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ABSTRACT

This curriculum guide was developed with the intention of providing an enrichment option for gifted and talented learners who are interested in pursuing current issues and topics in the fields of mathematics and science. The scope of the guide is meant to encompass a year's study of a set of topics which apply mathematics to science and technology. The units in the guide deal with: (1) energy; (2) genetics; (3) ecology; (4) space travel; (5) electronics; and (6) conservation. Learning objectives are stated at the beginning of each unit, along with an explanation of the focus of that unit. Many of the activities and problems included in the units are cross-referenced with a list of recommended materials. (TW)

A Curriculum Guide

to

Applications of Science and Technology

for

Able Learners

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Nature and Purpose of the Curriculum Guide

This curriculum guide has been developed for the purpose of providing an enrichment option for gifted and talented learners who come from many different backgrounds and geographical locations and who are interested in pursuing current issues and topics in the fields of mathematics and science. Most school textbooks in these content areas do not treat the topics delineated in this guide as richly or as in depth as may be appropriate for able learners. Thus the guide is available to provide a method for these able learners to access information and problem-solving activities within a specific topical area. We believe that the guide may be most useful within mathematics and science programs for talented learners. However, it can be adapted for use in other settings as well, including pull-out classes, Saturday or after-school classes, and in community-based mentor programs. Students who are very interested and motivated by the topical areas may pursue the curriculum independently as well.

The scope of the guide is meant to encompass a year's study of a set of topics in the application of mathematics. Extensive suggestions for readings and exemplary activities are provided to help learners explore the content area. Learning objectives are stated at the beginning of each unit, along with an explanation of the focus of that unit. Many activities and/or problems are cross-referenced to recommended materials. The use of the guide is recommended for talented learners in the age range of 11-14. It is intended to be a classroom resource to teachers at the middle school or junior high school levels in mathematics and science. Specific suggestions to the teacher are also included.

KEY COMPONENTS OF A SCIENCE PROGRAM FOR GIFTED LEARNERS

1. Opportunities for real laboratory experimentation and original research work.

An appropriate science curriculum for the gifted should reflect an emphasis on independent laboratory work, extensive reading and emphasis on the skills of using the library, and true experimental work. It should stress the real activiaties of scientists who conduct research: observation, measurement, experimentation, and communication, as well as stress a realistic scientific attitude.

2. High level content-based curriculum that is conceptually strong and carefully organized over the grade span of K-12.

Concern for students' understanding the structure of knowledge in science is an important goal in science programs. And strong content-based materials have shown greater effects in student learning of process skills, analytical skills, and creativity when compared to other types of material. The presentation of an organized body of knowledge within science with a careful curriculum sequence continues to be an important feature of science programs for the gifted. Thus science curriculum that not only has a significant content base but is strong conceptually can enhance the development of skills critical for doing science.

3. Opportunities for interaction with practicing scientists.

Providing the opportunity for students to interact with practicing scientists as mentors, as teachers, as role models is an important program component. Scientists can discuss and emulate for students the skills required for science as a profession, such as quantitative observation and attention to detail; and skills in learning, acquiring information; and inquiry organization. Involvement with scientists increases student understanding of the real world of science in ways not possible through a typical classroom. Furthermore, scientists can work directly with students on developing research proposals and sharing the nature of their own research.

4. A curriculum rich in current technological advances coupled with the human dimensions associated with those advances.

A fourth key component relates to the capacity of the curriculum to reflect the latest breakthroughs in scientific research as well as the technological progress made in applied areas of science. While this can be seen as important for all students, it is critical for the gifted who need access to new information at earlier ages in order to conduct meaningful cutting edge research. One of the major recommendations emanating from several recent national reports stressed the need for updating the scientific information shared with students and infusing the curriculum with new technological advances. Specifically, science programs for the gifted should present technological issues as a part of each formal topic in the standard curriculum and link them to social issues for relevant discussion.

5. A strong emphasis on inquiry processes.

Science education for the gifted should be realistic, and include training in problem finding problem solving, problem reevaluation, and scientific reporting. In this way, those who choose a career in science can make their choice on the basis of what doing science is like, rather than on the basis of a model of academic coursework.

Unit I
ENERGY

INTRODUCTION

Energy education was first incorporated into school classrooms in the early 1970's. Curricular materials were developed by the federal government, private industry, educational consulting firms, and by teachers themselves to give young people a sound background in the entire issue of the role of energy in contemporary society. This unit provides students with an intensive study of the basic features of energy, its use, production, transfer, and conservation. **A major goal of the course is to promote an understanding within each student that energy is no longer cheap and that new technologies need to be developed to assure our nation's strength in the years to come.** A possible theme that can serve as a point of focus for the unit would be an ongoing evaluation of the following statement: **Individuals and societies most often do not actively begin solving problems until those problems directly impact them.**

This energy unit focuses on the following goals:

1. Introducing students to physical and chemical principles underlying energy production and use,
2. Familiarizing students with forms of energy and the different ways energy is made available for human use, and
3. Developing within students an awareness of the economic, social, and environmental consequences of energy production and use.

Topics studied in this energy unit include matter and energy, various forms of energy, energy changes, energy efficiencies, energy production, and conventional and alternative sources of energy.

This curriculum unit is divided into two sections. The introductory section is intended to provide students with a thorough overview of energy sources. It is referenced to The World Book Encyclopedia which is readily available in school and public libraries. A central feature of this introductory section is the inclusion of hypothetical scenarios for the students to complete. These are useful tools for involving students in data collection, analysis, hypothesis formation and evaluation, and policy issues; the process of science.

The main section is comprised of eleven sub-units which lead the student through a more detailed series of salient topics and learning experiences. Sub-units are:

Unit I: Matter and Energy
Unit II: Work and Kinetic Energy
Unit III: Measuring Energy and Energy Used in the Home
Unit IV: Energy Changes
Unit V: Power
Unit VI: Efficiency
Unit VII: Energy in Foods
Unit VIII: Fossil Fuels: Stored Up Energy
Unit IX: Energy Flows: Wind and Water Cycles
Unit X: Nuclear Energy and Fuel Cycles
Unit XI: Energy For The Next 10,000 Years

This section is based almost exclusively on the text, ENERGY 85, AN INVESTIGATION OF SCIENCE, TECHNOLOGY, AND SOCIETY (published by Enterprise for Education, Inc. , 1320A Santa Monica Mall, Suite 205, Santa Monica, California, 90401.) Sub-units include investigative, discovery-oriented exercises and activities (reprinted with permission from publisher) intended to reinforce and generalize conceptual learning. These are provided as a guide. Evaluation procedures are also suggested. Quizzes and tests can be prepared by the teacher to reflect the nature of the course, and it is recommended that whatever evaluations is used facilitate student use of higher mental processes.

Teachers are encouraged to modify and supplement materials according to the unique needs and characteristics of their learners. Teachers are also encouraged to consider providing the opportuntity for students to complete a research proposal as a concluding activity (following the included guidelines). It is suggested that this proposal address a relevant topic and act as a further inquiry-oriented learning experience and source of evaluation. Finally, if possible, students should be exposed to the actual scientific environment. Trips to area laboratories, films (particularly, the

SEARCH FOR SOLUTIONS series from the Phillips Petroleum Company), and direct interaction with members of the scientific community are strongly recommended.

<u>OTHER MATERIALS:</u>

Liem, Tik. INTRODUCTION TO SCIENCE INQUIRY. Lexington, Ma. Ginn Press, Inc. 1977.

U.S. ENERGY POLICY--WHICH DIRECTION? Washington, D.C. The National Science Teachers Association, 1977. (Specifically, Asimov article)

ENERGY, ENGINES, AND THE INDUSTRIAL REVOLUTION. Washington, D.C. The National Science Teachrs Association, 1977.

Terry, Mark, and Witt, Paul. ENERGY AND ORDER. San Francisco: Friends of the Earth, Inc. N.D.

Bronowski, Jacob. THE ASCENT OF MAN. Chapter 8, "The Drive For Power". and Chapter 11, "Knowledge or Certainty".

INTRODUCTION TO THE STUDENT

Energy, its availability, environmental effects, and economics, has been in the forefront of current affairs for nearly three decades. The United States, with only about one-sixteenth of the world's population, uses more than one-third of the world's production of energy. In the first half of the twentieth century, vast reserves of Appalachian coal made possible the rise of America's industrial might. In the 1950's and 60's, cheap petroleum and natural gas, coupled with the construction of superhighways, resulted in the typically American phenomenon of suburban sprawl. New homes equipped with every modern appliance, two cars for every family, and a burgeoning economy led experts to predict that energy consumption would double every seven years.

Then in the early 1970's, Americans were rudely confronted with the reality that the days of cheap energy were over. Furthermore, they realized that there are economic, political, and environmental consequences of energy profligacy. Embargoes caused by warfare in the Middle East led to long lines at gasoline pumps. Prices soared as nation's competed for dwindling reserves. Prices for a barrel of crude oil increased from $12 in 1971 to $35 a barrel in 1980. The environmental effects of our excessive energy use were brought home by dangerously high levels of air pollution, the sight of thousands of sea birds dying in oil slicked waters near sinking oil tankers, and prime forest land laid to waste by stripmining.

Considering the nation's dependence upon energy, coupled with concern over problems associated with its use, it was only appropriate to begin developing new, environmentally safe, and, if possible, long-lasting, renewable energy sources. Could coal be mined with less environmental damage and burned more cleanly? Could small, previously used dams and power generators within city boundaries be recommissioned to supplement strained electrical generating plants? Innovative ideas designed to satisfy the extensive energy demands of our modern society have stretched the limits of available technology. Such proposals have included the use of solar energy, heat pumps, and geothermal, tidal, and wind electrical generation. More exotic energy sources currently being considered for future development include, on the one extreme, biomass -- organic waste used either directly for fuel or biochemically broken down by microorganisms to produce useable fuel. Ideas at the other extreme include thermonuclear fusion -- a highly sophisticated and still experimental technique for producing vast amounts of energy by fusing hydrogen atoms into helium, a reaction that occurs naturally in the sun. As you progress through this unit, consider the benefits and drawbacks of various energy sources both existing and proposed. Is there a source that can provide limitless, low-cost energy without risking environmental damage?

In the view of many experts, energy conservation offers the most promise for increasing energy availability in the years ahead. It offers endless opportunities for research and has already resulted in more efficient automobiles and electrical appliances, heat conserving buildings, and a heightened public awareness of personal conservation measures. A major goal of this unit is to get you involved in the promise and problems of energy sources and uses. The future condition of your community, country, and planet depends upon your creative solutions to current problems and inspired alternatives for meeting energy needs into the twenty-first century.

Energy is the name given to the ability to do work. Most of the energy on earth comes from the sun. The sun's energy is stored in many different ways. A number of energy sources will be investigated as the student begins working through this unit. The conversion of potential energy into electrical energy is a major consideration in this section.

Many sciences are involved in obtaining substances that can provide energy for people. Some substances are buried under dirt and rocks. The substances, in order to be useful to man, must be discovered, mined, processed, and delivered to the consumer. Other energy supplies come from harnassing the forces of nature such as wind, water, the tides and sunlight. **A major issue for you to consider as you work through this unit is that some of the most convenient and economical energy supplies in use today may be nearly used up within the next 25-35 years. What is the energy crisis and how can we use science and technology to provide enough energy for people in the next 10 to 100 years?**

Objectives

Upon completing this unit, the student will be able to:

1. Identify 11 sources of energy.
2. Describe problems involving energy sources.
3. Describe challenges involving energy sources.
4. Explain what petroleum is and how it is used.
5. Explain what coal is and how it is used.
6. Describe the use of nuclear fuels, its pros and cons.

7. Explain advantages of the 11 sources of energy.
8. Explain disadvantages of the 11 sources of energy.
9. Make predictions about the future use of energy supplies.

References:

THE WORLD BOOK ENCYCLOPEDIA

Energy Supply, E. Vol. 6, pp. 2260-226 1982
Fuel, F. Vol. 7, pp. 476-477 1983
Petroleum, P. Vol. 15, pp. 292-312 1982
Gasoline, G. Vol. 8, pp. 61-62 1983
Gasohol, G. Vol. 8, p. 61 1983
Gas, G. Vol. 8, pp. 50-59 1983
Coal, Ci-Cz. Vol. 4, pp. 566-583 1983
Nuclear, N-O. Vol. 14, pp. 448a-448o 1983
Nuclear Reactor, N-O. Vol. 14, pp. 448p-448r 1983

Major Learning Experiences

The student will:
1. Read the references listed above.
2. After reading the "Fuel" article, students will write answers to "Suggested Study Guide and Questions" and be prepared to discuss these questions with classmates.
3. Students will associate various energy sources with particular technological eras. Focus should be on how the demands of each era led to the use of particular sources and how the shortcomings of the source or changing demands required the invention of new sources (stating, for instance, why early Americans converted from wood to coal or later, the factors behind the shift from coal to petroleum and natural gas). Eras for study should be determined by the teacher; suggestions include pre 1700, 1850-1900, 1900-1940, 1940-2001, 2001-?

Evaluation Procedures

Students will complete Scenarios I and II and discuss solutions with teacher and classmates.

Additional Readings

1. Recent newspaper and magazine articles.
2. McGraw-Hill Encyclopedia of Science and Technology, 1982.
3. McGraw-Hill Yearbook of Science and Technology, recent editions.

After successfully completing the introductory unit, the student will now begin to explore energy-related issues in greater depth.

Note: Unless otherwise indicated, all sub-units in this section are based on the text, ENERGY 85: AN INVESTIGATION OF SCIENCE, TECHNOLOGY, AND SOCIETY and the accompanying teachers guide henceforth referred to as TG.

SUB-UNIT I: MATTER AND ENERGY

Objectives

Upon completion of this unit, students will be able to name several different forms of energy, to recognize that energy can neither be created nor destroyed, and understand that some energy is lost to our use whenever energy is converted from one form into another.

Major Learning Experiences

1. Students will discuss the primary sources of energy used by humans, recognizing that the original source for almost all life on earth is the sun.

2. Students will describe various energy-driven cycles on earth, including the water cycle, nutrient cycles, and the wind cycle.

3. Students will recognize different types of energy, including chemical energy, the form in which energy exists in food and fuels.

4. Students will discuss energy conversions, recognizing that useful energy is lost as energy is converted from one form to another.

5. Students will solve problems involving energy efficiencies, recognizing that there can be an economic loss as well as an energy loss as energy is converted from one form to another.

6. Students will view the film, SEARCH FOR SOLUTIONS, "Evidence, Patterns, Investigation."

Evaluation

Students will complete the ENERGY TRANSFORMATION Worksheet, marking those transformations that they think are the most efficient and those that are the least efficient.

REFERENCES

Text: ENERGY 85, pp 2 and 3, and TG worksheet 1-13, "Energy Transformations." SEARCH FOR SOLUTIONS

SUB-UNIT II: WORK AND KINETIC ENERGY

Objectives

Upon completion of this unit, students will be able to compare and contrast work, kinetic energy, and potential energy. Students will be able to demonstrate the mathematical relationship between force and distance as it applies to work, and to understand and be able to use energy-related terms such as joule and their derivations. Also, they will understand the differences among vibrational, rotational, and translational kinetic energy.

Major Learning Experiences

1. By way of individual or group assignments, students will complete a number of word problems related to the work and kinetic energy.

2. Students will show their competence for problem-solving by demonstrating solutions before their classmates.

Evaluation

Students will complete THE SPINNING RINGS investigation and provide definitions of potential, kinetic, rotational energies. Students will provide original demonstrations of each in their definitions.

References

Haber-Schaim, Cross, Dodge, and Walter. PHYSICS, 4th ed. (PSSC) D.C. Heath.

Williams, Trinklein, and Metcalf. MODERN PHYSICS laboratory manual, EXPERIMENTS AND EXERCISES IN PHYSICS, Holt, Reinhart, and Winston 1980.

SUB-UNIT III: MEASURING ENERGY/USES IN THE HOME

Objectives

Upon completion of this unit, students will be able to measure a quantity of heat, use measurement of energy to track energy flow, and be able to define energy-related terms including calorie, (kilo)Calorie, BTU, and kilowatt-hour. Students will also be able to read gas and electric meters, be able to interpret home gas and electric meters, and recognize that energy use varies during different times of the year.

Major Learning Experiences

1. Students will complete the following laboratory exercises from ENERGY 85:

a. "Measuring Heat". In this exercise, students will determine the amount of heat energy required to increase the temperature of a specific volume of water.

b. "Tracking the Elusive Calorie". In this exercise, students will measure heat loss of a given volume of water by comparing the temperatures of hot water -- the initial source of energy -- with a container of water that receives the heat.

c. "How Many Calories in a BTU?" In this exercise, students will compare the amount of energy in a Calorie with the amount of energy in a British Thermal Unit. This exercise gives students the opportunity to compare metric measurement with the English system of measurement.

d. "Reading a Meter." In this exercise students will learn to read gas and electric meters in their homes.

e. "Keeping an Electric Diary." In this exercise, students will record their household energy consumption for one week. This will be done by taking readings of gas and electric meters at the same time each day.

f. "Reading an Electric Bill." Students will relate their families' electric bills to energy consumption.

Evaluation

a. In the classroom, students will solve teacher prepared exercises stressing the following items:

1. Unit conversions within the metric system,
2. Unit conversions between the metric and English systems,
3. Calculations for system heat gain and heat loss.

b. Students will identify 4 sources of energy used in their homes, name their units, and identify transformations.

c. Students will make a one year projection of the energy requirements of their homes. They will graph the projected rises and falls of consumption over time and identify reasons for variation.

d. Students will institute a series of original energy-saving policies in their homes and calculate their effect on weekly consumption.

References

Science 85, worksheets from TG 1-54, "Measuring Heat:"
1-58, "Tracking the Elusive Calorie:" and 1-65, "How Many Calories In A BTU?" "Reading a Meter;" 1-102, "Keeping an Electric Diary;" 1-109, "Reading an Electric Bill;" and 1-111, "Reading a Gas Meter."

SUB-UNIT IV: ENERGY CHANGES

Objectives

Upon completion of this unit, students will be able to describe physical and chemical changes in terms of heat loss and gain (exothermic and endothermic reactions). Students will be able to define heat of formation, heat of fusion, heat of vaporization, and heat of combustion. Also, students will be able to write thermochemical equations and heat diagrams for physical or chemical changes.

Major Learning Experiences

1. Students will create an exothermic reaction by combining a fine powder of potassium permanganate with a few drops of glycerol on a fire resistant pad. A purple fire will result.

2. Students will complete the laboratory exercise, "Heat Effects of Chemical Reactions." In this exercise, students will observe the effect of a burning candle on the temperature of a given volume of water. The burning of the candle is a chemical reaction, and the resulting change in temperature of water heated by the candle demonstrates the energy produced by the chemical reaction.

3. Students will solve problems using the energy-conversion factor to make mole-energy conversions.

4. Students will view the SEARCH FOR SOLUTIONS film, "Adaptation, Trial and Error, and Context."

References

This laboratory exercise is taken from the lab manual accompanying the text, CHEMSITRY, by Masterson, Slowinski, and Walford, published by Holt, Reinhart, and Winston.

SUB-UNIT V: POWER

Objectives

Upon completion of this unit, students will understand the relationship between work and power, will be able to calculate the power output of a given appliance if its amperage and voltage are known, and will be able to convert among watts, kilowatts, and horsepower.

Major Learning Experiences

1. Students will complete word problems about power.

2. Students will complete a laboratory exercise about power from the lab guide of MODERN PHYSICS. In this exercise students will measure the power output of a person running up a flight of stairs, and will learn the precise meaning of the unit, horsepower.

Evaluation

Students will determine the power output ratings of various home items (family car, stereo, hairdryer, etc.) Students will estimate what effect an increase or decrease in power output would have on performance, weighing advantages and disadvantages of each. They will attempt to determine the factors that are relevant in determining appropriate power output level.

References

Williams, Trinklein, and Metcalf, MODERN PHYSICS laboratory manual. "EXPERIMENTS AND EXERCISES IN PHYSICS" Exercise No. 14, "POWER". New York: Holt, Reinhart, and Winston, 1980.

SUB-UNIT VI: EFFICIENCY

Objectives

Upon completion of this unit, students will be able to identify heat as an outcome of any practical energy conversion, and be able to define efficiency as the percentage of the energy put into a system that is converted to a form useful for the task intended. Students will understand that heat is the form of energy most often dissipated by a system and recognize the value of converting heat energy into useful work.

Major Learning Experiences

Students will conduct the following laboratory exercises from ENERGY 85.
1. "How Efficient is an Electric Hot Plate in Heating Water?" In this exercise students will compare energy input and energy output of an electric hot plate, thus determining the appliance's efficiency.

2. "Lighting Efficiency Survey." In this exercise students will compare and contrast energy efficiencies of incandescent and flourescent light fixtures in their classrooms and homes.

Evaluation

Students will revise energy saving ideas developed in **Subunit III** in light of new material, implement new ideas, and check for additional efficiency changes.

References

Text: ENERGY 85, pp 4, 5, and 27. Worsheets from TG 1-147, "Hot Plate;" and 1-152, "Lighting Efficiency Survey."

SUB-UNIT VII: ENERGY IN FOODS

Objectives

Upon completion of this unit, students will be able to describe the process of photosynthesis in terms of the substances involved, the similarities and the REASONS for similarities of the chemical equations for the processes of photosynthesis and respiration. Also, students will be able to trace the energy in a food chain from the sun to a human being.

Major Learning Experiences

1. In the laboratory, students will complete the following activities from ENERGY 85:

a. "Peanut Calorie Calculation." In this exercise, students will determine the amount of energy in a peanut by measuring the increase in temperature of a container of water heated by a burning peanut.

b. "Tracing Your Own Food Chain Backwards.' In this activity, students will trace the energy in food they eat back to green plants, recognizing that the energy in plants originates from the sun.

2. In the laboratory, students should complete as many of the following investigations as possible:

a. "A Nutty Way To Measure Calories." This experiment is essentially a repeat of 1a described above.

b. "Detecting Chlorophyll." Students will extract chlorophyll, the light capturing pigment in green plants, from a preparation of green leaves.

c. "Chromatography." Students will use paper chromatography to separate pigments in chlorophyll.

d. "Detecting the Products of Photosynthesis: Starch." Students will use iodine stain to identify the starch produced in green plants by photosynthesis.

e. "Detecting the Products of Photosynthesis: Oxygen." Students will use a glass jar to collect bubbles of gas produced by the aquatic plant ELODEA. They will then determine whether the collected gas causes a glowing splint to burst into flame, thus confirming that the gas is oxygen.

Evaluation

Students will trace the energy types and transformations occuring in the production and consumption of a hamburger. They will analyze the energy used in each step of the process of preparing, making, and eating the hamburger.

Students will also calculate the amount of calories received in a day and compare that to the amount of calories required. They will evaluate six proposed solutions to the food shortage problem, offer additional original ideas, and evaluate their effectiveness in dealing with the problem.

References

Text: ENERGY 85, pp. 8-9. Appropriate worksheets from TG

SUB-UNIT VIII: FOSSIL FUELS-STORED UP ENERGY

Objectives

Upon completion of this unit, students will be able to describe the formation of fossil fuels and recognize the importance of fossil fuels as an energy source.

Major Learning Experiences

1. Students will read pages 10-11 in Energy 85, "Fossil Fuels" in order to determine the following:
   a. The chemical element that makes up coal.
   b. What differentiates anthracite from bituminous coals.
   c. How coal is mined and processed.
   d. How petroleum and natural gas are obtained and processed.
   e. The importance of fossil fuels in the history of industrial development in the U.S.

2. Students will complete the classroom worksheet from TG, "Fuels in Your Life". In this exercise students will determine the quantity of electricity generated from fossil fuels in this area.

Evaluation

Students will estimate the percentage of energy used in their homes derived from fossil fuels and from nonfossil fuels. They will evaluate the implications of this situation and suggest possible strategies for efficiency and cost improvement.

References

Text: ENERGY 85 pp. 10-11, "Fossil Fuels" and worksheet from TG 3-7 "Fuels in Your Life."

SUB-UNIT IX: ENERGY FLOWS-WIND AND WATER CYCLES

Objectives

Upon completion of this unit, students will be able to describe energy conversions in the water cycle in nature and in wind patterns, and will be able to trace energy flows in the water cycle and in air circulation. Also, students will demonstrate an awareness that energy for these processes comes from the sun.

Major Learning Experiences

Students will complete the following activities:

1. Read pp. 6-7 in ENERGY 85, "Our Sun: Energy Superstar."

2. Complete the exercise, "Making A Waterwheel." In this exercise, students will construct a waterwheel from a coat hanger, steam, and heavy-duty aluminum foil. The waterwheel will demonstrate the principles of the turbine engine.

3. Complete the exercise, "Observing The Water-Cycle Jar."

4. Students will view SEARCH FOR SOLUTIONS, "Prediction, Modeling, and Theory."

Evaluation

a. Students will list the conditions needed to take best advantage of wind energy and demonstrate (explain) why the reliability of a wind system coupled with a solar system would be much higher than the reliability of either system alone.
b. Students will develop three realistic applications of hydroelectric energy.
c. Students will calculate the total price of installing a home wind generator system, determine the potential energy output of the system and evaluate its cost effectiveness compared to more conventional energy systems.

References

Text: ENERGY 85, pp. 6-7, and appropriate worksheets from TG.
SEARCH FOR SOLUTIONS

SUB-UNIT X: NUCLEAR ENERGY

Objectives

Upon completion of this unit, students will be able to identify and describe the parts of the atom, will recognize the relationship of isotopes to ordinary items, and will be able to describe a nuclear chain reaction. Students will also be able to describe steps involved in the nuclear fuel cycle, to describe the production of electricity from nuclear fission, to list advantages and disadvantages of nuclear fission as a commercial energy source, and to summarize problems associated with the storage of nuclear wastes and propose how these problems might be solved.

Major Learning Experiences

1. Students will read from ENERGY 85 and will complete the following activities:

a. "Energy From Fission." In this activity, students construct a model of a chain reaction similar to the fission reactions occuring in nuclear reactors.

b. "Half-Life of Isotopes." In this activity, students complete a worksheet demonstrating how the half life of isotopes determines their radioactivitiy.

c. "If You Were Nuclear Powered..."

d. At this point, the teacher should consider field trips and discussions. Students should be given the opportunity in these units to begin to understand the PROCESS of science and the challenges that are ahead in the area of energy. Discussions should emphasize divergent thinking and could include the following topics:

a. Classification of radioactive wastes.
b. Environmental dangers of radioactivity.
c. Problems of storing high-level nuclear wastes for centuries.
d. Comparison of nuclear energy to other forms of energy.

Evaluation

a. Students will develop questionnaires and conduct informal interview/polls of public attitudes toward nuclear energy. They will determine the extent of public awareness, commenting on common perceptions of pros and cons and evaluate whether the public is adequately informed.
b. Students will list and explain the 5 main components of a nuclear reactor and/or design a nuclear reactor on paper and explain the function of the major components.
c. Students will identify and then suggest alternatives to the problems of the storage of nuclear waste.

References: Text: ENERGY 85, pp. 22-25 and appropriate TG worksheets.

SUB-UNIT XI: ENERGY FOR THE NEXT 10,000 YEARS

Objectives

Upon completion of this unit, students will be able to define renewable energy resources and emphasize the need for their use, and will be able to describe how sunlight is converted to heat by absorption. Also, students will be able to describe one method of using sunlight for space heating in a home.

Major Learning Activities

1. Again, field trips and class discussions should constitute most of the activities in this unit. In addition, students should be allowed to complete as many of the following activities from ENERGY 85 as time permits:
   a. "Collecting Heat From Sunlight."
   b. "How Much Heat Can We Get From Sunlight?"
   c. "Reaching Higher Temperatures by Concentrating Sunlight."

Evaluation

a. Students will develop a brief research paper investigating various energy sources currently being developed to meet energy demands of the future. They should choose one of particular interest and develop it in greater depth (perhaps creating experiments to demonstrate the properties of the energy type) for informal presentations in class

b. Students should also be given a cumulative final exam on material from the entire unit. Specific nature of the exam should be determined by the teacher to reflect the unique characteristics of his/her class.

References

Text: ENERGY 85, pp. 26-27 and appropriate TG worksheets.

Unit II

GENETICS

INTRODUCTION

Genetics, the science of heredity, is one of the most promising and challenging disciplines. A day seldom passes without news of some new discovery in this multifaceted branch of science. In the medical field, genetics has made possible the production of interferon, the widely heralded drug that may unlock the mysteries and provide effective treatment for cancer. Genetics research has produced resistant strains of crops and animals able to survive in harsh climates and may represent the solution to the serious famine problem which plauges so many on our planet. Geneticists have produced new strains of bacteria that can gobble up oil spills and the possibility exists that strains developed in the laboratones of the near future will work to purify our air and water.

Despite the present high level of understanding in this field, the possibilities remain almost limitless for scientists wishing to do research in genetics. Thus, it is both appropriate and timely for a unit in genetics be offered to able learners. The goals of this unit in genetics are:

1. **To develop within students an understanding of the processes of science and scientific investigation,**
2. **To instruct students in the principles and investigative techniques related to the science and research of genetics, and**
3. **To provide students with a basic understanding of the role of genetics in contemporary society, including the moral dilemma and growing controversy involved in recent developments within the field of genetics research and rapidly increasing potential of gene splicing techniques.**

To meet these goals, teachers are encouraged to provide students with a variety of learning experiences. These should include, but are not limited to, reading and laboratory exercises, lecture and discussion sessions, independent and group work on genetic problems, independent research projects, utilization of film and videotape, and interaction with the scientific community through visits to area laboratories and other facilities for genetic research.

This unit is comprised of seven sub-units. Each unit is designed to provide investigative learning experiences and includes suggested learning objectives and major learning experiences. It is recommended that original essays serve as the major evaluation tool to facilitate student use of higher mental processes and require the students to analyze material and form original conclusions based on a synthesis and evaluation of available information. Topics are:

1. Introduction to genetics
2. Chromosomes and transmission of genetic information
3. Chromosomal rearrangements
4. Mendelian genetics
5. The structure and function of DNA and RNA
6. Mutagenesis
7. Topics in advanced genetics

For some topics, lecture notes are included outlining appropriate content material with suitable observation oriented questions for discussion and inquiry and topic based worksheets. These are provided as a guide. Teachers are encouraged to modify and supplement materials according to the unique needs and characteristics of their learners. Teachers are also encouraged to consider providing the opportuntity for students to complete a research proposal as a concluding activity (following the included guidelines). It is suggested that this proposal address a relevant topic and act as a further inquiry-oriented learning experience and source of evaluation.

UNIT 1: INTRODUCTION TO GENETICS

Objectives

Upon completion of this unit, students will be able to describe the history and importance of heredity and indicate the significance of genetics in medicine, agriculture and ecology.

Major Learning Experiences

1. Students will be introduced to some of the terminology used in the science of genetics including terms associated with recombinant DNA (see GENETICS VOCABULARY list).

2. Students will become familiar with some of the principles of scientific investigation through discussion and by watching the videotape program SEARCH FOR SOLUTIONS, "Prediction, Modeling, and Theory."

3. Students will do brief independent research assignments on the role of genetics in a selected area of science, health, or technology. They will report on the implications that recent discoveries in genetics may have in these other areas.

References

THE SEARCH FOR SOLUTIONS, Phillips Petroleum Company.

GENETICS VOCABULARY

adenine
A-DNA
alleles
anaphase
anti-codon
Anti-parallel
autoradiography
Avery
B-DNA
centrioles
centromere
centromeres
Chi-squared Goodness of Fit Test
chromatids
chromatin
chromosome
codon
cytokinesis
cytoplasm
Cytosin
deoxyribonucleic acid
diploid
DNA
DNAse non-virulent
eukaryotes
exons
Okazaki fragments
operon
peptide

gametes
gametogenisis
genome
Griffith
guanine
haploid
Hershey and Chase
histones
homologous
homologu
hybird
hydroxal group
immunoglobulins
interphase
introns
meiosis
Mendal
Messelson and Stahl
methaphase
mitosis
mRNA
mutagen
Nobel Prize
nucleotide
(-OH) group
thymine
translocation
tRNA

phenotype
phosphodiester
polymerase
polypeptide
polysaccaheride
post-translational control
post-transcriptional control
Pribnow sequence
prokaryotes
prophase
protease
Punnett Square
purines
pyrimidines
radiolabeling
Recombinant DNA
reverse transriptase
ribosome
RNA
RNAse
rRNA
semi-conservative
somatic
telophase
uracil
Z-DNA

total of 177 words

UNIT 2: CHROMOSOMES & TRANSMISSION OF GENETIC INFORMATION

Objectives

Upon completion of this unit, students will understand the significance of reproduction in the perpetuation of life. They will be able to describe the role of chromosomes in genetic transmission and differentiate between mitotic division and meiotic division. They will describe DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) as carriers of the genetic code and outline classic experiments confirming the roles of DNA and RNA.

Major Learning Experiences

1. Students will observe and record patterns that exist between types of organisms and the number of chromosomes it carries.

2. Students will differentiate among viruses, prokaryotes and eukaryotes in terms of chromosomal number.

3. Students will complete worksheet exercises based on mitosis and meiosis. They will also prepare microscope slides of onion skin to observe cells undergoing mitosis.

4. Students will study the history of the discovery of DNA. They will read original source material describing this discovery. They will describe classic experiments (Avery, Griffith, McCleod, etc.) that provided evidence for the role of DNA in genetic transmission.

5. Students will become familiar with non-disjunction as an abnormal mitotic process and be able to decribe the results of non-disjunction.

6. Students will be able to differentiate between ALLELE and GENE and will be able to give examples of different alleles for a given trait.

References

Villee, J., et al. ANIMAL BIOLOGY.

Ayala, F. and Kiger, J. MODERN GENETICS.

Crick, F.H.C. "The Structure of the Hereditary Material." 1954, and others in GENETICS, Readings from Scientific American.

LECTURE NOTES (UNIT II)

EXPERIMENTS THAT LED TO PROOF OF DNA AS THE GENETIC MATERIAL

Griffith's Experiment

The medical condition of pneumonia is caused by a bacterium called pneumococcus. Two forms of this bacterium exist and they are called smooth (S) and rough (R) depending on the presence or absence of a slimy polysaccharide coat. The S strain of the virus is the one which produces a polysaccharide coat and is the virulent form of the virus (virulent means that it causes the disease state and eventual death if untreated). The fact that the S strin in virulent is because the slimy polysaccharide coat allows the bacterium to avoid the body's immune system and therefore be around long enough to cause an infection.

Griffith made a series of injections using these two forms of pneumococcus and found the results which are shown on page 20. Just looking at the drawings, what do you note that is unusual about step **d**? How might you explain what is happening here?

The unusual things is that the dead, virulent bacteria are somehow able to transform the living, non-virulent bacteria into living, virulent bacteria! In addition, the transformed bacteria produce progeny which are also virulent.

Griffith proposed that this observation was due to an as-yet-undiscovered "transformation factor." Fifteen years afater his obsevation, Avery, McLeod, and McCarth, isloated the transforming factor. They did this by making several pure extractions and testing to see which of these extraction would cause transformation. Let's look at how they did this.

Avery's Experiment

Avery and his colleagues showed that the isolated transformation factor was indeed DNA by using different types of enzymes. First, they used a simple protease. Proteases break up proteins thus makint them become inactive. Proteases have no effect on he actions of DNA or RNA. If the transforming factor was a protein, exposing it to a protease would greatly reduce or eliminate the factor's ability to transform cells. It did not--so the substance was not RNA. But when a DNAse was exposed to the transforming factor, a great reduction in the ability to transform was noted. Thus, the factor must contain DNA which is responsible at least in part, for the factors ability to transform.

OBSERVATION 5: What problem did Griffith run into in his work? How was the problem resolved?

Hershey and Chase's Experiment

Viruses are obligate intracellular parasite that have the ability to transform cells. The life cycle of a viarus (T2 virus) is shown on page one. A virus is made up of a protein coat which surrounds the viruses genetic materials (DNA or RNA). When a virus infects a cell, it injects its DNA into the cell. The protein coat wich houses the DNA doe s not enter the cell. Using this information, design an experiment that could be used to determine which part of the virus (the DNA, the protein or both) are needed to transform a cell.

UNIT 3: CHROMOSOMAL REARRANGEMENTS

Objectives

Upon completion of this unit, students will be able to describe the basic processes of chromosomal crossing-over. They will be able to use cross-over data to diagram simple cross-over models and manipulate genetic materials to provide evidence for crossing-over. They will be able to calculate the percentage of progeny that are produced through crossing over thus determining the order of genes on a chromosome.

Major Learning Experiences

1. Given data from hypothetical genetic crosses, students will construct genetic "maps".

2. Students will use ascomycete fungus SORDARIA to observe frequencies of cross-over.

3. Students will observe the videotape program from SEARCH FOR SOLUTIONS, "Evidence Pattern, and Investigation."

References

Ayala, F. and Kiger, J. MODERN GENETICS.

BSCS, BIOLOGY: A MOLECULAR APPROACH, 4th ed. D.C. Heath, 1980.

UNIT 4: MENDELIAN GENETICS

Objectives

Upon completion of this unit, students will be able to solve probability problems that involve two or more factors. Students will be able to define genetics terms appropriate to the study of Mendelian inheritance and will be able to solve problems involving one, two, and three pairs of alleles. Finally, they will be able to describe the "goodness of fit" test.

Major Learning Experiences

1. Students will conduct monohybrid experiments with the fruitfly DROSOPHILA MELANOGASTER. In addition to observing the difference in phenotype of the flies, students will learn to recognize differences between females and males.

2. Students will solve monohybrid and dihybrid genetics problems prepared by the instructors.

3. Refer to lecture notes on "Mendelian Genetics" and worksheet, "Segregation and Independent Assortment."

4. Students will read articles by Mendel and Crow reprinted from Scientific American.

References

BSCS, BIOLOGY: A MOLECULAR APPROACH 4th ed., D.C. Heath, 1980.

Mendel, G. "Experiments in Plant Hybridization", and Crow, J. "Genes That Violate Mendel's Rules", in GENETICS, published by Scientific American

LECTURE NOTES (UNIT IV)

MENDELIAN GENETICS

Law of Dominance

Mendel found that by controlling the process of pollination he obtained plants which were pure breeding. He found that when he crossed two plants which were each pure breeding for a different trait (say for example, white flowers and red flowers) that in the next generation of plants from this cross of pure breeders, one color would dominate over the other. The original plants that were crossed are called the parental generation and their progeny are referred to as the F_1 or first filial generation. Taht trait which is observed in the F_1 generation is said to be a dominant trait--that which is not is said to be a recessive trait.

As an example, say we cross a white flower plant with a red flower plant. When we look at the progeny we see that all the F_1 generation has red flowers. Red is the dominant trait and white is the recessive.

An allele is an alternate form of a gene. Every trait is represented by at least two alleles. If both alleles of a gene are recessive, the plant is described as homozygous recessive; if both alleles are dominant the plant is described as homozygous dominant. The plant may also have one of each allele, dominant and recessive, and is then described as heterozygous dominant. Only one allele must be dominant for the dominant trait to be expressed.

We can describe a plant by what it looks like, its phenotype, or in terms of its genetic constitution, its genotype. Different genotypes may produce the same phenotype since only one allele must be dominant to be expressed.

Law of Segregation

Each trait is represented by two alleles. The Law of Segregation states that in gametogenesis (the formation of gametes) the two alleles are separated and one allele goes to each gamete.

Law of Independent Assortment

This law simply means that int he formation of gametes, the distribution of each pair of genes into gametes is independent of the distribution of any other pair.

A MONOHYBRID CROSS

In a monohybrid cross we follow one trait through several generations and observe the phenotypes and genotypes that result.

Continuing our example of flower color let us say the capital letter **R** stands for red flowers and is dominant. The small letter **r** stands for white flowers and is recessive. A pure breeding red flowered plant will be homozygous dominant (**RR**) and a pure breding white flowered plant will be homoozygous recessive (**rr**). We analyze this cross using a Punnett square.

In using a Punnett Square, we list all the possible gametes of one parent along one side of the box, and all the possible gametes of the other parent on the adjacent side of the box.

		R	R	red flowered plants gametes (**RR**)
white flowered plants gametes (**rr**)	r	Rr	Rr	
	r	Rr	Rr	

We see that all of the plants in the F_1 generation have the exact same phenotype and the exact same genotype. All have the genotype **Rr** and since **R** is dominant, all have red flowers. They have the gene **r** for white flowers, but that gene is not expressed.

We can now take two of these F_1 progeny and cross them. We draw the Punnett square in the same way, listing the possible gametes on the adjacent sides of the box.

		R	R	red flowered plants gametes (RR)
white flowered plants gametes (rr)	r	Rr	Rr	
	r	Rr	Rr	

We see now in the F_2 (second filial) generation that we have three different genotypes (RR, Rr, and rr) and two different phenotypes. The two different phenotypes are inat he ratio of 3:1. We would expect that no matter how many F_2 progeny were produced we would observe a ration of three red flowered plants to one white flowered plant.

A DIHYBRID CROSS

Just as we were able to use a Punnett square to analyze what happens to one trait over several generations, we can use it to look at two different traits. In the same way we can look at three traits--a tri-hybrid cross.

OBSERVATION 7: Using a Punnett square predict what the genotypes and phenotypes of the F_1 generation would be in the following cross:

Plant One: **TtRR** (Tall with red flowers)
Plant Two: **ttRr** (Short with red flowers)

(If you would like, try creating a trihybrid cross on your own. Make up your own characteristics and symbols.)

UNIT 5: THE STRUCTURE AND FUNCTION OF DNA AND RNA

Objectives

Upon completion of this unit, students will be able to summarize the work of Watson and Crick that led to the discovery of the struture of the DNA molecule. Students will show how the Watson-Crick model met the requirements of chromosomal activity during mitosis and meiosis and will describe the significance of base sequence during DNA replication and protein synthesis. Students will describe and diagram the roles of m-RNA and t-RNA in protein synthesis and solve problems based on their understanding of the role of base sequence in replication and protein synthesis. Finally, students will show how the genetic code assures the genetic variability essential for evolution.

Major Learning Experiences

1. Students will complete assigned readings based on research in DNA and RNA modeling. They will be able to trace the steps involved in the discovery of DNA and apply these steps to the larger process of scientific investigation.

2. Students will participate in lecture-discussion sessions based on readings and problems about DNA and RNA structure and solve problems appropriate to understanding DNA and RNA structure.

3. Students should have the opportunity to manipulate models of DNA double helix noting important features of its design.

4. See lecture notes on "DNA Translation".

References

BSCS, BIOLOGICAL SCIENCE: A MOLECULAR APPROACH.

Curtis, Helena, BIOLOGY, Worth Publishers, N.Y.

LECTURE NOTES (UNIT V)

DNA TRANSLATION

The Genetic Code

Proteins, such a enzymes, histones, hemeglobin, and hormones like insulin are composed of amino acids connected in series with one another in a very specific arrangement. On the following page is a drawing of the series of amino acids, and the the order youm would find them in the enzyme lysozyme. (Lysozome is an enzyme which has the ability to kill bacteria by breaking them up. In humans it is found in tears).

We have seen that genes (portions of DNA) can forma mRNA which goes into the cytoplasm and somehow dictates that order of amino acids to form a protein. A problem exists how this is done. Since RNA only has for bases (what are they???) and their are 20 different amino acids, how might you speculate that this is done?

It was determined that this was done with a group of studies which I have summarized below. Synthetic mRNA's were constructed, combined with ribosomes, and the peptides formed from them were observed. Given the following examples of mRNA's and the observed peptides formed by them, how might you say that peptides are coded for by mRNA?

mRNA	Observed Product
UUUUUUUUUUUU	Phe-Phe-Phe-Phe
UAUAUAUAUAUA	Tyr-Ile-Tyr-Ile
UUAUUAUUAUUA	Leu-Leu-Leu-Leu
UUUAUUUAUUUA	Phe-Ile-Tyr-Leu

You can see from the above that the code is read in a triplet fashion with every three bases coding for one amino acid. From experiments like the above, scientists raced to determine which sets of bases coded for which amino acid. The result of all this was the formation of the genetic code. The table on the cover of your book shows this code.

Three bases in series on an mRNA that code for a particular amino acid are referred to as a codon. The codon pairs with an anti-codon on a tRNA molecule and thus dictates which amino acid is to be used next in the formation of a peptide.

DNA TRANSLATION

Formation of a peptide chain.

We can basically break down the events of the formation of a peptide chain into three major events: Initiation of the chain, Elongation of the chain, and termination of the chain.

Initiation. Initiation begins once the mRNA reaches the cytoplasm and comes in contact with a ribosome. Amino acids are brought to the complex via tRNA's and a peptide is begun. As soon as the ribosome begins to proceed down the mRNA another ribosome can be attached to the mRNA and another protein be begun. Many proteins are formed off of a single mRNA at the same time. The result of this is a "Christmas tree" structure which is visible using a light microscope.

Elongation. As the ribosome moves along the mRNA it does so reading the mRNA three bases at a time. A set of three bases is called a codon. We have already discussed this in the section on the genetic code. Each codon signals a tRNA to attach to the mRNA-ribosome complex. The tRNA has an anti-codon which is a compliment to the codon. It also has an amino aid attached to it, which it brings tot he comples, to be added to the growing peptide chain. So, ultimately, the codon in the tRNA's, be aded to the growing peptide. In this way, the mRNA dictates a specific sequence of amino acids to be linked to one another. Elongation continues until a "stop codon" is reached.

Termination. A stop codon is one which codes for no amino acid. When a stop codon is reached, no new amino acid is present to add to the growing peptide chain is released from the complex.

OBSERVATION 14: How is a peptide formed forma cell? Include in you answer a description of the genetic code and how it is used.

Some basic facts that I would like you to know about the genetic code are the following:

1. The code is triplet. We have seen that every amino acid is coded fo rby a series fo three bases and thus we say that the genetic code is triplet.

2. The code is degenerate. By this we mean that many of the twenty amino acids are coded for by more than one codon. For an example consider Lysine (Lys) which is coded for by the codons: AAA and AAG.

3. The code is non-overlapping. This means that in a series of bases on an mRNA, th code is read always using the same sets of three on a given piece of mRNA.

4. The code is universal. All organism interpret their DNA in the same manner. (e.g., UUU is Phe in humans, E. coli, etc.)

UNIT 6: MUTAGENESIS

Objectives

Upon completion of this unit, students will be able to describe mutations as changes in genetic material (DNA). They will be able to describe different kinds of mutations and will be able to show schemes for detecting mutations. They will be able to describe different mutagens (mutation-causing agents) in terms of effect, effectiveness, and source.

Major Learning Experiences

1. Students will complete assigned readings from biology textbooks and participate in lecture-discussion sessions about mutagenesis.

2. Students will consider the effects of ultraviolet rays, X-rays, and chemical mutagens on DNA and will consider the significance of mutagenesis to the process of evolution.

3. Students will identify the four main postulates of Darwin's theory of evolution, how it improved existing (Lamarckian) theory, understanding why radical theories as this become so controversial, and how genetics contributes to the process of evolution.

References

BSCS, BIOLOGICAL SCIENCES: A MOLECULAR APPROACH.

Otto, J. and Towle, A. MODERN BIOLOGY, Holt, Reinhart, and Winston, 1985.

Mayr, "Evolution", reprinted from GENETICS, published by Scientific American.

UNIT 7: TOPICS IN ADVANCED GENETICS

Objectives

Upon completion of this unit, students will be able to summarize techniques used for research in recombinant DNA and will be able to describe how gene expression is regulated in eukaryotes (introns and exons) and in prokaryotes (the lac-operon). Students will give examples of techniques used in population genetics and will be able to solve simple problems in population genetics including problems associated with horizontal and vertical evolution.

Major Learning Experiences

1. Students will complete assigned readings and problems and participate in lecture-discussion session about topics in advanced genetics including the functions of operons, repressor and regulator genes, and translocations.

2. Students will consider genetically caused diseases including Tay-Sachs disease, Down's Syndrome and Cri-du-Chat and the role of genetic research in diagnosing and treating such diseases.

3. Students will select a plant or animal and suggest one trait that could be improved by genetics.

4. Students will engage in moral discussions expressing their attitudes toward recombinant DNA research; the risk-benefit ratio controversy of, on the one hand, the potential advantages to mankind of this research and, on the other hand, the possibility of biohazards and the value judgements involved in altering life.

References

Grobstein, "The Recombinant-DNA Debate", and Fuchs, "Genetic Amniocentesis", from GENETICS, reprinted from Scientific American.

Unit III
ECOLOGY

INTRODUCTION

Historically, courses in ecology became incorporated into teaching programs in response to national concern for environmental quality. In the United States, environmental consciousness has had three peaks during this century. The first peak occurred between 1900 and 1910, reflecting President Theodore Roosevelt's enthusiasm for the outdoors. Textbooks began to stress conservation, especially of forests and wildlife, and children were taught to be responsible stewards of their natural domain. Three decades later, as an anguished nation in the throes of the Great Depression watched millions of acres of topsoil disappear during the dustbowls of the 1930's, schools began including instructional programs about soil and water management

Between 1940 and 1965, "conservation" evolved gradually into "ecology" in academic discussions and casual conversations. Rachel Carson"s 1962 bestseller SILENT SPRING, followed five years later by Paul Ehrlich's POPULATION BOMB, forced Americans to recognize that all living things are interrealted, and that there are serious environmental consequences for humans if they continue to regard themselves as something apart from nature. Thus, the third peak of environmental consciousness began in the 1960's and continues largely unabated today.

Ecology, until the 1960's taught in colleges and universities as a separate discipline of science, became recognized as appropriate--even essential--for inclusion in all levels of scientific instruction. Elementary students began analyzing water and soil, studying population densities of dandelions, and learning about endangered species. High school students studied the physical and chemical properties of air, soil, and water, and calculated the growth rates of populations. Today, almost every high school textbook has a unit about fundamental ecological principles. Indeed, ecology is the unifying theme of several high school textbooks, most notably, the Green Version of the Biological Sciences Curriculum Study, first published in 1963. Thus, a unit in ecology is an important and appropriate component for study by academically able junior high school age students.

There are three goals of this ecology unit. They are:

1. To introduce students to ecology and the scientific principles that underlie it.

2. To develop within students a familiarity with the processes of science.

3. To give students a basic understanding of how human activity affects the natural environment.

This unit is organized in 9 topics. Each one is designed to provide investigative learning experiences and includes suggested learning objectives, major learning experiences, and evaluation procedures. Specific topics are:

1. Introduction unit
2. The process of scientific investigation
3. The physical environment
4. The biological environment and energy flow
5. Laboratory techniques
6. Biogeochemical cycles
7. Communities and population dynamics
8. The interaction of organisms
9. Territoriality, habitat, and niches

Teachers are encouraged to modify and supplement these materials according to the unique needs and characteristics of their learners. Teachers are also encouraged to consider providing the opportuntity for students to complete a research proposal as a concluding activity (following the included guidelines). It is suggested that this proposal address a relevant topic and act as a further inquiry-oriented learning experience and source of evaluation. Finally, if possible, students should be exposed as much as possible to the actual scientific environment. Trips to area laboratories, films (particularly, the SEARCH FOR SOLUTIONS series from the Phillips Petroleum Company), and direct interaction with members of the scientific community are strongly recommended.

Students are also expected to maintain an "ecological interaction diary". This journal should act as a focus for processes of scientific observation, data collection, analysis, and evaluation. Teachers are encouraged to require frequent, inquiry-based, field assignments and regularly check student entries.

The basic textbook suggested for this unit is ECOLOGY AND FIELD BIOLOGY by Roger L. Lederer (Benjamin/Cummings, 1984). Additional recommended readings are noted at appropriate places throughout the unit and a list of selected references is included at the end.

UNIT 1: INTRODUCTION

Objectives

Students will develop an awareness of their attitudes toward the environment.

Major Learning Experiences

1) Students are asked to respond to a list of environmental and ecological terms. Terms include dioxin, Greenpeace, Superfund, California condor, Three-Mile Island, toxic substances, symbiosis, carrying capacity, succession, and niche. Students discuss which terms are "ecological" and which are "environmental" as they attempt to develop definitions for both categories.

2) Students are asked to begin an "ecological interaction diary" where they observe a plant, patch of grass, etc. over a two week period making careful records of their observations and interpretations of events and changes. This is intended to exercise their powers of observation and hypothesis formation as well as sensitizing them to their environment.

3) Students will read "Ecosystems: A Summary." (see appendix)

Evaluation

Students are given a biodot (a small, temperature-sensitive disk that exhibits distinct color changes within a narrow temperature range; 87-95 degrees Fahrenheit.) Disks are attached by adhesive backings to the crease between each student's thumb and forefinger. Students are not told how the biodots will react, but are instructed to take careful notes on whatever they observe during the next 24 hours. Students are to record changes that occur and provide explanations.

References

Hungerford, Harold and Peyton, R. TEACHING ENVIRONMENTAL EDUCATION. Portland, Maine, Welch, 1976.

UNIT 2: THE PROCESS OF SCIENTIFIC INVESTIGATION

Objectives

After completing this unit, students will be able to define the process of scientific investigation, including statements of problem, hypothesis, experimental evidence, and conclusion. Students will recognize that scientific theories are not statements of facts, but that they explain facts. Finally, students will develop a sense of the impact of the scientific process and scientific progress on their lives.

Major Learning Experiences

1) Students will observe the demonstration of the implantation of corn seed in a ball of Plaster-of-Paris. Students will predict what will happen, and observe and record what actually does happen five days later.

2) Students will learn how to construct and use a dichotomous key. Students will be given examples of different leaves to use in the construction of a key.

3) Students will watch the first program of SEARCH FOR SOLUTIONS focusing on evidence, patterns, and investigation.

4) Students will continue observations for ecological interaction diary begun earlier.

Evaluation

5) Students will set up a "mini-ecosystem" from hay infusion medium and samples of pond water. Detailed observations of developments, statements of hypotheses, evidence, and conclusions should be recorded.

References

Beveridge, W.I.B. THE ART OF SCIENTIFIC INVESTIGATION, N.Y., Vintage Books, 1950.

Mayer, William, V. ed. BIOLOGY TEACHERS' HANDBOOK, N.Y., John Wiley and Sons, 1978.

THE SEARCH FOR SOLUTIONS, sponsored by PHILLIPS PETROLEUM COMP.

UNIT 3: THE PHYSICAL ENVIRONMENT

Objectives

Upon completion of this unit, students will be able to describe the significance of abiotic and biotic factors in the environment. These factors include light, temperature, water, gases, minerals, fire, and soil. In addition, students will be able to use scientific techniques to measure physical and chemical properties of soil and water.

Major Learning Experiences

1) Students will read chapter 1, "The Bases of Ecology and the Physical Environment" in the textbook for the course, ECOLOGY AND FIELD BIOLOGY, by Roger Lederer (Benjamin/Cummings, 1984).

2) Students will explore their immediate school or home environment to test properties of soil, including pH and water-holding capabilities in order to draw conclusions regarding soil characteristics.

3) Students will investigate current research in monitoring environmental pollution. They will identify sources of pollution and develop measures, based on new technology, for the reduction of various pollution forms.

Evaluation

4) Students will complete an exercise based on a hypothetical situation where water is diverted from the Great Lakes to arid regions of the central plain states. Students will consider the impact of such a project and its effect on the overall water budget of the Unites States and on national politics.

References

Lederer, Roger, J. ECOLOGY AND FIELD BIOLOGY. Menlo Park, Ca. Benjamin/Cummings, 1984.

Richard, Paul, W. BIOLOGICAL ENVIRONMENTAL PICTORIAL INVESTIGATIONS. Greeley Colorado, Stonecrop Publications, 1976.

UNIT 4: THE BIOLOGICAL ENVIRONMENT AND ENERGY FLOW

Objectives

Upon completion of this unit, students will be able to describe the processes of energy flow through the biological environment, define and give examples of trophic levels within an ecosystem, compare and contrast food chains and food webs, and summarize energy efficiencies in a typical ecological pyramid.

Major Learning Experiences

1) Students will read chapter 2, "The Biological Environment and Energy Flow" in the text, ECOLOGY AND FIELD BIOLOGY.

2) Students will pick apart an owl pellet, purchased from a laboratory supply company, and construct a skeleton from the bones within. This exercise is good not only for leaning about trophic levels, but also about predator-prey interactions as described in chapter 10 of the text.

3) Students should be given the opportunity to visit a neighborhood nature center or forest preserve in order to perform an informal ecological survey.

Evaluation

4) Students will collect samples of animal and plant life through their ecological survey of nature center, forest preserve, or school grounds. They will record their findings, perform classifications, and then diagram an energy pyramid based on their observations.

References

Text, ECOLOGY AND FIELD BIOLOGY.

UNIT 5: LABORATORY TECHNIQUES

NOTE: This unit can only be assigned when access to microscopes is possible. In situations where this cannot take place, a substitute technique based experience should be provided.

Objectives

Upon completion of this unit, students will be able to use compound and dissecting microscopes to observe living and non living objects. Also, they will be able to construct line graphs and histograms from scientific data.

Major Learning Experiences

1) Students will become familiar with the parts of a compound microscope and will be able to use it to observe living and non-living objects. They will also learn appropriate techniques fro micrescope care. The exercise used by the students will be The Compound Microscope" from the lab manual BIOLOGY, by George Zahrobsky (Addison-Wesley, 1984).

2) Students will complete an exercise on graphing, from the lab manual mentioned above. This exercise will develop skills in constructing line graphs and histograms.

Evaluation

3) Students will demonstrate mastery with the microscope by obtaining specimens, preparing slides, observing and diagraming matter.

References

Laboratory text: Zahrobsky, George, BIOLOGY. Menlo Park, Ca. Addison-Wesley, 1984.

UNIT 6: BIOGEOCHEMICAL CYCLES

Objectives

Upon completion of this unit, students will be able to describe important cycles of the biosphere, including the water, the oxygen-carbon cycle, and mineral and nutrient cycles. Students will be able to give examples of how human activities have affected natural cycl. . Included will be the phenomenon of biological magnification, where non-biodegradable substances such as DDT, lead, and mercury become concentrated as they pass through the ecological food chains, often resulting in infertility or death in animals at the top of the chain.

Major Learning Experiences

1) Students will read chapter 3, "Biogeochemical Cycles" in the text.

2) Students will complete the "Invitation to Enquiry" exercise "Use of Pesticides" from the BIOLOGY TEACHER'S HANDBOOK, (William Mayer, Ed. John Wiley and Sons, 1978).

3) Students will diagram the gaseous cycle, hydrologic, and sedimentary cycles.

Evaluation

4) Students will demonstrate understanding of biogeochemical cycles by describing how all three are related. They will provide an element or compound and describe how it participates in all three cycles.

5) Students will find evidence of the effect of human activities on natural cycles in their immediate area (acid rain, pesticides, etc.) and describe the nature of the effect, role in the cycle, and implications.

References

Text: ECOLOGY AND FIELD BIOLOGY.

UNIT 7: COMMUNITIES AND POPULATION DYNAMICS

Objectives

Upon completion of this unit, students will be able to describe and give examples of ecological succession, evolution, and climax. Students will be able to compare and contrast major biomes of the world, and will summarize ways in which human activity has interfered with natural ecosystems. Students will also be able to define population in terms of density, reproductive rate, and growth potential, and will be able to plot data on arithmetic and logarithmic graph paper.

Major Learning Experiences

1) Students will read chapters 8 and 9 in the text.

2) Students will prepare charts and diagrams of different biomes and ecosystems

3) Students should visit a quarry to provide examples of primary bare-rock successions, diverse ecological communities.

4) Students will observe the film, POPULATION ECOLOGY available through Michigan Department of Natural Resources, illustrating population growth and factors that affect population growth.

Evaluation

Using data from a hypothetical population of sparrows, students will plot data arithmetically and logarithmically, thus determining the reproductive potential of a population.

Students will conduct a census of a common plant, such as a dandelion, on the school grounds. Then, using metric measurement, students will determine the density of the plant per unit area.

References

Text: ECOLOGY AND FIELD BIOLOGY, Lederer, Roger, J.

BIOLOGICAL SCIENCES: AN ECOLOGICAL APPROACH. 3rd edition BSCS, Chicago, Rand McNally, 1973.

POPULATION ECOLOGY. Film available from the Mich. Dept. Nat. Resources.

UNIT 8: THE INTERACTION OF ORGANISMS

Objectives

Upon completion of this unit, students will be able to describe various ways in which organisms interact with each other. These include two-species interactions, competitions, symbioses (and evolutionary implications of symbiosis), and animal grouping.

Major Learning Experiences

1) Students will read chapter 10 in the text and answer questions at the end of the chapter.

2) Students will observe parts two and three of the educational film, SEARCH FOR SOLUTIONS. These include the segments "Prediction, Modeling, and Theory," and "Adaptation, Trial and Error, and Context." Also, students should, at this time, be encouraged to give further thought to the development of an original respearch proposal or project.

3) Students will continue observing their "mini-ecosystems" established at the beginning of the course. By now various populations will have increased in number and possibly begun distinct stages in ecological succession.

Evaluation

Students will develop models for interaction of species. For example, three hominids, AUSTRALOPITHECUS ROBUSTUS, A. AFRICANUS, and HOMO HABILIS lived in what is now Africa for about one million years. What were possible causes of the extinction of these species and why is it likely that HOMO HABILIS was the direct ancestor of modern man? These models will provide a basis for understanding Gause's Law also known as the "Principle of Competitive Exclusion."

References

Text, ECOLOGY AND FIELD BIOLOGY

Film series, SEARCH FOR SOLUTIONS

UNIT 9: TERRITORIALITY, HABITAT, AND NICHES

Objective

Upon completion of this unit, students will be able to describe the ecological significance of territory, to differentiate between habitat and niche, and compare and contrast the long-term stabilities of various types of ecosystems. Finally, students use their understanding of ecological principles to predict the effects of human activity on various world ecosystems.

Major Learning Experiences

1) Students will read chapter 11 in the text.

2) Students will complete and turn in the skeletons constructed from the bones found in the owl pellet.

3) Students will examine and report on the effects of human intereference on natural ecosystems.

4) Students will engage in various, teacher prepared, values-related activities about the relationship of humans to the world's ecosystems.

5) Students will read and discuss the short story WEEDS, by Rick DeMarinis, a fictional account of the effects of indiscriminate spraying with a potent weed-killing chemical.

6) Students should be given the opportunity to visit laboratories, forest preserves, fisheries, etc. and interact with ecologists and biologists as they conduct the processes of scientific investigation.

Evaluation

It is suggested that some summative evaluation on the major themes and concepts of the overall unit be performed. The nature of this evaluation should be determined by the teacher based on the unique needs and characteristics of the particular learners. Student presentations of original research findings (either in the research proposal or "mini-ecosystem" experience) might be considered.

References

Text; ECOLOGY AND FIELD BIOLOGY.

WEEDS, By Rick DeMarinis.

Unit IV. SPACE TRAVEL

Introduction to Unit:

A. Scope and Sequence to be presented:

I. History of Our Conception of the Cosmos

-Ancient Greek and Babylonian Perceptions.

-Stonehenge.

-Medieval Astrology. Invention of the telescope.

-Galileo and the Copernican Revolution.

Growth of Modern Astronomy through bigger and better telescopes and space probes.

II. Man's Dream to Fly

-Early Myths: Daedalus; Bellerophon; Skidbladnir, the magic ship of the Norse god Frey, that could sail over land or sea.

-Jules Verne's visions of flying and space travel. Hermann Oberth's <u>The Rocket into Interplanetary Space</u>.

Invention and early uses of the airplane.

III. Time and Distances in Space

-Measuring distances in space (experiment)

-The question of Destinations:

Calculate how long it will take to go to the moon at presently attainable speeds. The planets?

The closest star?

How fast would a spaceship have to travel to reach the closest star within the lifetime of a human being?

IV. Rocketry

-History: Chinese rockets to Goddard and Von Braum

-Streamlining and Rocket Design (Experiment)

-Powering a Spaceship

To escape Earth's gravitational pull

In Space

The problem of fuel weight

V. The Problems of Living in Space

-Cosmic Rays; Meteors

-Temperature Control (experiment: how color changes an object's ability to absorb or reflect heat)

-Pressure in Space (experiment: differences between internal vs external pressure)

-Gravity (experiment: Using centrifugal force to simulate gravitational force)

-Problems of Vertigo due to weightlessness

-Sources of Food and Water

-Mental Strain of Spending Long Periods in Cramped Quarters

VI. Unmanned Space Probes

-Above the Earth's atmosphere

-To the Moon

-To Venus and Mars

-Voyager II's close encounters with Jupiter and Saturn

-Prospects for the Future

VII. Manned Space Missions

-Orbiting the Earth

-Landing on the Moon

-The Space Shuttle

-Skylab

-Future Space Travel

VIII. Space Age Technology

-Monitoring Space Probes from Earth

-Controlling Space Probes from Earth

-Calculating Speed, Direction, and Power: Everything is Relative

-Back-up Systems

-Trouble-Shooting when things go wrong

-Earth-bound Uses for Space Technology

IX. Do Sentient Extra-Terrestrial Creatures Exist?

-Conditions Necessary for Intelligent Life

-Probabilities for these Conditions Being Met

-Our Attempts to Contact and Communicate with E.T.'s

B. Key Materials to be Used:

<u>Man and the Cosmos</u> by Gerald E. Tauber. Greenwich House, New York, 1979. 352 pp.

This large and far reaching book covers the history of man's view of the Cosmos from the beginnings of recorded history through the present. It is concerned not only with scientific developments but also with how these developments have structured man's view of himself and the world. Beginning with ancient Greek and Egyptian geometry and astronomy, we are led through the ancient understanding of the earth as a flat universe through Medieval astrology and Arab astronomy, and finally the birth of modern astronomy in Europe with the Copernican Revolution. The invention of the telescope in the 17th century and the new perception of a round earth not at the center of the universe, but revolving around the sun introduced a new world order, fiercely opposed by the politically powerful Catholic Church. The author continues to trace the development of astronomy through the 20th century theories of relativity, quantum mechanics and the life and death of stars. He discusses the growth of modern technologies such as the radio telescope and space travel and the latest discoveries from recent findings of interplanetary space missions to the discovery of residual radiation from the Big Bang.

Valuable as a reference book, and a readable historical account. An excellent source of report material. Good source of information for Chapters I-III.

Experiments in the Principles of Space Travel by Franklyn M. Branley. Thomas Y. Crowell Co., New York, 1973. 113 pp.

This book discusses the basic laws of science that must underly rocket research and development as well as space travel. Experiments and activities are described using easily obtainable household materials to demonstrate these laws clearly and graphically. Branley then shows how man can make these laws work for him instead of against him in the exploration of space. He discusses how to measure distances in space, design of rockets, how space ships are posered, temperaturo control, and the force of gravity. Each discussion is accompanied by experiments and demonstrations that the students can do themselves to gain a better understanding of the problems involved in space travel and exploration.

The experiments indicated in Chapters III-V are described in this book. They can either be done as a class or as student or teacher demonstrations.

Any of a number of books can be used for material for Chapters VI-VIII, particularly the following, all described in the list of Suggested Readings:

Man's Reach for the Stars by Roy A. Gallant, 1971.

Space: The Story of Man's Greatest Feat of Exploration by Patrick Moore, 1969.

Man's Conquest of Space by William R. Shelton, 1975.

History of NASA: America's Voyage to the Stars by E. John and Nancy Dewaard, 1984.

Major Learning Objectives:

The object of this unit is for students to gain an awareness of the problems and complexities involved in space travel and how modern technology has dealt with them. Students should see how advances in space research and computer technology have built upon and accelerated one another, and how the technological by-products of space research have affected the way we live our daily lives here on Earth.

Major Learning Experiences:

1) Have each child read one science fiction book or story involving space travel and discuss how realistic or unrealistic the book is, given what we now know about outer space and space travel.

2) Prior to the beginning of the unit, distribute the outline of the unit, above, and have each student choose one subject in the outline as a report topic. The student will be in charge of experiments, demonstrations, and lecture material for that topic. Reports will be presented in the order given in the outline, with the

instructor covering all material not chosen for a report. Presentations will be judged by the students on clarity, depth, and scope of coverage. Source material for the presentations is given in the list of Suggested Readings below.

3) Introduce the following subjects and questions for class discussion:

How has our growing understanding of the universe affected Man's view of himself and his Universe?

The U.S. Space Program: Government Funded Research in a Democratic Society:

How have different administrations affected the Space Program?

What effect does a democratic system of making funding decisions have on long-term research?

How do funding cuts determined by the Congress affect the quality and safety of our Space Program?

Must scientific goals take a second place to "Public Relations" goals?

How will the fate of the Space Shuttle Challenger affect the launching of the first Space Telescope?

Can some space research be carried out by the private sector, and is this desirable?

How have the by-products of Space Research affected our daily lives?

eg. Weather forecasting, Mapping, Cooking, Clothing, Television, Information Management (the miniaturization necessary to reduce weight in space ships led to the invention and development of the electronic computer chip, which in turn led to the possibility of powerful personal computers)

4) Hold a debate, with students taking positions pro and con on:

A. U.S. vs U.S.S.R. System of Space Research

B. Is there intelligent life on other planets?

5) If possible, arrange a trip to a local planetarium or museum featuring an exhibit of advances in Space Travel or Space-Age Technology.

Evaluation Procedures:

A. Pre test

How clear an understanding is demonstrated by the student's perception of the possibilities or impossibilities presented in the chosen Science Fiction work?

B. Post test

Have the class as a whole evaluate each student's presentation based on the difficulty of the material and the clarity with which it is presented.

Space Travel: Suggested Readings

<u>Man's Reach for the Stars</u> by Roy A. Gallant. Doubleday and Co., Inc., Garden City, N.Y., 1971. 201 pp.

In easy to read text, Gallant discusses the challenges of aerospace travel to both man's mind and body. He presents the problems of zero gravity, high speed and zero atmospheric pressure and the technology necessary to overcome such obstacles to simulate a livable environment for man in space.

The book chronicles the progress in space medicine and engineering that enabled us to put a man on the moon. He speculates about future accomplishments such as manned space probes of the planets and the eventual possibility of traveling beyond our solar system to the stars. Clear explanations and good illustrations.

Space: The Story of Man's Greatest Feat of Exploration by Patrick Moore. The Natural History Press, Garden City, N.Y., 1969. 216 pp.

This is a dated but nevertheless very good history of rocketry and the attempts to conquer space up through 1968. It discusses the problems that had to be solved in creating rockets that could escape the earth's atmosphere and eventually carry a man into space. It covers the development of space travel from the German war rockets of Peenemunde through the first space walks, landing a man on the moon and unmanned probes to study Venus and Mars.

Man's Conquest of Space by William R. Shelton. National Geographic Society, Washington D.C. 1975. 199 pp.

This book treats of the dream of space travel from a notion of fantasy through the history of the space industry, overcoming the problems of weightlessness and airlessness, to photographing the cosmos and finally reaching the moon. A final chapter on the promise of space discusses possibilities for the future. The best things about this book are the photographs and illustrations and the interviewer narrative which are done in the familiar National Geographic style.

Voyager: The Story of a Space Mission by Margaret Poynter and Arthur L. Lane. Atheneum, New York, 1981. 152 pp.

This is an easy to read narrative about the story behind the unmanned Voyager space mission to Jupiter and the planets beyond. It describes the intricate planning that went on before the two space craft were designed, how the scientists, eager to collect information from space cooperated with the engineers and computer experts to design the spacecraft and equip them with the necessary measuring, recording and scanning devices as well as communications instruments necessary to send the information back to Earth. The book makes interesting and exciting reading, so that the student hardly realizes how much he is learning as he continues reading to see how things will turn out.

Your Career in the Aerospace Industry by Waldo T. Boyd. Julian Messner, New York, 1966. 236 pp.

This is an out of date but historically interesting account of the types of jobs (and salaries!) available in the aerospace industry in 1966 at the height of the Space Race.

The Uses of Space by Ben Bova. Holt, Rinehart and Winston, New York, 1965. 144 pp.

This interesting little book was written at a time when NASA was experiencing a flush of growth and optimism, as the U.S. geared up to put a man on the moon by the end of the decade. Already many by-products of space research were hitting the market and many more were expected to follow. The author, a prolific writer of science fiction as well as science fact books, speculates on the potentials of a moon-based space station for a medical haven, an electronics center, and as a prime base for interplanetary flights. He discusses the possibilities of Mars one day sheltering some of Earth's overflowing population, how Venus may offer an extensive source of oil(!), and how Mercury may provide a location for high and low temperature laboratories.

It must be remembered that this book was written before unmanned probes had been sent to any of the planets, and that much of what Bova assumes about them has since been disproven. (For instance, Bova confidently asserts, "There is apparently life on Mars.", and goes on to tell of how we can change the atmosphere of Venus so that it can one day support life forms imported from Earth.) This is, nevertheless, a very interesting book, as long as facts are checked against more recent data.

Workshops in Space by Ben Bova, E.P. Dutton & Co., Inc., New York, 1974. 67 pp.

This book, by the same author as The Uses of Space, above, was written almost 10 years later, and after the moon landing. In it, Bova discusses the future of the American space program at the time just after the Apollo 17 mission to the moon. Many were tired of the space program, feeling that it was very costly and that its goals had been accomplished. Bova argues that the real effort is just beginning. As Phase II opens, he looks forward to 4 major workshop type efforts that were underway at that time: Skylab; the Earth Resources Satellites; the joint Apollo-Soyuz mission; and the Space Shuttle. These orbiting workshops would attack problems of polution, natural resources, weather forecasting and much more. Very readable, a view of the space effort through the eyes of a science fiction writer.

Skylab by William J. Cromie. David McKay Co., Inc., New York, 1976. 146 pp.

This book discusses the experiments that were carried out during 172 days of work in space by the astronauts who were part of the Skylab project. The author is a freelance and newspaper column writer whose job it was to cover the manned space flight missions between 1964-74, and so the book is written from the perspective of someone who knew the astronauts personally and was well acquainted with the space program. He discusses how the information gathered during the Skylab project will help predict weather, crop failures, control floods and draughts and find new sources of oil, minerals and seafoods. Cromie is particularly interested in conveying to children something of the wonder of space exploration. He includes in his narrative the experiments that were created by high school students who won a nationwide contest for designing projects to be done aboard man's first home in space. These included a search for a new planet, an experiment to test the predictability of volcanic eruptions and how spiders spin webs in a weightless environment. He speaks also of the problems that plagued the missions--sickness, human error, equipment breakdown and accidents, and how the astronauts solved the problems and performed beyond all expectations. It is a well-written and engaging first-hand account of the skylab missions with documentary photographs. Highly recommended.

Skylab by Charles Coombs. William Morrow & Co., New York, 1972. 128 pp.

This book is written on a much more elementary level than that by the same name, above. It is illustrated with drawings based on Skylab models rather than photographs of the real thing. The text is much more general, having been written before the actual launch of the first Skylab mission, while the mission was still in the planning stages. Not nearly as interesting as Skylab by Cromie.

The Promise of Space by Arthur C. Clarke. Harper & Row, Evanston, 1968. 325 pp.

This book, written by the well-known science fiction author of 2001: A Space Odyssey, is an engrossing look into the future from a time when America's space effort still centered around landing a man on the moon. Clarke's inventive mind, like that of Jules Verne, envisions things that now, almost 20 years later, we know have taken place. Clarke tells of the early successes of the space program and then goes on to relate the promise that the future holds for space travel, space exploration and living on other moons and planets. His is informed speculation, based on facts and an understanding of the technological advances necessary, but also on a strong belief in man's curiosity and inventiveness. He deals not only with technicalities, but also with the effects of space colonization on man's artistic and aesthetic nature. Advanced reading level.

Into Space by Arthur C. Clarke and Robert Silverberg. Harper & Row, Evanston, 1954, revised 1971. 129 pp.

This book covers the history of rocket development, the launching of the satellites, a step-by step account of manned space flight and finally the great achievement of landing a man on the moon. Then the future of space exploration is discussed: the possible uses of space stations; scientific work that can be done in space; interplanetary travel and what may be found on the planets in our solar system; and finally interstellar trips.

Man's aims and purposes in exploring space are realistically appraised and sound suggestions are given to young readers interested in taking part in future space programs. Intermediate reading level. Interesting and solid account of the U.S. Space Program up to 1971.

Space Science and You by Frank Ross, Jr. Lothrop, Lee and Shephard Co., New York, 1970. 190 pp.

This book discusses the contributions of the U.S. space program to earth-bound man in many areas of endeavor. Varied fields such as communications, meteorology, medicine, education, navagation, geology and industry have all profitted enormously from the space industry. Wheel chairs that walk without wheels, new tools, alloys and techniques for industry, and satellites that gather information on the Earth's weather or its mineral, vegetable or water resources are just a few examples of the useful products of space research. The book is written at an intermediate level in an interesting style, and is illustrated with photographs of space age technological inventions. Excellent source for report material.

History of NASA: America's Voyage to the Stars by E. John and Nancy Dewaard. Exeter Books, New York, 1984. 192 pp.

This large book discusses the history of NASA, with a concentration on the men and women, astronauts and ground personnel who accomplished the various manned space missions from the Project Mercury (first man in space) through the early missions of the Space Shuttle. There are many large photographs of the various space craft, astronauts and views from space. Written at an intermediate to advanced level. Excellent source for report material.

Periodicals:

Bulletin of the Atomic Scientists

Discover

Popular Science

Science 19-- (1981-1986 and following years)

Science Digest

Science News

Scientific American

Space World

UNIT V. ELECTRONICS

Introduction to Unit:

A. Scope and Sequence to be presented:

I. Electrons and Static Electricity

-The electron. Collecting electrons by friction.
-Demonstrations of Static Electricity.
-Electroscopes. Building The Van de Graaff Generator.

II. Storing Electricity

- Capacitors. How to alter their capacity. Making a fixed capacitor. Commercial capacitors.

III. Electrons in Motion

-Simple circuits. Making an electromagnet. Testing an electromagnet. Uses of magnetic fields. Making ammeters, voltmeters, milliammeters, relays, buzzers and electric motors. Measuring the horsepower of an electric motor.

IV. Retarding Electrons

-Resistors. The Color code. Ohm's Law. Uses of Ohm's Law. The milliammeter used as a voltmeter. Extending the range of a milliammeter. The potentiometer. Resistors in series and in parallel. The ohmmeter.

V. Electrons Moving To and Fro

Alternating currents. Generating alternating currents with magnetic fields. Magnetic brakes. Making an A.C. generator. Uses of a toy motor. Making transformers, A.C. vibrators and A.C motors.

VI. Chokes, Capacitors and Resonant Circuits

-The resistance effect of (a) coils, (b) capacitors, (c) coils and capacitors. Resonance. To set up a resonant circuit. To transmit electrical oscillations. The cathode ray tube.

VII. Transistor Circuits

-Transistors. To make a unit for testing transistors. A simple telephone circuit. To generate Morse signals. A radio receiver using a diode. To amplify the output of the diode receiver. To build a three-transistor receiver. The phototransistor. To make a toy organ.

VIII. Silicon Chips

-The invention and uses of microchips. Microchips in digital watches, mini-computers, calculators, robots, heart pacemakers and military weaponry.

B. Key Materials to be Used:

<u>Transistors and Circuits: Electronics for Young Experimenters</u> by W. E. Pearce and Aaron E. Klein. Doubleday & Co., Inc., New York, 1971.

This is a practical book of electronics experiments that can be done by the young scientist without elaborate or expensive equipment. The student learns about electronics incidentally by working through the experiments and experiencing the thrill of creating electrical machines that really work. The outline above is taken from this book, and the book is recommended as a text for the unit. It is recommended that the class work through as many of the projects and experiments as time allows.

The instructions for building the Van De Graaff Generator (section I above) are in Science Projects with Electrons and Computers by Alfred Bender, Arco Publishing Co. Inc., New York, 1977. paperback, 139 pp.

Information for the final chapter can be found in Miracle Chip: The Microelectronic Revolution by Stanley L. Englebardt, or in The Magic Chip: Exploring Microelectronics by Frank Ross, Jr., or in journal or magazine articles.

Students will be asked to find and bring to class a discarded transistor radio, stereo amplifier or other electronic device. This will be used throughout the course to demonstrate what electronic circuitry looks like, to identify components of electronic circuitry, and as an inexpensive source of parts for their own projects (to be tested first, using the skills and materials developed in chapters III and IV above).

Background Narrative:

Students will learn the basic concepts of electricity, beginning with static electricity, and then the storage of electricity, and the construction of simple circuits. They will learn about capacitors and resistors and how to measure the electric potential across points in a circuit. They will see how an electric motor and an A.C. generator are made and how they work, and finally how transistors work in a circuit. Finally, they will see how silicon microchips have only recently revolutionized the entire field of electronics by allowing a degree of miniaturization never before dreamed of. The Unit is very much a "hands on" experience, where students learn by making as well as simply reading about the various components and electronic devices that they are studying. The excitement of making things themselves will lead the students to a higher and more meaningful level of learning than mere reading about and being tested on the material.

With the recent development of the silicon chip the electronics industry has experienced a huge growth spurt in terms of miniaturization of many electronic devices and an enormous increase in power, particularly in terms of computer speed, accuracy and memory storage space.

The impact of recent technological advances on our daily personal lives will be discussed as well as their impact in greater matters, such as Space Travel, Star Wars, World Economy and the computerization of information on the entire populace of whole nations.

Major Learning Objectives:

The object of this unit is to stimulate interest on the part of the student in the field of electronics. Upon completion of the course students should have some understanding of how electricity works, what the basic components of electronic circuitry are and what they do, and how we use electronic devices in our daily lives. Some understanding of the impact of electronic technology on our present and future lives should also be gained. The student will also learn how he can continue to learn about electronics on his own should he desire to do so.

Major Learning Experiences:

1) Two weeks prior to the beginning of the unit students will be asked to find and bring to class a discarded radio, stereo amplifier or other electronic device to examine on the first day of the unit on electronics. [NOTE: Students should not bring discarded television sets unless there is someone who is knowledgeable about electronics available to discharge the electrical charge on the picture tube. This charge is sufficiently great to cause a serious shock or burn if the tube is inadvertently touched without having been discharged.]

On the first day of the unit, divide the students into groups so that each group has an electronic device to examine. [Do not allow the students to plug their devices into an electrical outlet!] Have the students unscrew the chassis of their device so as to expose the wiring and circuitry. Then have each student write down as many components of their electronic device as they can. Next, have the class compare lists and see how many components the class as a whole can name and how many they know the function of.

After the material in each chapter is covered, have students return to their electronic device and see if they can find and isolate each of the components covered on that chapter. Have students test resistors found in their devices both singly and in series. Does the resistance measured correspond to that indicated by the color code on the resistors? (Refer to Appendix II in Pearce and Klein, The color code.) After learning about capacitors in chapter VI, have them isolate and test the resistance effect of capacitors found in their device. Similarly, have them test transistors following their introduction in chapter VII.

2) Assign the book Transistors and Circuits: Electronics for Young Experimenters by W. E. Pearce and Aaron E. Klein to be read by the class. Assign each chapter prior to covering the material in class. If this book is not available, an alternative text is Science Projects with Electrons and Computers by Alfred Bender.

3) Class project: Have the class build and experiment with the Van De Graaff Generator described in Science Projects with Electrons and Computers.

4) Individual Projects: Each student should choose between:

a) Preparing a written report on some electronic device or component, based on library research using at least 5 sources, including encyclopedias, books and magazines about science, electronics, or technology listed at the end of the Suggested Reading list, or

b) Building an electronic device using a kit or instructions from a book or magazine such as those listed in Suggested Readings. Students who build projects must present them to the rest of the class at the end of the unit, and explain how they work and what they do. Projects must be approved by the teacher and must be of sufficient complexity to require an amount of work equivalent to that needed to do the written report, but sufficiently simple that the student can actually complete them in the amount of time allotted.

5) Invite someone from the community who works in electronics to visit the class and tell about the kind of work he does

and the kinds of jobs that are available in the field of electronics and electrical engineering.

Where to look for such a person:

Radio-T.V Repair Men (or women)

Auto Parts Proprietors

Electricians

Ham Radio Operators

Hardware proprietors (that sell and/or repair appliances)

Agricultural Extension Agents

Hobbyists

Rock Band Technicians (not rock band musicians)

6) Discussion:

What impact have recent technological developments had on our daily lives?

eg. Digital watches, microwave ovens, T.V.s, VCR's, Home computers, Computer Games

On the Computer Industry?

eg. Increasingly greater power in smaller and smaller packages; Personal Computers replacing Mainframes; Increased Computerization of everything from personal income taxes to small businesses

On the World Economy?

eg. A great boost for heavily technological countries such as Japan and the U.S.

Evaluation Procedures:

A. Pre test

How many components were the students able to identify in their electronic devices and how much did they know about their uses?

B. Post test

Have each student present his project or report to the class. Have the class as a whole evaluate each student's project or report on the basis of difficulty of the material and the degree to which the student has shown his understanding of it.

Electronics: Suggested Readings

Reference:

Funk & Wagnalls Dictionary of Electronics, Funk and Wagnals, New York, 1969, 230 pp.

An alphabetically organized set of definitions of terms used in electronics, covering electronic equipment and concepts as well as symbols used in circuit diagrams. Clearly written and complete as far as publication date allows.

Introductory Reading:

Electronics for Young People by Jeanne Bendick and R. J. Lefkowitz, 5th Edition. McGraw-Hill Book Co., New York, 1973. 206 pp.

This little book gives a very good simplified introduction to electronics, beginning with an explanation of what electron tubes are, what they do, and how they do it. Next, the replacement of electron tubes by transistors is explained, followed by the miniaturization made possible by the silicon chip. The development and nature of lasers is also explained. The second half of the book describes how these elements of modern electronics have been put to use in industry, scientific research, and for our greater entertainment and convenience. This is a good introduction for the student with no prior background in electricity.

Electronics by Robert Irving, Alfred A Knopf, publ., New York, 1961. 173 pp.

This book presents clear and simple explanations of the development, use and performance of such familiar electronic equipment as television, radio, geiger counters, electron microscopes and radio telescopes. The book is certainly out of date with respect to present technology, but is interesting and enlightening from an historical point of view. It is written very clearly and simply with good illustrations. It is a good introduction for the beginner with little or no prior knowlege.

Science Projects with Electrons and Computers by Alfred Bender, Arco Publishing Co. Inc., New York, 1977. paperback, 139 pp.

This is an excellent introduction to electricity with a project and demonstration oriented approach which is particularly suited to firing the imagination of the gifted student. It is written in easy clear prose and illustrated with clear diagrams. It teached the basics of electricity in an exciting way by presenting instructions for such projects as building a Van De Graff generator, making a simple battery from a potato, electro-plating a spoon, and building an electromagnet which is later used as a component in an electric buzzer, a burglar alarm, and an electric motor. The final chapter shows how to make a simple analog computer and how it works. All projects are made from inexpensive, readily available materials. The text explains exactly what is happening electrically in each project.

This book is excellent for use either as a text or as a supplement to the text. It would be a useful guide for the teacher in putting together class demonstrations or for individual student projects. It is particularly appropriate for students who would rather learn by doing than merely read about a subject.

Electronic Kits and Projects:

The Boys' First Book of Radio and Electronics by Alfred Morgan, Charles Scribner's Sons, New York, 1966 (first published in 1954). 230 pp.

Although this book is technologically dated (often using obsolete radio tubes rather than the transistors and microchips used today) there is still a great deal of good information in very readable form on the history of the development of radio, wireless telegraph and wireless telephone. The first part of the book gives some historical and technical background on radios, while the second half of the book gives instructions on how to build your own radio receivers, amplifier, antenna and ground, and how to send and receive radio telegraph signals. The author has also published sequels to the book entitled, The Boys' Second Book of Radio and Electronics

The Boys' Third Book of Radio and Electronics, and

The Boys' Fourth Book of Radio and Electronics.

These are all good project-oriented books which might be useful for student projects.

Electronics for Everybody by Ronald Benray, Popular Science Publishing Co., Harper & Row, New York, 1970. 317 pp.

This book presents an introduction to the field of electronics by describing how the student can get started building any of a number of kits on his own, either using any of the kits available commercially (a list of companies and addresses is provided) or from scratch, by following instructions for simple projects available in books or magazines. Intercoms, timers, burglar alarms, hi fi stereos, radios, and musical instruments from electric quitars to organs are just a few of the electronic devices that come in kit form. The author tells clearly how to unpack your kit, read the printed circuit, set up a work schedule, mount components properly, and how to spot mistakes before you are finished. He includes names and addresses of companies that make electronics kits and explains where to obtain instructions and parts for projects one might like to build from scratch. He also describes what tools and instruments are needed and how to use them, as well as what equipment is not really needed. This is an excellent introduction to electronic project building for the serious and more advanced student.

Best Electronics Projects from Electronics Illustrated by Editors of Electronics Illustrated, Arco, New York, 1966. 112 pp.

This book presents step-by-step construction plans with wiring diagrams for a number of home electronics projects ranging from a socket light dimmer to building your own automatic telephone answering set. It includes projects for hi-fi buffs and instructions on how to install a CB radio and how to improve reception.

Because of the complexity of the material, this book is recommended for more advanced students who already have some background in electronics.

Additional Reading:

ABC's of Lasers and Masers by Allan Lytel, Howard W. Sams and Co., Inc., and The Bobbs-Merrill Co., Inc., Publ. , New York 1966. 128 pp. paperback.

This book explains what MASERS and light Masers, or LASERS are and some of their applications. At the time the book was written, many of the applications were only known to be possible in theory. Today thay are in common use. Requires some background understanding of physics or a willingness to look up unfamiliar terms.

Miracle Chip: The Microelectronic Revolution by Stanley L. Englebardt. Lothrop, Lee and Shepard Books, New York, 1979. 128 pp.

This book tells about silicon chips, the quarter-inch squares of silicon about the thickness of a credit card, which form the basis of a whole new technology in information retrieval, mini-computers, calculators, digital watches, and countless other microelectronic devises. The author explains how they were developed, how they work, what they can do, and how they are manufactured on space-age production lines. The text is clear and easy to read. This is an excellent source book for a written student report.

The Magic Chip: Exploring Microelectronics by Frank Ross, Jr. Julian Messner publ., New York, 1984. 160pp.

No larger than a child's thumbnail, the microchip is one of the greatest technological advances of the 20th century. It is used in all sorts of devices from heart pacemakers to all kinds of computers, robots, and military weaponry. This book presents an interesting and easily readable account of the invention and commercial development of the microchip. It explains how the chip works, why it is so cheap and versatile, and the changes it has brought to our society. This is an excellent source book for a written student report.

Magazines:

Computers & Electronics (formerly Popular Electronics) (out of print after 1985)

Discover

Popular Mechanics

Popular Science

Science 19-- (1981-86) and following years

Science News

Scientific American

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Unit VI. CONSERVATION

Introduction to Unit:

A. Scope and Sequence to be presented:

Yesterday

I. Pre-industrial Man and his impact on Nature

-The Hunter and Fisherman

-The Shepherd

-The Farmer

II. Man Against Nature

-History of Man's destruction of habitats, over-hunting, over-grazing, and introduction of foreign species in Europe, North America, The Antilles, South America, Asia and Malaysia, the Pacific, Australia, Africa, Madagascar and the Mascarene Isles, the Subantarctic Islands and the Seas

III. Man to the Aid of Nature

-History of the relatively recent Conservation Movement and its historical antecedents in North America, South America, Europe, Africa South of the Sahara, Asia, Australia and Neighboring Territories and beginning attempts at International Cooperation

Today

IV. The 20th Century Population Explosion

-Man and population growth before modern times;

Man since the beginning of modern times, expected population growth in the near future; Population and livelihood; Medical and social results of human swarming.

V. Man's Destruction of the Land

-Natural and Accelerated erosion

-Forms of accelerated erosion; Deforestation; Brush fires; Overgrazing; Bad agricultural practices, Erosion and water control; Destruction of aquatic habitats;

Will erosion defeat Man?

VI. Pests and Pesticides

-Principal insecticides in use;

-Abuse of insecticides

Toxicity to animals

Toxicity in relation to plants

Effect on the soil

Delayed effects

Disturbances in biological balances

-Resistance of insects to insecticides

-Chemical warfare against undesirable plants

-Rational use of chemical weapons

VII. Pollution by waste products

-Pollution of fresh waters

-Pollution of the seas

-Atmospheric pollutions

-Radioactive pollutions

VIII. Artificial biological communities

- -Imported plants
- -A harmful mollusk: The Achatina or Giant African Snail
- -Fishes and other aquatic animals
- -Transportation and acclimatization of insects
- -The Starling and other airborne invaders
- -The Rabbit in Australia
- -Mammals as Man's accomplices
- -The devastation of New Zealand by imported animals

IX. Pillage or Rational Exploitation of Maritime Resources

- -Hallibut fishing
- -The problem of the Pacific sardine
- -The Hake
- -The Herring problem
- -Fishing in the North Sea
- -Limitations on overfishing
- -Whale Hunting and its regulation
- -The crustacian problem
- -The mollusk problem
- -Sea turtles
- -The dangers of sport fishing and underwater hunting
- -Marine resources in the future

X. Man in Nature

-The great dangers menacing man and nature in the
  - modern world
  - The Population Explosion
  - Land waste

-Rational Land Use
  - Conservation of primitive habitats
  - Rational management of cultivated lands
  - Management and rational use of marginal zones:
    - Rational management and use of large terrestrial mammals, both in temperate zones and in Africa
    - Rational exploitation of Marine mammals and birds:
      - Seals and walruses
      - Guano birds
    - Nature and tourism to the rescue of human health
  - Threatened species survive in captivity
    - Breeding in captivity
    - Transplanting threatened species

-Towards a reconciliation of man and nature

B. Key Materials to be Used:

<u>Before Nature Dies</u> by Jean Dorst. (translated by Constance D. Sherman) Houghton Mifflin Company, Boston, 1970. 352 pp.

The above outline is taken from this book. The book is suggested as a source book for lecture material for the teacher and/or report material for the students. Advanced reading level.

This is a comprehensive and detailed book which treats the entire earth as a single unit. Dorst explores the unforeseen ramifications of men's actions throughout nature--for example, the historical process of soil degradation, through bad agricultural practices and accelerated erosion, and the uncontrollable ravages of introduced animals. He brilliantly illuminates the side effects of the Industrial Revolution--the progressive poisoning of the earth's seas, rivers, and atmosphere by vast quantities of industrial waste--and of the Scientific Revolution--the disruption of delicate biological balances caused by the indiscriminate use of pesticides.

In many ways man's understanding of his fragile environment remains as rudimentary as that of an early nomad, and yet his technological advances have made it possible for him to have a far greater effect on his environment. He may deplore the wanton slaughter of the huge herds of buffalo of the American West in the last century, but at the same time he continues to poison the world with chemicals and undustrial effluents.

The preservation of wildlife is only one of the most obvious aspects of man's need to protect the world's dwindling natural resources from man's stupidity. The population explosion makes the continuation of man's present pattern of behavior suicidal. Nature reserves and national parks are not enough. Man must develop on international policy of restraint and a program of land management and environmental control. This book suggests ways in which man can learn to live in harmony with nature, before nature dies.

Background Narrative:

Students will learn about man's impact on Nature from his beginnings through modern times. Pre-industrial man was able to make a living by studying nature and working with nature hunting and gathering for the food and materials that he needed to live and mak himself comfortable. As man learned more about nature, he was able to domesticate and breed animals for food and eventually to cultivate certain plants for food. As long as man was a nomadic hunter, he moved from one place to another, living lightly on the land, in harmony with nature. With the advent of farming, it became possible for man to establish permanent year-round settlements. As farming became more successful, more people could live in a smaller area, and man began to have more of an effect on the land. Now he built his homes of more durable materials, such as logs and stones, and cut down forests to create fields for agriculture. Nevertheless, the work of taming nature to his ends was laborious, and man seldom used more than he needed.

It was with the advent of the industrial revolution that man first developed the ability to really control nature in a big way. He developed the ability to build huge dams for hydro-electric power, changing the ecology of huge areas by flooding and forming artificial lakes. With the invention of powerful guns, man was able to eradicate huge herds of millions of buffalo in the American West. When western europeans came to the Caribbean islands, they destroyed the entire ecology of whole islands by cutting down the native plants and introducing large plantations of new plants from the old world such as breadfruit, mangoes, and sugar cane for food and cash crops. Many of the native species of birds and mammals living on these islands became extinct as a result of man's activities. The same story has been repeated in many other parts of the world as areas were colonized by western man. Species introduced by man, such as rats, rabbits, foxes and mongooses have wrought havoc on native ecosystems, upsetting the natural balance and reproducing out of control until the habitat cannot support even themselves.

Students will learn how bad agricultural practices on a large scale have caused erosion to such a degree that once lush habitats have been transformed into virtual desserts. They will also see how man is poisoning land, air, and water with pesticides, and with the waste products of an industrial society. Over-fishing, possible because of technological advances and over-population of humans is threatening to destroy the ecological balance of the seas. For most of man's history, he has worked to develop new technologies to improve the efficiency with which he is able to subdue nature to his own purposes. Now he must learn to work with nature to restore the balance that he has upset before his own run-away population explosion and his careless land and water management practices reduce the entire earth to a dessert.

Major Learning Objectives:

The object of this unit is for students to gain an awareness of the problems and issues in Conservation and how advances in technology have created, and continue to create, imbalances in the ecosystems of the Earth beyond the Earth's abilities to heal itself. They should also become aware of some of the ways in which modern technology can be used to help to correct the imbalances that have already occurred. Students should understand that with Man's new capacity for changing the earth, he must now assume a responsible role of stewardship over the planet's resources, before he destroys the planet's very ability to sustain him.

Major Learning Experiences:

1) Visit a wildlife sanctuary, wildlife conservation area or a game farm. Addresses and directions are available through the State Department of Natural Resources, Division of Fish and Wildlife; The Nature Conservancy, State Tourist Information Services, or State or Federal Parks Service. What type of ecosystem(s) are being preserved there? Are the natural resources of the area only being preserved or are they also being used for recreation (hiking, canoeing, swimming, skiing, etc.), hunting, fishing, logging, or for mineral or water resources? How does the area provide a home for year-round birds and mammals? What about migratory species?

2) Using an atlas, have the students create a map of your state, indicating all of the different ecological zones. Have them next indicate which areas are heavily populated, what areas are being farmed, mined, logged, or otherwise exploited, and what areas have been left natural. The state cooperative extension service should be able to provide such information. How much habitat is left for native species of plants and animals to thrive?

3) Introduce the following subjects and questions for class discussion:

> How has our growing understanding of the the complex interactions in an ecological system affected Man's use of land and water resources?

The Conservation Movement: In the U.S. and Worldwide

How have different U.S. administrations affected attempts at Conservation?

What effect does a democratic system of making funding decisions have on long-term Conservation goals?

In what ways do conservation decisions made in one state affect conditions in another state? What about neighboring countries?

Why do we need a global policy of management for the Ocean's resources rather than individual national policies?

When the Chernobyl nuclear power plant meltdown occurred, the Russian government was severely criticized for not promptly reporting the nature and extent of the problem to neighboring nations. What business was it of theirs?

What is meant by "Government Accepted levels" of radioactivity and of various chemical pollutants in air, soil and water? How are such levels determined?

Why is a multi-national effort needed to protect migratory birds from extinction?

Many zoos in the world have begun an attempt to preserve species from extinction by keeping colonies of endangered species alive in captivity until such time as their habitat can be restored and they can be restored to the wild. Because of the present rate of habitat destruction and human population growth, some scientists estimate that species may have to be kept in captivity for 500 to 1000 years in order to escape extinction.

Have the class debate the probability of such a plan succeeding.
Consider the problems of:

inbreeding within the zoo stock,

the possibility of freezing viable sperm and eggs
the importance of behaviors learned from parents
the problem of maintaining any policy for such a long period of time
the difficulty of restoring an entire ecosystem once it has disappeared

Evaluation Procedures:

A. Pre test

Have the students write one page answering the question, How has our country's growing technological development affected our Natural Resources?

B. Post test

Have the students write one page answering the question, How can we put our technological skills to work in protecting and preserving our Natural Resources?

Conservation: Suggested Readings

<u>Hunger on Planet Earth</u> by Jules Archer. Thomas Y. Crowell Company, New York, 1977. 216 pp.

This book discusses the problem of a world population that is growing at a greater rate than the world's capacity to produce food. As the problem becomes more and more acute, starvation and malnutrition spreads, so that it affects not only the underdeveloped countries in Africa, Asia and South America, but also the poor in American cities.

The problem is both urgent and complex, with each possible solution containing the seeds of conflict. The hoped for "Green Revolution" cannot be accomplished without the use of costly and polluting fertilizers. The United States and other food-rich nations use the promise or withholding of food aid to enforce their own foreign policies in poor nations. Some of the food aid offered is inappropriate for the people involved, either because of cultural or religious opposition, or because the recipients are unable to tolerate the food offered (eg. lactose intolerance).

Nevertheless, Archer warns, the problem must be faced and dealt with before the entire world erupts in a huge series of wars between the food-rich nations and the starving people of the world.

Intermediate reading level, excellent source for report material.

<u>Conservation: The Challenge of Reclaiming Our Plundered Land</u> by C. William Harrison, Julian Messner, New York, 1973. 192 pp.

Through the eyes and exploits of pioneers and railroad tycoons, of miners and sod-busters, of hunters and industrialists, this book tells the shameful story of the destroyers and plunderers of America's natural bounties, from the time of the conquistadors up to the present day. Woven through this chronicle of destruction is another story--the adventures and achievements of those men of vision who fought to preserve and restore our natural resources so that all might enjoy them. Their battles against vested interests--and at times an indifferent public--gave birth to the conservation movement in America. The author tells with remarkable clarity why the battles of conservation are never finished, and how the resources of . ture can benefit or jeopardize our lives, depending upon ~w wisely we use them.

<u>What Shall We Do with the Land?: Choices for America</u> by Laurence Pringle. Thomas Y. Crowell, New York, 1981. 152 pp.

This book, written by the same author as <u>Water: The Next Great Resource Battle</u> is about potential uses and choices that must be made in land use issues in the United States. America is a land-rich country compared to many other countries, with an average of ten acres per person in 1980. Furthermore, most of our population is actually concentrated on only 3 percent of the total land area. This book deals only indirectly with land use questions in the cities and suburbs. Concentration is on the 2.18 billion acres of farms, pastures, range, forests, deserts, canyons, mountains, barrier islands, and coasts. This is the land that sustains us with food and materials, and also with recreation, beauty, and solitude. Clearly, decisions to use the land in one way often eliminate the possibility of its being used in another way, sometimes forever. Particularly as our population expands, we must make careful and responsible decisions about land use that we and our children's children will be happy with in the future.

Easy to read. A good resource for report material.

Water: The Next Great Resource Battle by Laurence Pringle. MacMillan Publishing co., inc. New York, 1982. 144 pp.

This book discusses the importance of water to life, and its present uses in the United States. Though the United States is primarily a water-rich country, increases in per capita water use for non-essential purposes, such as lawn irrigation, swimming pools, flush toilets with large tanks, and leakage due to worn out city water systems have caused shortages even in areas that receive 45 inches of rainfall per year. The Southwest has encountered a much more serious problem, particularly in cities like Phoenix and Tucson, in which ground water was being used five times more quickly than it was being replenished. Here and in Florida, sections of land have caved in due to the removal of ground water that they had been resting on. The contamination of ground water by chemical wastes has also reduced the usable water supply in some areas.

The solutions which Pringle offers range from towing iceburgs from Antarctica to California to developing a more conservationist attitude toward water use. He points out for instance that drip irrigation requires 50% less water and actually produces as much as 40% more produce, since less water is lost to evaporation and fewer weeds are able to grow between the rows. Another possibility is to run two separate water lines: One for washing, watering, and sewage, and another for drinking and cooking. Intermediate reading. A good source for report material.

The Frail Ocean by Wesley Marx. Coward-McCann, Inc., New York. 1967. 248 pp.

Marx discusses the vulnerability of the world's oceans, and our dependence on them for food, recreation, and transportation (both commercial and military). He discusses the long prevailing attitude that the oceans are so immense that they are impervious to any insult that man has the power to visit upon them, and points out that nevertheless, man now is in fact destroying the offshore life along vast stretches of shoreline through his own ignorance and lack of foresight. He describes the ruin of kelp forests off the coasts of California, the increasing frequency of the "red tide" off the Florida coast (a diatom that poisons all of the fish life for as long as months at a time), and the smothering of seabirds and beach life in crude oil from wrecked oil tankers. In many cases, people are not even aware of what is causing their seas to lose their vitality or become poisoned, and are all too willing to point an accusing finger elsewhere. Marx points out that often the problem is a complex one, requiring detailed research on the ecology of the ocean, beaches, and estuaries. "Quick fix" solutions such as damming all of the Florida rivers to control the "red tide" (which is fed by river effluent) might destroy the estuaries which are the nurseries of the commercial fisheries.

Marx discusses the problems caused by the lack of coordination between the various U.S. government agencies involved in different projects concerning the sea. For Example, the Navy may booby trap an area that contains valuable sea beds administered by the Dept. of the Interior which has approved the drilling of off-shore oil wells which in turn make the area unsafe for navigation. Or the Corps of Engineers excavates estuaries for deep-draft vessels in an area that the Bureau of Commercial Fisheries is seeking to protect as a nursery. If the government of a single nation cannot agree on the uses of the oceans, how much harder is it for different nations that border on an ocean to agree.

This book is of intermediate difficulty to read, the problems presented usually carrying one through the chapters to see what solution, if any is reached. For Marx, the ultimate challenge is to find a political solution to the government of the oceans so that while they may be exploited for man's profit, they will also be protected from "the passions of exploitation, the abuses of one-eyed technology, the tensions of the cold war, the nagging distrust between poor nations and rich, and, not least of all, human carelessness".

Wildlife Conservation by Ira N. Gabrielson. The Macmillan Co., New York, N.Y., 1959, 2nd Edition. 237 pp.

This book, first written in 1941, discusses the effects of U.S. farming practices on the already dwindling wildlife, and the need for a more humane policy toward this (often unappreciated) valuable resource. He warns that people need to take into account the effects of modern methods of agriculture on our wildlife. He discusses the interrelatedness of wildlife to soil conservation, water conservation and the conservation of forests and grasslands. He explains the situations affecting migratory and resident game as well as non-game birds and mammals, and he discusses the plight of vanishing species. He includes fly-way maps for migratory species and maps of breeding areas of many waterfowl, and explains that in order to preserve game species (as well as any other species), we must take their life histories into account. We cannot drain swamps where waterfowl breed in order to produce more farmland and still expect to have an abundance of these species to hunt in the fall. We cannot destroy the over-wintering areas of game birds by building new cities and recreation areas in Southern Florida and still expect large numbers ofthose same species to appear in Eastern Maryland and New Jersey for the Fall hunting season.

Aside from the wealth of information presented, this book is interesting from an historical perspective, because it gives an indication of conservation issues and conditions in this country in the '40s and '50s which can be contrasted with present issues and conditions.

Reading level is advanced. May be more useful as a source of lecture material for the teacher than as a book for students to read on their own.

Animal Rescue: Saving our Endangered Wildlife by William Wise. G. P. Putnam's Sons, New York, 1978. 95 pp.

This book, written on an intermediate level, discusses the problem of endangered wildlife and attempts to save a number of endangered mammals, including the American Bison, the Pacific sea otter, beavers, prairie dogs and pronghorn antelope. The plight of several species in other parts of the world is also documented, including the tiger, the Indian rhinoceros and the koala bear. Protection from hunting is important, but is only a first step in many cases. Many species suffer because of habitat degradation or destruction and the encroachment of man. This book discusses the battle of conservationists to rescue endangered wildlife, through bans on hunting, setting aside reserves where animals will be undisturbed and, if all else fails, preserving populations of the endangered species in zoos.

The book does not deal with the thousands of smaller and less noticeable species that are endangered by habitat destruction, nor with the fact that ecosystems are interlocking systems, with plant, insect, bird and mammalian species all dependent one another in countless subtle ways. It may well be that Pere David's deer and other species may be "saved" from extinction by being kept alive in zoo populations, but if their habitat cannot be restored to a level whereby it can support them, they can never be reintroduced into the wild.

The Pursuit of Wilderness by Paul Brooks. Houghton Mifflin Co., Boston, 1971. 220 pp.

This book presents and discusses various battles which have taken place or are still taking place between those who would preserve and protect large tracts of wilderness habitat on the one hand and those who would exploit and "develop" these areas on the other. Three major areas in the United States and one area in Africa are examined in some detail, along with various plans proposed for their "development" and what the enactment of these plans would mean for the people and wildlife now living there. For example, the author discusses the controversy over Project Chariot, a proposition made by the Atomic Energy Commission in the late 1950's to construct a large bay in northern Alaska by means of a chain reaction of five nuclear blasts, supposedly to improve fishing and to create a port (in an area ice-locked for 9 months of the year!) for shipping substantial amounts of coal and oil. The true purpose of this project was apparently really to obtain data on crater-producing nuclear detonations, with no apparent concern or interest in the devastating and long lasting effects that such a massive blast would have on the environment or the poeple living there. The mentality behind such propositions, evidenced also in the plan proposed by the Army Corps of Engineers to create the largest artificial lake in the world by damming the Yukon river, in order to create the largest hydroelectric power plant in this country, appears to be to do things which will have a huge effect on the land, simply for the power of doing them, rather than because a power plant or a port is needed or is more desirable than what the untouched land itself has to offer. Similar projects, which would destroy huge areas of natural land and which would serve little practical purpose aside from "progress", or development for development's sake are discussed in other chapters of the book.

Brooks points out that wild areas have a beauty and value of their own that can never again be recaptured when once they have been destroyed. He discusses the conservationist movement and urges people to keep up the good fight, "For our need to understand the world of nature signifies something in us deeper than mere curiosity. Here, we feel, is some statement of the truth, if only we have the wisdom to read it.".

The book is engaging and easy to read. Each chapter takes on the flavor of a mystery story as one reads on to see what the motives are of the different actors in the drama, and whether or not the dastardly deed will in fact be committed.

What's a Wilderness Worth? A Story of Environmental Action by Anne Stewart. Dillon Press, Inc., Minneapolis, 1979. 104 pp.

This short and simply written book describes a very special and beautiful natural wildlife area in northern Minnesota known as the Boundary Waters Canoe Area Wilderness (BWCAW). This is a land of sparkling lakes and magnificent pine forests, where loons and moose can still live undisturbed. No roads may be built in this area, and no motorized boats or vehicles are allowed. It is one of the most well-preserved and unexploited natural regions in America.

This forest-lake region along the U.S. boundary with Canada was once home to the Ojibway Indians who hunted and harvested wild rice and maple syrup there. Later, European fur traders and trappers worked the area until it was nearly depleated of its natural fur-bearers, a food source for the native Indians. Later, loggers and miners wanted to exploit the vast supplies of timber and minerals in the area.

As it became clear that the forest was being leveled faster than it could renew itself, some began to consider the need to replant logged areas and to leave some areas uncut for people to enjoy and for forest managers to study. The book tells the story of how the BWCAW was first set aside for preservation as a natural area and the various battles that have occurred over subsequent decisions as to its preservation and management. The book presents a strong argument for leaving some areas completely natural and undeveloped.

Periodicals:

Defenders of Wildlife

Discover

Conservation

Science 19-- (1981-1986 and following years)

Conservationist

Environment

Scientific American

International Wildlife

National Parks and Conservation

National Wildlife

Oceans

Successful Farming

World Health

Television Programs:

Wild Wild World of Animals

Nature

Wild America

National Geographic Specials (those dealing with wildlife and conservation)

Jacques Cousteau's Odessey

Curriculum Development for the Gifted in Science

Excellent science curriculum materials for the gifted were produced in the 1960's, including BSCS biology, ISCS, Chem Study, IPS, and PSSC physics. These "new science" materials were regarded as inappropriate for most students; the emphasis on learning by *doing* was time-consuming, the reading too demanding, the conceptual orientation of the materials too difficult. These "shortcomings" of the l960s curricula are precisely the characteristics that make them an appropriate foundation for a gifted science curriculum today.

Admittedly, existing materials must be adapted to reflect the accelerated rate of development of new information in the sciences resulting from the enormous technological advances of the intervening decades. Further, the role of technology as a tool for gifted learners must be considered. In addition, when coupled with a rigorous mathematics program, an appropriate science program for gifted adolescents could rely more heavily on mathematical methods.

Students who have outstanding abilities in science are ready, by the time they reach grade 6, for a program which fosters a deep understanding of the major science areas while emphasizing that science is a dynamic, creative field (Martin, l979). Rapid change, advanced technology, and the use of more sophisticated mathematics must be incorporated into the curricula while retaining a strong *conceptual* focus and an emphasis on problem finding, problem solving, evaluation, and reporting. A major goal should be to give student an understanding of scientific thought as it actually occurs among scientists (Sternberg, l982).

The overall aim is the development of curriculum that will facilitate the learning of both the content and methods of the sciences in grades 6-l2, yet that is adaptable to an independent study format with the guidance of a qualified mentor (see Pyryt, l979).

Science Scope and Sequence

Table 2 describes a possible scope and sequence of courses in the physical and life sciences covering grades 6 through l2 that would be appropriate for academically gifted adolescents. Science coursework that is typically available to high school students (biology, chemistry, and physics) are included in this curriculum; however, students would begin the formal study of specific science subjects such as biology and phsyical science at the junor high level, allowing them to take more science courses and to achieve advanced placement credit for science subjects during high school. This curriculum in its entirety is particularly appropriate for students who wish to enter honors science programs at the university level, for students who wish to pursue further study in college in an integrated science program (involving more than one subject), for students who plan a career that involves major intensive study in several science fields (e.g. bio-physicist), and for students who plan to pursue study in a science field to the doctoral level.

Table 2
Science Scope and Sequence:
Appreciation of Science (the History and Development of Scientific Systems)

Major Themes	Grade Levels and Courses						
	6 Philosophy of Science and Technology: The Scientific Method	7 IPS Physical Science	8 BSCS Biology	9 AP Biology	10 Honors Chemistry	11 Physics (PSSC)	12 Course Options: AP Physics/ AP Chemistry/or Geology
History of Science	X						
Cycles of Nature			X	X			
Doctrine of Limit (Conservation of Energy-Minimization of Entropy)		X			X		
Growth, Development, and Transformation		X	X				
Interdependence	X		X			X	
Humans as Actors/ Reactors in the World	X	X	X	X	X	X	X
Moral and Ethical Dimensions of Science	X			X			X

The science curriculum would begin in the sixth grade with a course in the history and philosophy of science with a particular emphasis on the scientific method and its component skills of critical and deductive thinking. The scientific method *as a process* would be introduced to students at this level but would be a major recurrent theme for the next five years. Entry into and exit from the curriculum would be flexible depending upon each student's interest and ability level and career or college goals. High school credit for courses taken at the junior high level would be accomplished via proficiency examinations in each content area by the local schools, perhaps through the use of College Board achievmenet tests.

Incorporated into the science curriculum for gifted students is an emphasis on the major ideas or concepts within both the physical and biological sciences as determined by scientists within those fields (Shane, 1981). These include: the cycles of nature; interdependence; growth, development and transformation; and humans as actors and reactors in the physical world.

An emphasis on these ubiquitous concepts would elucidate the structure of the individual science disciplines as well as their interrelatedness. Objectives of the science curriculum would be to give students information about the scientific advances that are at the cutting edge of knowledge in the field, as well as to teach them the methodology of research and scientific inquiry.

Curriculum Development in Technology

Science curriculum for the gifted should include a strong component on technology, its history and development as a field. This component can emphasize the linkages and con-commitancy between advances in science and technology. That is, since science typically provides the underlying knowledge base for technology, each science content area (physics, biology, and chemistry) would include separate units focusing on the technological advances that have been possible as a result of specific discoveries within that content area. These units have been developed independently so as to be easily integrated into the study of the content area where appropriate, for example, when students have sufficient knowledge of the underlying scientific basis to permit a thoughtful and indepth examination of some of the technological results. The impact of technology on furthering scientific discoveries that make a contribution to the knowledge base or the reciprocity between science and technology (e.g., the telescope causing a revolution in astronomy) are also examined.

Woven throughout these curriculum units is an emphasis on overarching and recurrent themes and issues that relate to the field of technology as a whole and to specific technologies somewhat more cogently or urgently. These include the power of technology as a force which causes exponential growth; the impact of technology on society (movement from an industrial society to an information society); the results of technology: societal progress versus societal regression; the effect of technological technology: societal progress versus societal regression; the effect of technological advances on the quality of life; and the strategies that society and individuals can employ (problem-solving, problem prediction, decision making) to cope with the rapidity of changes wrought by technological and scientific advances and their potential results.

Conclusion

It is clear that a new way of conceptualizing for the gifted curriculum in mathematics and science is necessary to address the needs of this population in the context of a rapidly changing society. As educators of the gifted becomes more informed about applications of new advances in learning theory, and more sophisticated about integrating complex concepts and skills in a curricuium for the gifted, there may emerge an appropriate curricular response to the public demand for greater emphasis on mathematics and science education in secondary school programs. These course guides represent an attempt to move in that direction.

References

Adler, I (1966). The Cambridge Report: Blueprint or fantasy? The Mathematics Teacher, 59, 210-217.

Conference Board of the Mathematical Sciences, National Advisory Committee on Mathematics Education. (1975). Overview and analysis of school mathematics, grades K-12. Reston, VA: National Council of Teachers of Mathematics.

Implementation Issues

The use of new curriculum materials with any group of learners raises real questions about how to pursue appropriate implementation. The following issues may be relevant to considering these materials for inclusion in your gifted and talented program:

1) Pilot testing

Given the flexibility in the use of these materials in respect to grade level, it may be important to pilot test a given unit with your target group of learners prior to using the entire course guide. Some groups may be abe to handle the material at 6th grade while others may not be ready until 8th grade. Groups of gifted children vary tremendously in respect to readiness. Also it may be that certain types of activities are more successful with particular groups of learners. A form is included in this guide that you may use to aid you in the pilot testing effort. We would be pleased to hear of your results as well.

2) Small group activities

It is recommended that the majority of the activities in this guide be carried out in small groups where 3-5 gifted students have the opportunity to read, react and discover learning for themselves. Many of the problem-solving tasks should be seen as group efforts where in-class contact time is limited. Organizing small group work outside of school may be desirable.

3) Independent activities

The course guide includes many activities that are oriented toward independent study. In fact, the guide has been structured to provide individual students the opportunity to complete the course on their own. However, it is quite important that a mentor be assigned to meet periodically with the student to check progress and provide encouragement. Independent activities should be perceived as an integral part of the course design with several alternatives built-in for students at various stages.

4) The role of the instructor

If the focus of learning for this course is to occur in small groups and independently, then the role of he instructor must be as a facilitator of learning and collaborative in nature. The most important criteria for teachers of this course for the gifted are:

a) in-depth knowledge of the subject matter
b) interest and enthusiasm for working with academically talented young people
c) flexibility in managing a program of study that varies from the typical one offered in school.

In order to find individuals who exhibit these qualities, it may be necessary to recruit from the high school level or from the community. Community mentors could be quite useful in getting this type of program underway.

5) <u>Administrative Models for Implementation</u>

In implementing this curriculum, it is important to think about the variety of ways it might be used with gifted learners. Possiblities abound from the opportunity for use in self-contained gifted classes at the seventh grade in math/science to use as an independent study option. The following types of organizational arrangements, however, seem to be optimal, given the nature and scope of the guide:

a) <u>Use as a supplement in junior high classes</u>

The course guide could be thought of as providing readings, projects, and activities in a topical area not covered by standard textbooks and yet useful for the gifted to have exposures to and understanding of. Thus, it could be infused into a gifted or honors section at the middle school, or junior high school level. The class instructor would work directly with the targeted students.

b) <u>Use as a special one-day a week program in addition to the regular school class in science/mathematics.</u>

If community mentors or university personnel are available, the course could be offered as a two hour per week intensive for talented learners at school or at some other central location. Students could then spend two hours outside of class reading and working on related projects. And the class could be organized across school district lines so that <u>only</u> the most able and the most interested would become participants. In rural and suburban areas, this approach may be very feasible.

c) Use as an independent study option at the middle school/junior high school level

The course guide could be used as a self-standing tool for students who are interested in exploring the specific topic under consideration. An advisor would need to be assigned by the school to facilitate student progress and provide evaluative feedback. Some opportunities for community-based contacts would also need to be considered, as one of the values of the materials is encouragement for students to apply the ideas presented in real world situations.

As school personnel consider the use of this course guide, we urge you to remain flexible in your thinking regarding how it may best be utilized in your school district. Remember that all curriculum for the gifted must be adapted to special settings and local constraints. We hope the use of such materials as these will be worth your efforts to make it happen in your school context.