. The student will describe the effect of various hazardous wastes on living things.		*	*	
195. The student will explain current methods for dealing with hazardous wastes.			*	
196. The student will describe legislation designed to control hazardous waste.			*	
197. The student will identify major types of pesticides.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
198. The student will have an understanding of why pesticides are needed and used.			*	
199. The student will demonstrate an understanding of the term "persistence" as it relates to pesticides.		*	*	
200. The student will identify the exposure routes by which pesticides move into an organism.		*	*	
201. The student will demonstrate an understanding of how pesticides are regulated.			*	
202. The student will list examples of pesticides used on crops in Louisiana.			*	
203. The student will describe alternative methods of pest control including biological control, pheromones, and hormones.		*	*	
204. The student will describe three types of heavy metal pollution and sources of each.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
205. The student will be able to describe both physical and biological effects of heavy metals.		*	*	
206. The student will describe how heavy metal pollution can be reduced.		*	*	
207. The student will describe what radiation is and what sources exist.	*	*		
208. The student will demonstrate an understanding of the biological effects of radiation.	*	*		
209. The student will be able to discuss the appropriate use of radiation in medicine and in industry.		*	*	
210. The student will describe the global dangers of nuclear war and how it would affect all life.	*	*		
211. The student will describe the global dangers of nuclear war and how it might affect the environment.	*	*		

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
212. The student will describe examples of chemical mutagens.	*	*		
213. The student will describe the effects of chemical mutagens.	*	*		
214. The student will be able to differentiate between a direct and an indirect additive.		*	*	
215. The student will identify uses of direct additives.		*	*	
216. The student will demonstrate an understanding of specific laws designed to protect consumers.			*	
217. The student will be able to describe types of noise pollution.			*	
218. The student will be able to describe how noise pollution might affect organisms.		*	*	
219. The student will state examples of diseases associated with pollution, a high population density, and unsanitary practices.		*	*	

	REVIEW	MASTERED	INTRODUCED	TEXT OR LAB. PAGE #
220. The student will be able to explain the difference between infectious and noninfectious disease.	*	*		
221. The student will describe cancer and discuss its nature and effect, incidence and geography, and risk factors.		*	*	

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SPECIAL REFERENCE MATERIALS

Your approach to addressing the learning styles of your students and leading your class through a set of investigations, or providing them with background information and motivation for community projects, depends on the ability levels of your students and the resources that are available to you. There are no set of references for you to use for any of the Domain areas. Your students should use familiar resources such as textbooks, encyclopedias, and the Readers' Guide. Because of the unique nature of Environmental Science, it may become necessary for the students to use more frequently consulted sources of information such as personal interviews, minutes of town meetings, and pertinent audiovisual materials. This can make researching a topic an important and exciting part of each activity.

Many reference books listed here for you and your students were chosen because they are usually available in junior high/middle school libraries. Materials from state and federal government, business and industry, and organizations are free.

GENERAL INFORMATION

GENERAL REFERENCE BOOKS

Almanac of the Environment. J. Cousteau, 1981.

Educator's Guide to Free Science Materials. Annual listing of films, filmstrips, tapes, and printed materials in aerospace education, biology, chemistry, environmental education, general science, physics. Directory is indexed by subject and title; complete instructions for requesting materials. Published by Educators Progress Service, Inc.

Experiments in Water Pollution. D. I. Williams and D'Anglesea. 1978. Twenty performed experiments measuring water pollution, its effects, and exploring ways to treat it.

McGraw-Hill Encyclopedia of Environmental Science, second edition, 1980.

New Games. The New Games Foundation. These games are excellent vehicles for group learning.

Our Natural Resources. H. B. Kircher, D. L. Wallace, Interstate Publishers, Inc. 1982 (5th ed.) An excellent text evaluating the natural resource situation in the United States: energy, forest, soil, wildlife, the seas, conservation, and human ecology and wealth.

Process Modules for Investigating Environmental Problems. Harold Hungerford, Ralk Litherland. Criterion referenced, informal, thorough, and clear exploration of processes for analyzing and acting on environmental projects.

Projects in Conservation. D. I. Williams and D'Anglesea. 1978. Seventeen conservation projects covering a broad range of topics. List includes conservation-oriented organizations.

Tuning the Green Machines. Institute for Environmental Education and the Association of New Jersey Environmental Commissions. Oceana, 1978. Explains ecological systems, the sources of their problems; discusses possible solutions.

Yellow Pages of Learning Resources. Wurman, Ed. Group for Environmental Action, MIT Press, 1972. A general guide to the city as a learning resource.

SPECIAL FILMS FOR ENVIRONMENTAL SCIENCE

"America's Changing Energy Story." 7 min., 48-frame filmstrip with sound cassette. Covers uses of energy, past and present, and how different sources of energy differ in efficiency, convenience, and environmental impact. #N81110. Free to teachers from American Gas Association, Educational Services, 1515 Wilson Blvd., Arlington, Virginia 22209, or local gas utility.

Movies and Energy. An extensive guide to films on the topic. Published by the American Petroleum Institute. Many of the 547 entries are free on loan. API, Publications and Distribution Section, 2101 L Street, N. W., Washington, D.C. 20037.

RECOMMENDED FILMS FOR ENVIRONMENTAL SCIENCE

GENERAL ENVIRONMENTAL SCIENCE

1. The Agricultural Revolution: Man as Food Producer
2. And Who Shall Feed This World? Parts 1 and 2
3. Backyard Alternative Energy
4. Bates Car: Sweet as a Nut
5. Botanic Man #9: Extinction Is Forever
6. To Build a Pollution-free Car
7. Can the Earth Provide?
8. Farming with Nature
9. China: Feeding One-Fourth of the Human Race

(films continued)

10. The Choice Is Ours
11. A City Farmstead
12. Diet for a Small Planet
13. Down to Earth: City Living
14. Earth: No Vacancy--Limits to Growth
15. The Earth and Mankind Series (Six 28 min b/w films produced by the National Film Board of Canada)
16. Ecology: The Silent Bomb
17. The Edge of Survival
18. Food and People: An Introduction to the World's Food Problems
19. Food for a Modern World
20. Food: Green Grow the Profits
21. Food Revolution
22. Food Supply: Its Effect on Civilization
23. A Future for Every Child
24. Grain of Conscience
25. Growing Concerns
26. Hunger
27. Hunger in America
28. Malnutrition in a Third World Community
29. Nails
30. The New Alchemists
31. Organic Farming: Can if Feed the Multitudes?
32. The Power to Change
33. Population Explosion (1959)
34. Population Explosion (1967)
35. Population Time-Bomb
36. Projection '70: Food Production
37. The Quest for Food Series (Five 29-min. videocassettes produced by Penn State in 1977)
38. Rice
39. The Solar Promise
40. Sorry, No Vacancy
41. 3900 Million and One
42. A Tale of Three Cities
43. Tilt
44. Toast
45. Tragedy or Triumph
46. Will the Fishing Have to Stop?
47. World Food I
48. Waste: Penalty of Affluence
49. Waste: Recycling the World
50. Wastewater Bonanza

(films continued)

GENERAL ECOLOGY

1. Appalachia: No Man's Land
2. Appalachia: Rich Land, Poor People
3. Automania 2000
4. Black Coal-Red Power
5. Boomsville
6. Botanic Man #8: On the Limit
7. Botanic Man #10: Crackpot Jackpot
8. Bulldozed America
9. Chain of Life
10. Cities in Crisis: What's Happening...?
11. The City
12. City Limits
13. Computology: Preventing Eco-collapse
14. Conservation and Balance in Nature
15. Conservation Down on the Farm
16. Conservation Road
17. Ecological Biology
18. Ecology: Barry Commoner's Viewpoint
19. Ecology: The Silent Bomb
20. E.F. Schumacher...As If People Mattered
21. The End of One
22. Environment
23. Farming h Nature
24. The Fin rth Series (Four 29-min. videocassettes produced by Penn State Television in 1978)
25. Fires of
26. Focus on t nvironment
27. Gambling with Our Lives
28. The Garbage Explosion
29. Have Our Planet and Eat It Too?
30. House of Man, Part 1: Our Changing Environment
31. Industrial Britain
32. Interview with Garrett Hardin
33. Junkdump
34. Land Use and Misuse
35. Law of the Land
36. Limits to Growth (Edited Version)
37. Look to the Land
38. Look What We've Done to this Land
39. Man and the "Second" Industrial Revolution

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40. Mission Possible, Part III: They Care for a Nation
41. Mountain Music
42. Multiply...and Subdue the Earth
43. Once Upon a Wilderness
44. Pandora's Easy-Open Pop-Top Box
45. Pave It and Paint It Green
46. Planning the Land
47. The Ravaged Earth
48. The Ravaged Land
49. Rich Man, Poor Man: Food
50. River (Planet Earth)
51. Room to Breathe
52. Seeds of Destruction (Living Earth Series)
53. Self Service
54. The Stationary Ark: How Dead Is Dead?
55. The Stationary Ark: Surviving
56. Strip Mine Trip
57. Technology and Values: The Energy Connection
58. This Vital Earth (Living Earth Series)
59. Time for Survival
60. The Tragedy of the Commons
61. The Turtle People
62. To Defeat the Doomsday Doctrine (Target the Impossible Series)
63. Up to Our Necks: The Garbage Problem
64. Urban Ecology Series (Three 15-20 min. films produced by CBL)
65. Use It, Use It Up
66. Visions of Tomorrow (Oasis in Space Series)
67. Water Famine
68. Web of Life
69. Yours Is the Land

GENERAL ECOLOGY: HUMAN IMPACT

1. The Aging of Lakes
2. The Arctic: Our Last Chance
3. At the Crossroads: The Story of America's Endangered Species
4. Before the Mountain Was Moved
5. Cry of the Marsh
6. Deep Threat

(films continued)
7. Ecocide: A Strategy of War
8. The Edge of the Bay
9. The Endless Sea
10. Environment in Crisis: The Aging of Lakes
11. The Everglades
12. From the Desert to the Sea
13. Habitat: A Special Place
14. Inside the Golden Gate
15. Let the Little Lake Live
16. Man and His Natural Environment--the Creek
17. The Rocky Mountains (The Nature of Things--The Last Stand Series)
18. The Salt Marsh: A Question of Values
19. Survival on the Prairie
20. Tomorrow Is Maybe
21. Our Vanishing Wilderness: Prudhoe Bay--or Bust
22. Our Vanishing Wilderness: Slow Death of the Desert Water
23. Our Vanishing Wilderness: The Chain of Life
24. Water Wars: The Battle of Mono Lake
25. Where Did the Colorado Go?

ENERGY

1. Coal
2. Coal: Solution or Pollution?
3. Dawn of the Solar Age: Solar Energy
4. Dawn of the Solar Age: Wind and Water
5. Energy: A Conversation
6. Energy: A Matter of Choices
7. Energy: An International Crisis
8. The Energy Carol
9. The Energy Connection
10. Energy Crisis
11. The Energy Crisis Series (Seven "NBC White Papers" which comprise a three hour documentary as shown on television in 1978)
12. Energy: Critical Choices Ahead...A New Look
13. The Energy Crunch: The Best Way Out
14. The Energy Crunch: The Nuclear Dilemma
15. The Energy Crunch: The Sunbeam Solution
16. Energy: The Dilemma (Second Edition)
17. Energy: Fuels and Man

(films continued)

18. Energy for the Future
19. Energy for the Day Star
20. Energy: Innovative Alternatives
21. Energy: Less is More
22. Energy: The Problems and the Future
23. Energy: New Sources (2nd Edition)
24. Energy: The Nuclear Alternatives (2nd Edition)
25. Energy Seekers
26. Energy: Toward the Age of Abundance
27. Energy: What About Tomorrow?
28. Focus on Energy Conservation
29. Focus on Energy: What Are Our Choices?
30. Focus on How Much Gas and Oil Do We Have?
31. Fusion: The Energy Promise
32. Future Fuels
33. Gambling with Our Lives
34. Geothermal: The Energy Within
35. The Global Energy Game
36. Incident at Browns Ferry: Parts 1 and 2
37. The Invisible Flame: Parts 1 and 2
38. Joey's World
39. Lovins on the Soft Path
40. Natural Gas
41. No Act of God
42. Nuclear Energy: The Question Before Us
43. The Other Way
44. Power
45. The Power Game (Oasis in Space Series)
46. Solar Energy: The Great Adventure
47. The Solar Frontier
48. The Sun: Its Power and Promise
49. Terraset Sun
50. Thine Is the Power: A Citizen's Guide to the Nuclear Energy Debate
51. A Thousand Suns
52. We Will Freeze in the Dark
53. When the Circuit Breaks...America's Energy Crisis
54. Which Energy?

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POLLUTION

1. Acid Rain: Requiem or Recovery
2. Ah, Man--See What You've Done
3. Air
4. Air is for Breathing
5. Air Pollution: Sweetening the Air
6. Alone in the Midst of the Land
7. And on the Eighth Day
8. Ark
9. The Atmosphere in Motion
10. The Cities: A City is to Live In
11. Complex Human Ecosystems
12. Danger Radioactive Waste: Parts 1 and 2
13. Death Be Not Loud
14. Dioxin
15. Don't Hold Your Breath
16. Energy Consequences
17. Eternal Water
18. The First Pollution
19. The Second Pollution
20. The Third Pollution
21. Hazardous Waste Options
22. Hazardous Waste: Who Bears the Cost
23. Knowing It Survives Us
24. A Love Canal Family
25. Man: The Polluter
26. Mare Nostrum
27. Mud
28. The Myth and the Parallels: A Story of Conservation
29. No Deposit--No Return
30. Noise: The New Pollutant
31. Open Space
32. Our Poisoned World Series
33. A Plague on Our Children: Part 1--Dioxins
34. A Plague on Our Children: Part 2--PCB's
35. The Poisoned Air
36. The Poisoned Planet
37. Pollution is a Matter of Choice
38. Pollution of the Upper and Lower Atmosphere
39. Population and Pollution
40. The Quiet Crisis
41. Radiation: Impact on Life

(films continued)
42. Rise and Fall of DDT
43. Secrets of Limestone Groundwater
44. The Sky's the Limit
45. Stream
46. Survival
47. Troubled Water (Oasis in Space Series)
48. Urban Impact on Weather and Climate
49. Water
50. Water: A Precious Resource
51. Water: The Effluent Society
52. Weather: Who Votes for Rain?
53. "We Have Met the Enemy and He Is Us"
54. What Are We Doing to Our World (The 21st Century Series) Parts 1 and 2
55. What Price Progress?

The audiovisual materials suggested in the curriculum guide can be obtained from the following suppliers:

Association Instructional Materials
347 Madison Avenue (Department (DC))
New York, New York 10017

BFA-Ealing Corporation
2211 Michigan Avenue
Post Office Box 1795
Santa Monica, California 90406

BFA-Educational Media
2211 Michigan Avenue
Post Office Box 1795
Santa Monica, California 90406

Beckman Instruments Inc.
Attention: New Dimensions
2500 Harbor Boulevard
Fullerton, California 92634

Coronet Films
65 East South Water Street
Chicago, Illinois 60601

Inquiry Audio Visuals
1754 West Farragut Avenue
Chicago, Illinois 60640

International Communication Films
1371 Reynolds Avenue
Santa Ana, California 92705

John Wiley and Sons, Inc.
605 Third Avenue
New York, New York 10016

Kalmia
Department Cl
Concord, Massachusetts 01742

Lansford Publishing Co.
Post Office Box 8711
1088 Lincoln Avenue
San Jose, California 95155

(film companies)

Education Audio-Visual Inc.
Pleasantville, New York 10570

Encyclopedia Britannica
Educational Corp.
425 North Michigan Avenue
Chicago, Illinois 60611

Harper and Row Media
10 East 53rd Street
New York, New York 10022

Holt, Rinehart, and Winston, Inc.
383 Madison Avenue
New York, New York 10017

Indiana University
Audio-Visual Center
Office for Learning Resources
Terrytown, New York 10591

Prentice Hall Media
Servode HC236
150 White Plains Road
Terrytown, New York 10591

Scholarly Audio-Visuals Inc.
5 Beekman Street
New York, New York 10038

Science Software Systems Inc.
11899 West Pico Boulevard
West Los Angeles, California 90064

Shell Oil Film Library
1433 Sadlier Circle W. Drive
Indianapolis, Indiana 46239

McGraw-Hill Films
CRM/McGraw-Hill
110 15th Street
Del Mar, California 92014

Modern Learning Aids
1212 Avenue of the Americas
New York, New York 10036

Modern Talking Picture Service
2323 New Hyde Park Road
Hyde Park, New York 11040

Peter M. Robeck and Company
230 Park Avenue
New York, New York 10017

James J. Ruhl and Association
Post Office Box 4301
Fullerton, California 92631

Thorne Films
1229 University Avenue
Boulder, Colorado 80302

Universal Education and Visual Arts
100 Universal City Plaza
Universal City, California 91608

Westwood Educational Productions
701 Westport Road
Kansas City, Missouri 64111

Sutherland Educational Films
201 North Occidental Boulevard
Los Angeles, California 90026

Catalog of U.S. Government-Produced Audio-Visual Materials. 1978; 1980 update. Available from General Services Administration, National Archives and Records Service, National Audiovisual Center, Washington, D.C. 20409.

Classroom Science Films. Catalog lists free films available on loan from a number of sources. Available from the Department of Energy, Technical Information Center, Oak Ridge, Tennessee 37830.

Environments and Ecology. Annotated list of films, filmstrips, tapes, and publications available from Audio Visual Resource Center, 8 Research Park, Cornell University, Ithaca, New York 14850.

PRIVATE OR TRADE ORGANIZATIONS

Basic Concepts of Environmental Health. National Institute of Environmental Health Sciences, Public Information Officer , P. O. Box 12233, Research Triangle Park, North Carolina 27709.

Educational Service Bureau, Dow Jones & Co., Inc., P. O. Box 300, Princeton, New Jersey 08540.

Environmental Quality Index, National Wildlife Federation, Educational Services Division, 1412 16th Street, N.W., Washington, D.C. 20036.

Conservation Foundation. 1717 Massachusetts Avenue, N.W., Washington, D.C. 20036.

Louisiana Cooperative Extension Service, 102 LSUAC Administration Building, Louisiana State University, Baton Rouge, LA. 70893

ACTIVITIES

Environmental Action Guide. Lists 16 ways to help improve the environment. Can help teachers focus classes on problems, specific courses of action. Single copies available from Davis Conservation Library, Conservation District Foundation, P.O. Box 776, League City, Texas 77573.

The World Around You: Environmental Education Packet. Study guide and activity leaflets designed for 4th through 6th grades, but adaptable to other contexts. Materials cover a wide range of issues and activities. Single copies available from The Garden Club of America, 598 Madison Avenue, New York, New York 10022.

REFERENCE BOOKS

The Energy Balloon. Udall, Conconi, Osterhout. McGraw-Hill, 1974.

Energy, Electric Power, and Man. Timothy Healy. Boyd and Fraser, 1974.

Energy Future. Stobaugh and Yergin, editors. Random House, 1979.

Energy: Global Prospects 1985-2000. McGraw-Hill, 1979.

Energy in America's Future. Schurr, et al. Johns Hopkins University Press, 197 9.

Global 2000 Report to the President, Vol. 1. Council on Environmental Quality, 1980.

The Home Energy Guide: How to Cut Your Utility Bills. Rothchild and Tenney. Ballantine, 1978.

No-Cost, Low-Cost Energy Tips. Stuart Diamond. Bantam Press, 1980.

Producing Your Own Power. Carol Stoner, editor. Vintage, 1974.

Alternate Energy Sources. J. W. Watson. Watts. Presents methods of using sun, wind, and water energy.

Alternate Energy. Paul McClary. Wayland, 1980.

Catch the Wind: A Book of Windmills and Wind Power. Landt Dennis. Four Winds Press, 1976. History and overview of windmills and wind power, and prospects for wind power in the future.

Conservation of Energy. J. W. Watson. Watts, 1978. Explains basic systems, suggests methods of conservation.

Earth Power: The Story of Geothermal Energy. Madeleine Yates. Abingdon, 1980. Explains geothermal energy and its origins.

Energy and Environment. N. F. Smith. Steck-Vaughn, 1974.

Energy and the Future. M. A. Rothman. Watts, 1975.

Energy for America. I. Kiefer. Atheneum Press, 1979.

Energy in the World of the Future. H. Hellman. M. Evans & Co., 1973.

Energy: Power for People. Laurence Pringle. Macmillan, 1975. An introduction to Earth's energy resources and to new alternatives to traditional sources of power.

The Energy Trap. D. S. Halacy, Jr. Four Winds Press, 1975. Historical explanation of energy shortage faced by developed nations. Suggests coordinated efforts for the future.

Exploring with Solar Energy. G. G. Bilter, T. H. Metos. Messner. Activities related to solar energy. Illustrated with diagrams and photographs.

Nuclear Power--From Physics to Politics. Laurence Pringle. Macmillan, 1979. Examines history and feasibility of nuclear power.

The Race for Electric Power. Jerry Grey. Westminster Press, 1972. Clear presentation of present problems of electricity supply and demand.

Sun Power--Facts About Solar Energy. S. J. Gadler, W. W. Adamson. Lerner Publishing Company, 1979. Overview of solar power, including analysis of state-of-the-art systems.

GOVERNMENT SOURCES AND PUBLICATIONS

Council on Environmental Quality
722 Jackson Pl., N.W. Interior Bldg.
Washington, DC 20006

U.S. Department of the Interior
C St. Between 18th and 19th, N.W.
Washington, DC 20240

U.S. Department of Agriculture National Park Service
Forest Service (Use address for U.S. Dept. of Interior)
P. O. Box 2417
Washington, DC 20013

Office of Surface Mining
1951 Constitution Ave., N.W.
Washington, DC 20240

Park Service
1951 Constitution Ave., N.W.
Washington, DC 20240

Environmental Protection Agency
401 M St., S.W.
Washington, DC 20460

U.S. Department of Energy
Forrestal Bldg.
Independence Ave.
Washington, DC 20314

Nuclear Regulatory Commission
Washington, DC 20555

U. S. Geological Survey
National Center
Reston, VA 22092

U. S. Department of Energy
Technical Information Center
P. O. Box 62
Oak Ridge, TN 37830

History of Energy (EDM 1138)
What We Can Do Right Now? (EDM 1139)
What About the Future? (EDM 1140)

Where to Find Information About Solar Energy. 33p. Answers the twelve most often asked questions about solar energy. Classroom quantities available in U.S.

General Services Administration
Consumer Product Information
19th & F Streets, N.W. (XEC)
Washington, DC 20405

300

299

United States Nuclear Regulatory Commission
Technical INformation and Document Control
Washington, DC 20055

Thomas Alva Edison Foundation
Cambridge Office Plaza, Suite 143
18280 West Ten Mile Road
Southfield, MI 48075

Alternative Energy Sources
Energy Conservation
Selected Experiments and Projects
Environmental Experiments
Simple Experiments on Magnetism and Electricity
Useful Science Projects

Emerging Energy Technologies--Energy Research--Answers to Your Questions. Publication examines aspects of energy research, focuses on new ways of providing energy for our society. Single copies available in North America. Edison Electric Institute, Educational Services, 1111 19th Street, N.W., Washington, DC 20036.

Energy and Our Environment. Booklet describes new sources of energy and explains effects on the animal world. Single copies available. Union Oil Co. of California, Public Relations Dept., Attn: Ms. Marylou Barrett, 1650 East Golf Road, Schaumburg, IL 60196.

Energy Conservation Posters. Series of full-color, 11 x 14 posters stressing energy conservation. Classroom quantities available. International Business Machines Corporation, IBM Educational Materials, Dept. 809, Armonk, NY 10504.

"From Start to Finish." 9 x 14 poster illustrating oil refining process. Single copies available to teachers. Quaker State Oil Refining Corporation, P. O. Box 989, Oil City, PA 16301.

Water Conservation in Your Home. Practical aids to reducing water use. Single copies available. National Water Well Association, NWWA Publications Mail Order Dept., Suite 135, 500 West Wilson Bridge Road, Worthington, OH 43085.

The organizations listed below will furnish information on request about the resources that concern them.

American Gas Association
Educational Services
1515 Wilson Blvd.
Arlington, VA 22209

National Coal Association
Education Division
1130 17th St., N.W.
Washington, DC 20036

Standard Oil, Indiana
200 East Randolph Dr.
Chicago, IL 60601
"Oil in Depth," "Catalysts and Crude"

Shell Oil Company: "The Story of Petroleum"; Shell Answer Books. #22--"The Home" Energy-Saving Book," #28-- "The Conservation Payback Book." Single copies available from Shell Oil Co., P. O. Box 61609, Houston, TX 77208.

ACTIVITIES

U.S. Department of Energy
Technical Information Center
P. O. Box 62
Oak Ridge, TN 37830

Energy Conservation: An International Comparison--Grades 7, 8, 9. This unit looks at ways that energy can be conserved without significantly altering the quality of life. Students analyze information about Sweden, West Germany, and Japan, and compare the energy use of these countries with that of the United States.

The Energy Dome (DOE/CA/06083-03)--Social studies packet for grades 4, 5, 6.

Energy for Tomorrow--Grades 5, 6, 7. In this unit students consider the way that our use of energy will affect the future of communication, transportation, housing and food. In a variety of imaginative fine arts and language arts activities, students plan high technology and low technology futures.

The Energy Future Today (DOE/CA/06083-01)--Grades 7, 8, 9. 86p. Four decision-making units projected for social studies classes. Unit lessons cover such concerns as economics, social living, and the environment, as well as informing students about the place of fossil fuels, solar and nuclear energy, and energy conservation in contemporary living and options for tomorrow.

How a Bill Becomes a Law to Conserve Energy (HCP/U3841-11)--Grades 9, 11, 12. Activities focus on the legislative process and include a simulated congressional hearing on the 55 mph speed limit bill and exercises in graph construction and interpretation.

How We Make Energy Work (DOE/CA/06083-02)--Grades 4, 5, 6 science. Four units covering a variety of energy-related issues and activities.

Mathematics in Energy (HCP/U3841-02)--Grades 7, 8. Activities in which students practice important mathematical skills such as fractions, decimals, graphs, and percents. Students then apply these skills to a series of energy-related mathematical problems.

Solar Energy--Grades 6, 7, 8. Packet investigates solar radiation as a source of energy. It describes fusion, solar cells, solar experiments. Other lessons are appropriate for art and literature classes.

Educator's Guide to the Three E's: Energy/Ecology/Economics. Booklet includes discussion questions, activities, and projects relating to three topic areas. Single copies available to teachers. Sears, Roebuck and Co., D1703, Consumer Information Services, Sears Tower, Chicago, IL 60684.

Energy: Selected Resource Materials for Developing Energy Education/Conservation Materials. 35-page booklet listing energy-related materials available free or at low cost from organizations throughout the U.S. Single copies free from the National Wildlife Federation, Educational Services Division, 1412 16th Street, N.W., Washington, DC 20036.

Project for an Energy-Enriched Curriculum. Provides lists of energy-related activities for the classroom, films on energy-related topics, and other education materials available through NSTA and other organizations. Available from National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, DC 20009.

REFERENCE BOOKS

The Closing Circle. Barry Commoner. A. A. Knopf, 1972.

Environmental Quality: The Tenth Annual Report of the Council on Environmental Quality.

Everyone's Trash Problem: Nuclear Wastes. M. O. Hyde. McGraw-Hill, 1979.

Recycling. Educational Service Division, Rodale Press.

Teaching Science With Garbage. Rodale Press.

Careers to Preserve Our Shrinking World: Working and Living with Appropriate Technology. Robert V. Doyle. Julian Messner, 1981. Explores fields in which appropriate technology is being used to conserve diminishing natural resources.

Clear Air--Clean Water for a Modern World. Reed Millard and editors of Science Book Associates. Messner. The emphasis of this book on pollution is on the threatening problems, rather than solutions to them.

Easy Experiments with Water Pollution. Harry Sootin. Four Winds Press, 1974.

How Do They Get Rid of It? Suzanne Hilton. Westminster Press, 1970. Comprehensive, but easily read book looks at trash disposal.

The Nuclear Energy Controversy. Stephen Goode. Watts, 1980. Discusses the positive and negative aspects of nuclear energy and the controversy surrounding its use.

The Only Earth We Have. Laurence Pringle. Macmillan, 1969. General ecological overview, with sections devoted to solid waste, energy.

Recycling: Reusing Our World's Solid Waste. James and Lynn Hahn. Franklin Watts, 1973. Straight forward explanation of ways paper, glass, metal, and garbage are recycled.

Save, Keep It, Use It Again. R. J. Lefkowitz. Parents' Magazine Press, 1977. Discusses ways that scarce material resources may be conserved through recycling.

The Shrinking Outdoors. Gary Jennings. Lippincott, 1972. Self-characterized as an "angry book;" very thorough treatment of environmental issues.

EVALUATION TECHNIQUES

Students in secondary school are developing into young adults, and are at different levels of development. Differences in physical and mental growth, opportunities, experience, and age affect a student's performance in the classroom. Evaluation should always take these differences into account. As with learning styles, evaluation should address the student's testing ability. In science, a tremendous amount of emphasis is placed on knowledge. This level of knowledge is aimed at promoting scientific literacy. Few students, however, will become scientists or engineers, yet many will work in technical fields, will be required to interpret scientific information, and will need to understand basic biological and physical principles.

Evaluation of student should be based on more than a score or a single observation. Evaluations should include many different methods, each addressing the various learning and testing styles of students, and each aimed at assessing all taxonomic levels. Evaluation is the first sign of what is expected of the students by the teacher, therefore initial evaluations should set the standard for the remainder of the course. The evaluation should reflect the performance objectives. Methods for evaluating pupil achievement and progress are an integral part of the instructional program. Evaluation techniques must reflect (1) the objectives to be reached, and (2) the activities employed to reach those objectives. If the objectives are stated clearly, the methods of evaluation are indicated within the objective. In this guide, the objectives are stated in behavioral terms and suggested activities are listed. The process skills are not identified because the skills will vary according to the manner in which the objective is taught. For every objective, it is clear what the student is expected to be able to do after successful completion of a learning activity. The successful attainment of an objective can be demonstrated by the student's being able to do specific things which can be observed.

One method of evaluation includes problem solving. Students should be required to gather data or information on which to base their response. These data or information should be presented in an appropriate manner for interpretation. Students may be evaluated on their interpretation and presentation.

Evaluation of problem-solving abilities involves more than assessing accuracy of information; it requires careful review of the explanation used for arriving at conclusions. The evaluation of criterion referenced tests, normative tests, essays, laboratory reports, activity reports, or explanations involves assessing the technical information used to explain the scientific principles, the analytical procedures, and the precision and quality of the language used in presenting the information.

Another method of evaluation includes paper and pencil tests. Students may be asked to analyze or interpret data. These interpretations may be evaluated as to how their responses were derived. Pencil and paper tests may be used to identify concepts, words, and ideas associated with objectives. Although essay questions are most effective for students who can write well, essay tests should be included in the testing experience of all students.

Performance and participation coupled with observed behavioral changes may also be an excellent method of evaluation. This type of evaluation may be used when simulation exercises are used. A simulation exercise in environmental science might include a local problem that involves environmental issues. Students are assigned "parts" or "roles." These roles may have alternative views about how the environmental problem might be solved. The students are asked to research their views and present their ideas and information before the class, much like a hearing. Following the "mock" hearing, the students may be tested with a paper and pencil test. Such activities promote the use of process skills and tend to move the learner into the center of learning, rather than to keep the teacher at the center of the instruction. Therefore, evaluation should consist of more than just paper and pencil tests on recall of factual knowledge. A variety of evaluative activities should be used.

The use of laboratories in environmental science may include field exercises: field trips, observations made outside of school, and special opportunities students might have to find issues that affect the environment. Students should be assessed as to their ability to observe outside the classroom environment.

Some norm-referenced instruments are available for teachers. It should be realized that often items may reflect historical issues to which many students have never been exposed. In addition, normative testing may also reflect regional or local issues that are unknown in this region of the nation.

PROGRAM EFFECTIVENESS

Teachers should be continually evaluating their own courses. The student performance level measured by normative reference tests are always good comparative devices. However, other methods should be used to evaluate a teacher's program. Consider these questions:

Do you apply up-to-date technology or laboratory apparatus when teaching?

Do you provide and encourage independent investigations?

Do you rely heavily on journal articles?

Do you encourage students to continue learning about science regardless of sex or role or performance?

What proportion of the students are enrolled in science classes at each grade level?

What is the proportion of students who take advanced science courses?

How much interdisciplinary teaching and cooperation is going on in your school?

Evaluation is a key in documenting success or need for improvement. Collecting test data, observations, and analyzing of such data should encourage a teacher to use science to evaluate their own progress.

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